Soil Salinization Hazards Associated with Devils Lake Flood Damage Reduction Alternatives

Sheyenne River Valley

Appendix B

January 22, 2002

Prepared for:

ST. PAUL DISTRICT
UNITED STATES ARMY CORPS OF ENGINEERS

Task Order Number: DACW37-00-D-004 (2;Partial Fullfillment)

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Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND003	Barnes County	2	Tonka Silt Loam	Tonka	80	P	1	Argiaquic Argialbolls, Fine, Montmorillonitic, Frigid	Vallers	12	Y
									Parnell	4	Y
									Hamerly	4	N
ND003	Barnes County	36	Fargo Silty Clay	Fargo	90	P	1	Typic Epiaquerts, Fine, Montmorillonitic, Frigid	Dovray	5	Y
									Lismore	3	N
									Ryan	2	Y
ND003	Barnes County	43	Gardena Silt Loam	Gardena	90	MW	1	Pachic Udic Haploborolls, Coarse-Silty, Mixed	Egeland	4	N
									Glyndon	3	N
									Overly	3	N
ND003	Barnes County	54	Lamoure Silt Loam, Channeled	Lamoure	80	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Colvin Channeled	9	Y
									Marysland	6	Y
									Rauville	3	Y
									Colvin, Saline	2	Y
ND003	Barnes County	56	Ladelle Silty Clay Loam	Ladelle	75	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Fairdale	18	N
									Sinai	5	N
									Lamoure	2	Y
ND003	Barnes County	62	Overly-Bearden Silty Clay Loams	Overly	73	MW	1	Pachic Udic Haploborolls, Fine-Silty, Mixed	Gardena	3	N
									Fordville	2	N
				Bearden	22	SP	2	Aeric Calciaquolls, Fine-Silty, Frigid	Gardena	3	N
									Fordville	2	N
ND003	Barnes County	82	Sinai Silty Clay Loam, 0 To 2 Percent Slopes	Sinai	80	MW,W	1	Typic Hapluderts, Fine, Montmorillonitic, Frigid	Nutley	18	N
									Ladelle	2	N
ND003	Barnes County	82B	Sinai Silty Clay Loam, 2 To 6 Percent Slopes	Sinai	80	MW,W	1	Typic Hapluderts, Fine, Montmorillonitic, Frigid	Edgeley	10	N
									Nutley	10	N
ND003	Barnes County	85	Exline Silty Clay Loam	Exline	80	SP	1	Leptic Natriborolls, Fine, Montmorillonitic	Overly	10	N
									Nahon	10	N
ND003	Barnes County	89	Fordville Loam, 0 To 3 Percent Slopes	Fordville	85	W	1	Pachic Udic Haploborolls, Fine-Loamy Over Sandy Or Sandy-Skeletal, Mixed	Divide	7	N
									Gardena	5	N
									Glyndon	3	N
ND003	Barnes County	9	Nutley Silty Clay, 0 To 2 Percent Slopes	Nutley	95	W	1	Chromic Hapluderts, Fine, Montmorillonitic, Frigid	Fargo	5	Y
ND003	Barnes County	90	Dovray Silty Clay	Dovray	85	P,VP	1	Cumulic Vertic Epiaquolls, Fine, Montmorillonitic, Frigid	Fargo	9	Y
									Hegne	6	Y
ND003	Barnes County	9B	Nutley Silty Clay, 2 To 6 Percent Slopes	Nutley	95	W	1	Chromic Hapluderts, Fine, Montmorillonitic, Frigid	Edgeley Var.	3	N
									Fargo	2	Y

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ND039	Griggs County	1062	Ladelle Silty Clay Loam, 0 To 3 Percent Slopes	Ladelle	67	W	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Wahpeton	15	N
									Laprairie	7	N
									Ludden	4	Y
									Rauville	4	Y
									Velva	2	N
									Lamoure	1	Y
ND039	Griggs County	1188	Ludden Silty Clay	Ludden	87	P	1	Typic Endoaquerts, Fine, Montmorillonitic, Frigid	Ludden, Saline	6	Y
									Ladelle	4	N
									Rauville	2	Y
									Lamoure	1	Y
ND039	Griggs County	1189	Ludden Silty Clay, Saline	Ludden	64	P	1	Typic Endoaquerts, Fine, Montmorillonitic, Frigid	Ludden, Nonsaline	22	Y
									Ryan	11	Y
									Lamoure	1	Y
									Ladelle	1	N
									Rauville	1	Y
ND039	Griggs County	1710	Southam Silty Clay Loam	Southam	79	VP	1	Cumulic Vertic Endoaquolls, Fine, Montmorillonitic (Calcareous), Frigid	Parnell	11	Y
									Vallers	5	Y
									Water	2	Y
									Colvin, Vpd	2	Y
									Colvin, Saline	1	Y
ND039	Griggs County	2156	Lamoure And Rauville Silt Loams	Lamoure	62	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Velva	3	N
									Marysland	3	Y
									Divide	1	N
									Harriet	1	Y
									Vallers	1	Y
									Fairdale	1	N
				Rauville	28	VP	2	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Marysland	3	Y
									Velva	3	N
									Fairdale	1	N
									Harriet	1	Y
									Vallers	1	Y
									Divide	1	N
ND039	Griggs County	2196	Bearden And Colvin Silt Loams, Saline	Bearden	35	SP	1	Aeric Calciaquolls, Fine-Silty, Frigid	Bearden, Nonsaline	8	N
									Colvin, Nonsaline	4	Y
									Harriet	2	Y
									Exline	2	N
									Perella	1	Y
									Colvin Saline, Vpd	1	Y
				Colvin	47	P	2	Typic Calciaquolls, Fine-Silty, Frigid	Bearden, Nonsaline	8	N
									Colvin, Nonsaline	4	Y
									Exline	2	N
									Harriet	2	Y
									Colvin Saline, Vpd	1	Y
									Perella	1	Y

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND073	Ransom County	1043	La Prairie Loam	La Prairie	80	MW	1	Cumulic Udic Haploborolls, Fine-Loamy, Mixed	Fairdale	12	N
									Fordville	4	N
									Laprairie, Channeled	3	Y
									Rauville	1	Y
ND073	Ransom County	1055	Ladelle Silt Loam	Ladelle	91	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Lamoure	4	Y
									Laprairie	2	N
									Ladelle, Channeled	2	N
									Rauville	1	Y
ND073	Ransom County	1081	Lamoure Silt Loam	Lamoure	81	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Colvin	6	Y
									Marysland	4	Y
									Lamoure, Channeled	4	Y
									Darnen	2	N
									Ladelle	2	N
									Rauville	1	Y
ND073	Ransom County	1472	Rauville Silty Clay Loam	Rauville	80	VP	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Marysland	15	Y
									Lamoure	5	Y
ND073	Ransom County	2215	Fairdale Loam, 0 To 6 Percent Slopes	Fairdale	81	MW	1	Mollic Udifluvents, Fine-Loamy, Mixed (Calcareous), Frigid	Laprairie	13	N
									Ladelle	3	N
									Fairdale, Channeled	3	N
ND073	Ransom County	772	Gardena-Eckman Loams, 0 To 3 Percent Slopes	Gardena	60	MW	1	Pachic Udic Haploborolls, Coarse-Silty, Mixed	Overly	7	N
									Zell	3	N
									Glyndon	3	N
				Eckman	27	W	2	Udic Haploborolls, Coarse-Silty, Mixed	Overly	7	N
									Glyndon	3	N
									Zell	3	N

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ND091	Steele County	1062	Ladelle Silty Clay Loam, 0 To 3 Percent Slopes	Ladelle	76	W	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Laprairie	8	N
									Wahpeton	4	N
									Dovray	4	Y
									Rauville	4	Y
									Velva	3	N
									Lamoure	1	Y
ND091	Steele County	2156	Lamoure And Rauville Silt Loams	Lamoure	60	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Colvin	4	Y
									Marysland	4	Y
									Fairdale	2	N
									Vallers	1	Y
									Divide	1	N
				Rauville	28	VP	2	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Colvin	4	Y
									Marysland	4	Y
									Fairdale	2	N
									Divide	1	N
									Vallers	1	Y
ND091	Steele County	2158	Velva Fine Sandy Loam, 0 To 6 Percent Slopes	Velva	84	W	1	Fluventic Haploborolls, Coarse-Loamy, Mixed	Laprairie	8	N
									Banks	5	N
									Fairdale	2	N
									Lamoure, Channeled	1	Y
ND091	Steele County	452	Colvin Silt Loam, Saline	Colvin	81	P	1	Typic Calciaquolls, Fine-Silty, Frigid	Arveson, Saline	5	Y
									Bearden, Saline	5	N
									Ojata	4	Y
									Tiffany	3	Y
									Borup, Saline	1	Y
									Kratka, Saline	1	Y

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ND103	Wells County	Cp	Colvin And Laprairie Soils	Colvin	40	P	1	Typic Calciaquolls, Fine-Silty, Frigid	Lamoure	9	Y
									Marysland	6	Y
									Borup	5	Y
				Laprairie	40	MW	2	Cumulic Udic Haploborolls, Fine-Loamy, Mixed	Lamoure	9	Y
									Marysland	6	Y
									Borup	5	Y
ND103	Wells County	Cs	Colvin Soils, Very Poorly Drained	Colvin	95	VP	1	Typic Calciaquolls, Fine-Silty, Frigid	Dimmick	3	Y
									Parnell	2	Y
ND103	Wells County	Ex	Exline Soils	Exline	85	SP	1	Leptic Natriborolls, Fine, Montmorillonitic	Aberdeen	6	N
									Heimdal	4	N
									Emrick	3	N
									Larson	2	N
ND103	Wells County	LaA	Ladelle Silt Loam, Level	Ladelle	92	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Marysland	3	Y
									Lamoure	3	Y
									Colvin	2	Y
ND103	Wells County	Ld	Lamoure And Divide Soils, Channeled	Lamoure	45	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Colvin	10	Y
									Marysland	8	Y
									Ladelle	7	N
				Divide	30	SP,MW	2	Aeric Calciaquolls, Fine-Loamy Over Sandy Or Sandy-Skeletal, Frigid	Colvin	10	Y
									Marysland	8	Y
									Ladelle	7	N
ND103	Wells County	Le	Lamoure-Exline Complex	Lamoure	65	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Ladelle	5	N
									Divide	4	N
									Colvin	3	Y
									Laprairie	3	N
				Exline	20	SP	2	Leptic Natriborolls, Fine, Montmorillonitic	Ladelle	5	N
									Divide	4	N
									Laprairie	3	N
									Colvin	3	Y

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ND602	Cass County Area	10	Fargo-Ryan Silty Clays	Fargo	47	P	1	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Nahon	5	N
									Enloe	4	Y
									Dovray	4	Y
				Ryan	30	P	2	Fine, Montmorillonitic, Frigid Typic Natraquerts	Nahon	5	N
									Dovray	4	Y
									Enloe	4	Y
				Hegne	10	P	3	Fine, Montmorillonitic, Frigid Typic Calciaquerts	Nahon	5	N
									Dovray	4	Y
									Enloe	4	Y
ND602	Cass County Area	24	Cashel Silty Clay	Cashel	75	SP	1	Fine, Frigid Aquertic Udifluvents	Wahpeton	8	N
									Fairdale	5	N
									Hegne	2	Y
				Fargo	10	P	2	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Wahpeton	8	N
									Fairdale	5	N
									Hegne	2	Y
ND602	Cass County Area	25	Cashel Silty Clay, Channeled	Cashel	75	SP	1	Fine, Frigid Aquertic Udifluvents	Wahpeton	8	N
									Fairdale	5	N
									Hegne	2	Y
				Fargo, Channeled	10	P	2	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Wahpeton	8	N
									Fairdale	5	N
									Hegne	2	Y
ND602	Cass County Area	35	Fairdale Silt Loam, 1 To 3 Percent Slopes	Fairdale	80	MW	1	Fine-Loamy, Mixed (Calcareous), Frigid Mollic Udifluvents	Cashel	5	N
									Fargo	3	Y
									Hegne	2	Y
				Ladelle	10	MW	2	Fine-Silty, Mixed, Frigid Cumulic Udic Haploborolls	Cashel	5	N
									Fargo	3	Y
									Hegne	2	Y
ND602	Cass County Area	37	Fargo Silty Clay, Depressional	Fargo	76	P	1	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Enloe	5	Y
									Dovray	5	Y
									Ryan	2	Y
									Cashel	1	N
									Wahpeton	1	N
				Hegne	10	P	2	Fine, Montmorillonitic, Frigid Typic Calciaquerts	Enloe	5	Y
									Dovray	5	Y
									Ryan	2	Y
									Wahpeton	1	N
									Cashel	1	N
ND602	Cass County Area	38	Fargo Silty Clay Loam	Fargo	68	P	1	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Overly	5	N
									Dovray	5	Y
									Ryan	2	Y
				Hegne	10	P	2	Fine, Montmorillonitic, Frigid Typic Calciaquerts	Dovray	5	Y
									Overly	5	N
									Ryan	2	Y
ND602	Cass County Area	38	Fargo Silty Clay Loam	Fargo Sic	10	P	3	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Dovray	5	Y
									Overly	5	N
									Ryan	2	Y

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ND602	Cass County Area	4	Perella Silty Clay Loam	Perella	68	P	1	Fine-Silty, Mixed, Frigid Typic Epiaquolls	Bearden	9	N
									Colvin	8	Y
									Colvin, Saline	7	Y
									Dovray	4	Y
									Lindaas	4	Y
ND602	Cass County Area	47	Fargo Silty Clay, Smooth Surface	Fargo	85	P	1	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Hegne	8	Y
									Wahpeton	3	N
									Ryan	2	Y
									Cashel	2	N
ND602	Cass County Area	5	Dovray Silty Clay	Dovray	63	VP	1	Fine, Montmorillonitic, Frigid Cumulic Vertic Epiaquolls	Fargo	10	Y
									Hegne	5	Y
				Ludden	12	P	2	Fine, Montmorillonitic, Frigid Typic Endoaquerts	Fargo	10	Y
									Hegne	5	Y
				Fargo	10	P	3	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Fargo	10	Y
									Hegne	5	Y
ND602	Cass County Area	55	Ladelle Silty Clay Loam	Ladelle	80	MW	1	Fine-Silty, Mixed, Frigid Cumulic Udic Haploborolls	Cashel	5	N
									Fairdale	5	N
									Overly	3	N
									Faifdale, Var	3	N
									Hegne	2	Y
									Lamoure	2	Y
ND602	Cass County Area	57	Fairdale Silt Loam, Channeled	Fairdale	80	MW	1	Fine-Loamy, Mixed (Calcareous), Frigid Mollic Udifluvents	Ladelle	5	N
									Fargo	3	Y
									Hegne	2	Y
				Cashel	10	SP	2	Fine, Frigid Aquertic Udifluvents	Ladelle	5	N
									Fargo	3	Y
									Hegne	2	Y
ND602	Cass County Area	59	Overly Silty Clay Loam, 0 To 3 Percent Slopes	Overly	75	MW	1	Fine-Silty, Mixed, Frigid Pachic Udic Haploborolls	Perella	5	Y
									Great Bend	5	N
									Fargo	3	Y
									Hegne	2	Y
				Bearden	10	SP	2	Fine-Silty, Frigid Aeric Calciaquolls	Great Bend	5	N
									Perella	5	Y
									Fargo	3	Y
									Hegne	2	Y
ND602	Cass County Area	61	Perella-Bearden Silty Clay Loams	Perella	47	SP	1	Fine-Silty, Mixed, Frigid Typic Epiaquolls	Overly	5	N
										5	Y
									Enloe	5	Y
				Bearden	28	SP	2	Fine-Silty, Frigid Aeric Calciaquolls	Colvin	5	Y
									Overly	5	N
									Enloe	5	Y
				Lindaas	10	P	3	Fine, Montmorillonitic, Frigid Typic Argiaquolls	Overly	5	N
									Enloe	5	Y
									Colvin	5	Y
ND602	Cass County Area	62	Overly-Bearden Silt Loams, 0 To 3 Percent Slopes	Overly	50	MW	1	Fine-Silty, Mixed, Frigid Pachic Udic Haploborolls	Fargo	5	Y

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									Colvin	5	Y
				Bearden	30	SP	2	Fine-Silty, Frigid Aeric Calciaquolls	Fargo	5	Y
									Colvin	5	Y
				Perella	10	P	3	Fine-Silty, Mixed, Frigid Typic Epiaquolls	Colvin	5	Y
									Fargo	5	Y
ND602	Cass County Area	72	Wahpeton Silty Clay	Wahpeton	80	MW	1	Fine, Montmorillonitic, Frigid Typic Hapluderts	Nutley	5	N
									Fargo	5	Y
				Cashel	10	SP	2	Fine, Frigid Aquertic Udifluvents	Nutley	5	N
									Fargo	5	Y
ND602	Cass County Area	73	Rauville Silty Clay Loam	Rauville	80	VP	1	Fine-Silty, Mixed (Calcareous), Frigid Cumulic Endoaquolls			
				Colvin, Saline	10	P	2	Fine-Silty, Frigid Typic Calciaquolls			
				Lamoure	10	P	3	Fine-Silty, Mixed (Calcareous), Frigid Cumulic Endoaquolls			
ND602	Cass County Area	85	Fairdale Variant Silt Loam	Fairdale Variant	68	MW	1	Fine-Loamy Over Clayey, Mixed (Calcareous), Frigid Mollic Udifluvents	Fargo	7	Y
									Hegne	5	Y
				Fairdale	10	MW	2	Fine-Loamy, Mixed (Calcareous), Frigid Mollic Udifluvents	Fargo	7	Y
									Hegne	5	Y
				Ladelle	10	MW	3	Fine-Silty, Mixed, Frigid Cumulic Udic Haploborolls	Fargo	7	Y
									Hegne	5	Y
ND602	Cass County Area	9C	Nutley-Fargo Silty Clays, 1 To 9 Percent Slopes	Nutley	35	W	1	Fine, Montmorillonitic, Frigid Chromic Hapluderts	Hegen	10	Y
									Ludden	5	Y
				Fargo	32	P	2	Fine, Montmorillonitic, Frigid Typic Epiaquerts	Hegen	10	Y
									Ludden	5	Y
				Wahpeton	18	MW	3	Fine, Montmorillonitic, Frigid Typic Hapluderts	Hegen	10	Y
									Ludden	5	Y

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ND603	Benson County Area	131D	Miranda Variant Loam, 3 To 15 Percent Slopes	Miranda Variant	85	W	1	Leptic Natriborolls, Fine, Montmorillonitic	Parnell	4	Y
									Darnen	4	N
									Esmond	3	N
									Tonka	2	Y
									Larson	2	N
ND603	Benson County Area	75	Ryan Silty Clay	Ryan	85	P	1	Typic Natraquerts, Fine, Montmorillonitic, Frigid	Lamoure	9	Y
									Rauville	6	Y
ND603	Benson County Area	78	Ladelle-Aberdeen Silt Loams	Ladelle	60	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Lamoure	5	Y
									Ryan	4	Y
									Gardena	4	N
									Colvin	2	Y
				Aberdeen	25	MW	2	Glossic Udic Natriborolls, Fine, Montmorillonitic	Lamoure	5	Y
									Gardena	4	N
									Ryan	4	Y
									Colvin	2	Y
ND603	Benson County Area	83	Ladelle Silt Loam	Ladelle	93	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Lamoure	7	Y
ND603	Benson County Area	85	Lamoure Silt Loam	Lamoure	85	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Ladelle	8	N
									Laprairie	7	N
ND603	Benson County Area	86	Ladelle Silt Loam, Channeled	Ladelle	80	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Colvin, Channeled	8	Y
									Lamoure, Channeled	5	Y
									Marysland, Channeled	4	Y
									Rauville	3	Y
ND603	Benson County Area	9	Rauville Silt Loam	Rauville	90	VP	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Lamoure	6	Y
									Ladelle	4	N

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND605	Benson, Eddy, Nelson Counties	Bo	Borup And Marysland Silt Loams, Very Wet	Borup	45	VP	1	Typic Calciaquolls, Coarse-Silty, Frigid	Borup	5	Y
									Divide	3	N
									Glyndon	3	N
									Marysland	2	Y
									Totten	2	Y
				Marysland	40	VP	2	Typic Calciaquolls, Fine-Loamy Over Sandy Or Sandy-Skeletal, Frigid	Borup	5	Y
									Divide	3	N
									Glyndon	3	N
									Marysland	2	Y
									Totten	2	Y
ND605	Benson, Eddy, Nelson Counties	Cn	Cavour-Cresbard Loams	Cavour	45	MW	1	Udic Natriborolls, Fine, Montmorillonitic	Vallers	6	Y
									Svea	5	N
									Hamerly	4	N
									Parnell	3	Y
									Tonka	2	Y
				Cresbard	35	MW	2	Glossic Udic Natriborolls, Fine, Montmorillonitic	Vallers	6	Y
									Svea	5	N
									Hamerly	4	N
									Parnell	3	Y
									Tonka	2	Y
ND605	Benson, Eddy, Nelson Counties	Ed	Edgeley Loam, Gravelly Variant	Edgeley Variant	83	W	1	Udic Haploborolls, Fine-Loamy, Mixed	Edgeley Var. /Bedrock	4	N
									Edgeley	4	N
									Renshaw	4	N
									Barnes	3	N
									Svea Var.	2	N
ND605	Benson, Eddy, Nelson Counties	Ge	Glyndon Loam, Saline	Glyndon	82	MW,SP	1	Aeric Calciaquolls, Coarse-Silty, Frigid	Borup	6	Y
									Lallie	5	Y
									Glyndon, Nonsaline	4	N
									Gardena	3	N
ND605	Benson, Eddy, Nelson Counties	Hc	Hamar Coarse Sandy Loam	Hamar	80	SP	1	Typic Endoaquolls, Sandy, Mixed, Frigid	Fossum	5	Y
									Venlo	4	Y
									Lohnes	4	N
									Hamar Sl, Pd	3	Y
									Wyrene	2	N
									Arveson	2	Y
ND605	Benson, Eddy, Nelson Counties	La	Ladelle Silty Clay Loam	Ladelle	85	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Lamoure Channeled	8	Y
									Laprairie	7	N
ND605	Benson, Eddy, Nelson Counties	Le	Lamoure Silty Clay Loam	Lamoure	84	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Lamoure, Saline	6	Y
									Ladelle	5	N
									Ludden	4	Y
									Lallie Vpd	1	Y

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND605	Benson, Eddy, Nelson Counties	Lm	Lamoure Silty Clay Loam, Saline	Lamoure	85	P	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Ladelle	7	N
									Lamoure, Nonsaline	5	Y
									Ryan	3	Y
ND605	Benson, Eddy, Nelson Counties	Ln	La Prairie Silt Loam	La Prairie	85	MW	1	Cumulic Udic Haploborolls, Fine-Loamy, Mixed	Lamoure	7	Y
									Ladelle	5	N
									Walsh	3	N
ND605	Benson, Eddy, Nelson Counties	Lp	La Prairie-Lamoure Complex	La Prairie	40	MW	1	Cumulic Udic Haploborolls, Fine-Loamy, Mixed	Ladelle	6	N
									Rauville	6	Y
									Lamoure, Saline	5	Y
									Ludden	3	Y
				Lamoure	40	P	2	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Rauville	6	Y
									Ladelle	6	N
									Lamoure, Saline	5	Y
									Ludden	3	Y

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND605	Benson, Eddy, Nelson Counties	Lu	Letcher Sandy Loam, Till Substratum	Letcher	80	SP,MW	1	Udic Natriborolls, Coarse-Loamy, Mixed	Embden	6	N
									Fram	4	N
									Vallers	3	Y
									Borup	3	Y
									Lemert	2	N
									Totten	2	Y
ND605	Benson, Eddy, Nelson Counties	Lx	Ludden Silty Clay	Ludden	85	P	1	Typic Endoaquerts, Fine, Montmorillonitic, Frigid	Lamoure	6	Y
									Wahpeton	5	N
									Ryan	2	Y
									Ludden, Saline	2	Y
ND605	Benson, Eddy, Nelson Counties	Lz	Ludden-Lamoure Complex	Ludden	40	P	1	Typic Endoaquerts, Fine, Montmorillonitic, Frigid	Ludden, Saline	8	Y
									Lamoure, Saline	6	Y
									Ryan	3	Y
									Rauville	3	Y
				Lamoure	40	P	2	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Ludden, Saline	8	Y
									Lamoure, Saline	6	Y
									Ryan	3	Y
									Rauville	3	Y
ND605	Benson, Eddy, Nelson Counties	Mh	Marsh	Marsh	90	VP	1	Cumulic Vertic Endoaquolls, Fine, Montmorillonitic (Calcareous), Frigid	Water	5	Y
									Southam	5	Y
ND605	Benson, Eddy, Nelson Counties	Ra	Rauville Silty Clay Loam	Rauville	90	VP	1	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Lamoure	6	Y
									Ludden	4	Y
ND605	Benson, Eddy, Nelson Counties	Ry	Ryan Silty Clay Loam	Ryan	85	P	1	Typic Natraquerts, Fine, Montmorillonitic, Frigid	Lamoure	7	Y
									Rauville	5	Y
									Ludden	3	Y
ND605	Benson, Eddy, Nelson Counties	Rz	Ryan And Lamoure Silty Clay Loams	Ryan	45	P	1	Typic Natraquerts, Fine, Montmorillonitic, Frigid	Lamoure, Saline	10	Y
									Rauville	6	Y
									Ludden	5	Y
									Laprairie	4	N
				Lamoure	20	P	2	Cumulic Endoaquolls, Fine-Silty, Mixed (Calcareous), Frigid	Lamoure, Saline	10	Y
									Rauville	6	Y
									Ludden	5	Y
									Laprairie	4	N
ND605	Benson, Eddy, Nelson Counties	Wa	Wahpeton Silty Clay	Wahpeton	85	MW	1	Typic Hapluderts, Fine, Montmorillonitic, Frigid	Laprairie	6	N
									Ryan	5	Y
									Ludden	4	Y
ND605	Benson, Eddy, Nelson Counties	WcA	Walsh Clay Loam, 0 To 3 Percent Slopes	Walsh	85	MW	1	Pachic Udic Haploborolls, Fine-Loamy, Mixed	Vang	6	N
									Edgeley	4	N
									Svea	3	N
									Laprairie	2	N

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND607	Nelson County Area	15	Borup Silt Loam	Borup	43	P	1	Typic Calciaquolls, Coarse-Silty, Frigid	Colvin	24	Y
									Glyndon	19	N
									Marysland	5	Y
									Hamerly	3	N
									Vallers	3	Y
									Divide	3	N
ND607	Nelson County Area	23	Cavour-Cresbard Loams, 0 To 3 Percent Slopes	Cavour	47	MW	1	Udic Natriborolls, Fine, Montmorillonitic	Miranda	8	N
									Svea	7	N
									Vallers, Saline	4	Y
									Playmoor	1	Y
									Hamerly	1	N
									Barnes	1	N
				Cresbard	31	MW	2	Glossic Udic Natriborolls, Fine, Montmorillonitic	Miranda	8	N
									Svea	7	N
									Vallers, Saline	4	Y
									Playmoor	1	Y
									Hamerly	1	N
									Barnes	1	N
ND607	Nelson County Area	25	Miranda-Cavour Loams, 0 To 3 Percent Slopes	Miranda	40	SP	1	Leptic Natriborolls, Fine-Loamy, Mixed	Vallers, Saline	10	Y
									Playmoor	5	Y
									Hamerly, Saline	3	N
									Svea	2	N
									Cresbard	1	N
									Hamerly	1	N
				Cavour	38	MW	2	Udic Natriborolls, Fine, Montmorillonitic	Vallers, Saline	10	Y
									Playmoor	5	Y
									Hamerly, Saline	3	N
									Svea	2	N
									Cresbard	1	N
									Hamerly	1	N
ND607	Nelson County Area	31B	Egeland Sandy Loam, 3 To 6 Percent Slopes	Egeland	64	W	1	Udic Haploborolls, Coarse-Loamy, Mixed	Embden	20	N
									Maddock	8	N
									Wyndmere	4	N
									Glyndon	4	N
ND607	Nelson County Area	34	Ladelle Silt Loam	Ladelle	64	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Walsh	13	N
									Laprairie	9	N
									Wamduska	5	N
									Lamoure	5	Y
									Borup	4	Y
ND607	Nelson County Area	35	Ladelle Silt Loam, Channeled	Ladelle	47	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed	Lamoure Channeled	14	Y
									Minnewaukan	10	Y
									Claire Channneled	10	N
									Velva Channeled	9	N
									Rauville	6	Y
									Embden	4	N

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND609	Richland And Parts Of Ransom Counties	Au	Arveson And Fossum Loams	Arveson	50	P	1	Typic Calciaquolls, Coarse-Loamy, Frigid			
				Fossum	50	P	2	Typic Endoaquolls, Sandy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Av	Arveson And Fossum Loams, Very Wet	Arveson	50	VP	1	Typic Calciaquolls, Coarse-Loamy, Frigid			
				Fossum	50	VP	2	Typic Endoaquolls, Sandy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Co	Colvin Silty Clay Loam	Colvin	100	P	1	Typic Calciaquolls, Fine-Silty, Frigid			
ND609	Richland And Parts Of Ransom Counties	DkB	Dickey-Towner Fine Sandy Loams, Undulating	Dickey	50	W	1	Udorthentic Haploborolls, Sandy Over Loamy, Mixed			
				Towner	30	MW	2	Udorthentic Haploborolls, Sandy Over Loamy, Mixed			
ND609	Richland And Parts Of Ransom Counties	En	Embden-Tiffany Fine Sandy Loams	Embden	50	MW	1	Pachic Udic Haploborolls, Coarse-Loamy, Mixed			
				Tiffany	30	P	2	Typic Endoaquolls, Coarse-Loamy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Fa	Fairdale Silt Loam	Fairdale	100	MW	1	Mollic Udifluvents, Fine-Loamy, Mixed (Calcareous), Frigid			
ND609	Richland And Parts Of Ransom Counties	Fb	Fairdale Silt Loam, Channeled	Fairdale	100	MW	1	Mollic Udifluvents, Fine-Loamy, Mixed (Calcareous), Frigid			
ND609	Richland And Parts Of Ransom Counties	Fd	Fairdale Silty Clay Loam	Fairdale	100	MW	1	Mollic Udifluvents, Fine-Loamy, Mixed (Calcareous), Frigid			
ND609	Richland And Parts Of Ransom Counties	Fe	Fargo Silty Clay Loam	Fargo	100	P	1	Typic Epiaquerts, Fine, Montmorillonitic, Frigid			
ND609	Richland And Parts Of Ransom Counties	Gd	Galchutt-Overly Silt Loams	Galchutt	50	SP	1	Vertic Argialbolls, Fine, Montmorillonitic, Frigid			
				Overly	30	MW	2	Pachic Udic Haploborolls, Fine-Silty, Mixed			
ND609	Richland And Parts Of Ransom Counties	Ge	Gardena Silt Loam	Gardena	100	MW	1	Pachic Udic Haploborolls, Coarse-Silty, Mixed			
ND609	Richland And Parts Of Ransom Counties	GfB	Gardena-Eckman Silt Loams, Undulating	Gardena	50	MW	1	Pachic Udic Haploborolls, Coarse-Silty, Mixed			
				Eckman	30	W	2	Udic Haploborolls, Coarse-Silty, Mixed			
ND609	Richland And Parts Of Ransom Counties	Gh	Gardena And Embden Loams	Gardena	50	MW	1	Pachic Udic Haploborolls, Coarse-Silty, Mixed			
				Embden	50	MW	2	Pachic Udic Haploborolls, Coarse-Loamy, Mixed			
ND609	Richland And Parts Of Ransom Counties	Go	Glyndon Silt Loam	Glyndon	100	MW,SP	1	Aeric Calciaquolls, Coarse-Silty, Frigid			
ND609	Richland And Parts Of Ransom Counties	Hb	Hamar Loamy Fine Sand, Moderately Deep Over Clay	Hamar	100	P,SP	1	Typic Endoaquolls, Sandy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Hm	Hecla-Hamar Loamy Fine Sands	Hecla	50	MW	1	Aquic Haploborolls, Sandy, Mixed			
				Hamar	30	P	2	Typic Endoaquolls, Sandy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Hn	Hecla-Hamar Fine Sandy Loams	Hecla	50	MW	1	Aquic Haploborolls, Sandy, Mixed			
				Hamar	30	P	2	Typic Endoaquolls, Sandy, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	La	Ladelle Silty Clay Loam	Ladelle	100	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed			
ND609	Richland And Parts Of Ransom Counties	Lb	Ladelle And Wahpeton Soils, Channeled	Ladelle	50	MW	1	Cumulic Udic Haploborolls, Fine-Silty, Mixed			
				Wahpeton	50	MW	2	Typic Hapluderts, Fine, Montmorillonitic, Frigid			
ND609	Richland And Parts Of Ransom Counties	Lp	La Prairie Silt Loam	La Prairie	100	MW	1	Cumulic Udic Haploborolls, Fine-Loamy, Mixed			

Table B1. Descriptive soil legend for soils mapped along the Sheyenne River Valley in Benson, Wells, Eddy, Nelson, Griggs, Steele, Barnes, Ransom, Richland, and Cass Counties, North Dakota.

Soil Survey Area	Soil Survey Name	Map Unit Symbol	Map Unit Name	Major Soil Series Component	Percentage Composition	Drainage Class (Major Component)	Sequence Number (Major Component)	Taxonomic Classification	Minor Inclusions	Percent Composition	Hydric
ND609	Richland And Parts Of Ransom Counties	Oc	Overly Silty Clay Loam	Overly	100	MW	1	Pachic Udic Haploborolls, Fine-Silty, Mixed			
ND609	Richland And Parts Of Ransom Counties	Pd	Parnell And Tonka Silty Clay Loams	Parnell	50	VP	1	Vertic Argiaquolls, Fine, Montmorillonitic, Frigid			
				Tonka	50	P	2	Argiaquic Argialbolls, Fine, Montmorillonitic, Frigid			
ND609	Richland And Parts Of Ransom Counties	Pr	Perella Loam, Moderately Deep Over Clay	Perella	100	P	1	Typic Epiaquolls, Fine-Silty, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	Ps	Perella Silty Clay Loam, Moderately Deep Over Clay	Perella	100	P	1	Typic Epiaquolls, Fine-Silty, Mixed, Frigid			
ND609	Richland And Parts Of Ransom Counties	To	Towner Loamy Fine Sand	Towner	100	MW	1	Udorthentic Haploborolls, Sandy Over Loamy, Mixed			
ND609	Richland And Parts Of Ransom Counties	Tw	Towner And Swenoda Fine Sandy Loams	Towner	50	MW	1	Udorthentic Haploborolls, Sandy Over Loamy, Mixed			
				Swenoda	50	MW	2	Pachic Udic Haploborolls, Coarse-Loamy, Mixed			
ND609	Richland And Parts Of Ransom Counties	Un	Ulen Fine Sandy Loam	Ulen	100	SP,MW	1	Aeric Calciaquolls, Sandy, Frigid			
ND609	Richland And Parts Of Ransom Counties	Wa	Wahpeton Silty Clay	Wahpeton	100	MW	1	Typic Hapluderts, Fine, Montmorillonitic, Frigid			
ND609	Richland And Parts Of Ransom Counties	We	Wet Alluvial Land	Wet Alluvial Land	100		1				

Official Series Descriptions of Soils Identified along the Sheyenne River: Devils Lake Salinity Study

Table Of Contents: Official Series Descriptions

LOCATION ABERDEEN SD+ND

Established Series
Rev. LDS-WJB-CJH
10/98

ABERDEEN SERIES

The Aberdeen series consists of very deep, moderately well drained soils formed in glacial lacustrine sediments on lake plains. Permeability is slow in the solum and moderate to slow in the underlying material. Slopes range from 0 to 2 percent. Mean annual precipitation is about 19 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Glossic Natrudolls

TYPICAL PEDON: Aberdeen silty clay loam - on a plane slope of less than 1 percent in cultivation. When described the soil was dry to 30 inches and moist below. (Colors are for dry soil unless otherwise stated)

Ap--0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary. (Combined thickness of A horizons is 5 to 12 inches thick)

BE--8 to 11 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; gray (10YR 6/1) silt coatings on faces of peds; weak medium subangular blocky structure parting to weak thin platy; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary. (2 to 6 inches thick)

Btn1--11 to 18 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to moderate fine blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; clear wavy boundary.

Btn2--18 to 26 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; clear wavy boundary. (Combined thickness of the Btn horizons is 8 to 26 inches.)

Bkz1--26 to 31 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common fine nests of gypsum and other salts; common very fine accumulations of carbonate; strong effervescence; slightly alkaline; clear wavy boundary.

Bkz2--31 to 38 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common fine nests of gypsum and other salts; common very fine accumulations of carbonate; strong effervescence; slightly alkaline; gradual wavy boundary. (Combined thickness of Bkz horizons is 0 to 20 inches.)

C1--38 to 51 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; few fine prominent of yellowish brown (10YR 5/6) redox concentrations and few fine distinct gray (10YR 5/1) moist redox depletions; massive; hard, friable, slightly sticky and slightly plastic; few fine threads and nests of gypsum and other salts; slight effervescence; slightly alkaline; gradual wavy boundary.

C2--51 to 60 inches; pale yellow (2.5Y 7/4) silt loam, laminated with thin layers of silty clay and very fine sandy loam, light olive brown (2.5Y 5/4) moist; common fine prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) redox concentrations, and gray (10YR 5/1) moist redox depletions; massive; laminations 1 to 3 mm thick; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; slightly alkaline.

TYPE LOCATION: Brown County, South Dakota; about 2 miles east and 4 miles south of Aberdeen; 580 feet west and 93 feet south of the northeast corner of sec. 9, T. 122 N., R. 63 W.

RANGE IN CHARACTERISTICS: The depth to carbonates ranges from 16 to about 40 inches.

The A horizon has value of 3 or 4 and 2 or 3 moist. It typically is silty clay loam or silt loam but is loam, fine sandy loam, or silty clay in some pedons. It is moderately acid to neutral.

The BE horizon has value of 4 or 5 and 3 or 4 moist, and chroma of 1 or 2. It has gray or light gray silt coatings on faces of peds. It is slightly acid or neutral. Some pedons have E or B/E horizons. Some pedons have relic columnar peds that are deeply degraded both in color and in structure, with horizontal and vertical streaks of gray or light gray extending an inch or more into the columns.

The Btn horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 3. It is silty clay, silty clay loam or clay that contains an estimated 35 to 55 percent clay and less than 15 percent fine sand or coarser. It ranges from neutral to moderately alkaline. Some pedons have Btk horizons.

The Bkz horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 3 to 5 moist, and chroma of 1 to 4. It is silty clay loam, silty clay or silt loam. It is slightly to strongly alkaline. It has more exchangeable magnesium plus sodium than calcium plus hydrogen and exchangeable sodium exceeds 15 percent in the Bkz or C horizons. The Bkz and upper part of the C horizons have few or common fine nests and threads of gypsum and other salts. Some pedons do not have accumulations of gypsum and/or other salts. Some pedons have a BCk horizon.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 and 4 to 6 moist, and chroma of 2 to 4. It is silt loam or silty clay loam and typically is laminated with very thin strata of very fine sand to clay. Varves range from less than 1 mm to 10 mm in thickness. It is slightly to strongly alkaline. Some pedons have sandy materials below a depth of 40 inches. Other pedons have loamy glacial till below a depth of 40 inches.

COMPETING SERIES: This is the Cresbard soil in the same family. Cresbard soils contain more than 15 percent fine sand or coarser.

GEOGRAPHIC SETTING: Aberdeen soils are on level and nearly level lake plains. Slope gradients are less than 2 percent. The soils formed in laminated

glaciolacustrine sediments of silt sized particles but with thin lens of very fine sand or clay sized particles. Mean annual air temperature ranges from 38 to 45 degrees, and mean precipitation from 17 to 24 inches. Most of the precipitation comes in the spring and summer. Growing season is about 120 to 140 days; average growing season precipitation is 14 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Beotia, Exline, Great Bend, Harmony, Nahon, and Zell soils. Beotia, Great Bend, Harmony, and Zell soils do not have a natric horizon and are on the slightly higher plane to convex surfaces. In addition Beotia and Great Bend soils are fine-silty and Zell soils are coarse-silty. Exline soils have visible salts within a depth of 16 inches and are in slightly lower parts of the landscape. Harmony soils lack natric horizons. Nahon soils have columnar structure in the Bt horizon. Harmony and Nahon soils are on the broad smooth flats in close association with the Aberdeen soils.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is low or medium. Permeability is slow in the solum and moderate to slow in the underlying material.

USE AND VEGETATION: Most areas are cropped to small grains, sunflowers, and alfalfa. Native vegetation includes western wheatgrass, green needlegrass, little bluestem, big bluestem, sideoats grama, blue grama, porcupinegrass, needleandthread, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and eastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: Brown County, South Dakota, 1925.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 26 inches (Ap, BE, Btn1, Btn2 horizons); natric horizon - the zone from a depth of about 11 to 26 inches (Btn1 and Btn horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION ARVESON MN+ND SD

Established Series
MNJ-CJH
01/2001

ARVESON SERIES

The Arveson series consists of very deep, poorly and very poorly drained soils that formed mostly in loamy glacial lacustrine or outwash sediments on glacial lake and outwash plains. These soils have moderate or moderately rapid permeability in the upper part and rapid in the lower part. They have slopes of 0 to 2 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 4l degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Arveson clay loam with a slightly concave nearly level slope adjacent to a beach ridge on a glacial lake plain in a meadow field. (Colors are for moist soil unless otherwise stated.)

A--0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable, slightly sticky; strong effervescence; slightly alkaline; gradual smooth boundary.

Bkg1--8 to 14 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak very fine granular structure; very friable, slightly sticky; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg2--14 to 25 inches; light gray (5Y 7/1) loam; weak very fine granular structure; very friable, slightly sticky; common convolutions of very dark gray (10YR 3/1); violent effervescence; moderately alkaline; clear wavy boundary. (6 to 15 inches thick)

Bkg3--25 to 34 inches; gray (5Y 6/1) sandy loam; weak very fine granular structure; very friable, slightly sticky; many fine and medium masses of gray (5Y 5/1); violent effervescence; moderately alkaline; clear smooth boundary. (Combined thickness of the Bkg horizons is 6 to 32 inches.)

2Cg1--34 to 46 inches; gray (5Y 6/1) loamy sand; few fine distinct pale olive (5Y 6/3) redoximorphic concentrations; weak very fine granular structure; very friable, slightly sticky; strong effervescence; moderately alkaline; clear smooth boundary. (0 to 16 inches thick)

2Cg2--46 to 60 inches; light olive gray (5Y 6/2) fine sand; few fine prominent olive yellow (2.5Y 6/8) and few fine distinct pale olive (5Y 6/4) redoximorphic concentrations; single grain; loose; slight effervescence; moderately alkaline.

TYPE LOCATION: Clay County, Minnesota; about 3 miles east of the village of Felton; about 660 feet west and 165 feet north of the southeast corner, Sec. 25, T. 142 N., R. 46 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 24 inches in thickness. The depth to loamy fine sand or coarser sediments is more than 20

inches. The average texture of the control section is fine sandy loam, sandy loam, or loam averaging less than 18 percent noncarbonate clay and more than 15 percent fine sand and coarser. These soils have 0 to 1 percent rock fragments. These soils contain carbonates in all parts. The content of calcium carbonate in the calcic horizon ranges from 15 to 60 percent. Masses of the A horizon in the C horizon are a common but are not a diagnostic feature of the series. A buried A horizon is in some pedons.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or is N 2/0 or N 3/0. It has redoximorphic features in some pedons. It is sandy loam, fine sandy loam, sandy clay loam, silt loam, loam, or clay loam. It is slightly alkaline or moderately alkaline. Some pedons have an Ak or ABk horizon up to 15 inches thick.

The Bkg horizons have hue of 5Y to 10YR, value of 3 to 7, and chroma of 1 or 2, or is N 4/0 to N 7/0. It is sandy loam, fine sandy loam, sandy clay loam, loam, or clay loam; but the lower part is loamy sand or loamy fine sand in some pedons. It is slightly alkaline or moderately alkaline.

The 2Cg horizons have hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It has redoximorphic features in most but not all pedons. It is coarse sand, sand, fine sand, loamy sand, loamy fine sand, sandy loam, or fine sandy loam. It is slightly alkaline or moderately alkaline. It has a calcium carbonate equivalent of less than 25 percent. Some pedons have a clay loam 3C horizon below 40 inches.

COMPETING SERIES: These are the Hedman, Percy and Rockwell series. These soils formed all or partially in till and have greater than one percent rock fragments within the series control section. In addition, Percy soils have a calcium carbonate equivalent of more than 25 percent below the Bk horizon.

GEOGRAPHIC SETTING: Arveson soils have plane or concave slopes with gradient of less than 2 percent on glacial lake plains and outwash plains. The soils formed in loamy or loamy and sandy outwash or lacustrine sediments of Late Wisconsinan Age. Mean annual air temperature is 38 to 45 degrees F. Mean annual precipitation is 16 to 24 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Flaming, Hecla, Ulen and Wyndmere soils which formed in sediments somewhat similar to those of the Arveson soils. The Flaming, Hecla, and Ulen soils are somewhat poorly and moderately well drained and are on slightly higher lying terrain. They are sandy. The somewhat poorly drained Wyndmere soils are coarse-loamy and are on somewhat higher lying terrain.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Runoff is slow and very slow. Permeability is moderate or moderately rapid in the upper part and rapid in the lower part. The water table is commonly at or near the surface during at least part of the growing season unless these soils are drained.

USE AND VEGETATION: Most of these soils are cropped to small grains and in a few places corn and soybeans. Some are used for growing pasture. Native vegetation is a wetsite community of the tall grass prairie.

DISTRIBUTION AND EXTENT: Mainly in the Red River Valley of northwestern Minnesota, eastern North Dakota, and northeastern South Dakota. Extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Roseau County, Minnesota, 1933.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface of the soil to a depth of 14 inches (A and Bkg1 horizons); calcic horizon - zone from 8 to 25 inches (Bkg horizons); aquic moisture based upon low chroma below calcic horizon.

National Cooperative Soil Survey
U.S.A.

LOCATION BANKS ND+MT SD WY

Established Series
Rev. CJH
5/94

BANKS SERIES

The Banks series consists of very deep, excessively or somewhat excessively drained, rapidly permeable soils that formed in recently deposited sandy alluvium. These soils are on levees, flood plains and low terraces of larger streams and have slopes ranging from 0 to 6 percent. Mean annual temperature is 42 degrees F, and the mean annual precipitations is 16 inches.

TAXONOMIC CLASS: Sandy, mixed, frigid Typic Ustifluvents

TYPICAL PEDON: Banks very fine sandy loam - native grassland. (Colors are for dry soil unless otherwise stated)

A--0 to 4 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium granular structure; very friable; many roots; slight effervescence; slightly alkaline; abrupt wavy boundary. (2 to 12 inches thick)

C1--4 to 30 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; single grain; loose; few roots; slight effervescence; slightly alkaline; abrupt wavy boundary. (0 to 40 inches thick)

C2--30 to 60 inches; light brownish gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; some very thin (1/8 to 1/2 inch) bands of silt and very fine sand; slight effervescence; slightly alkaline.

TYPE LOCATION: Burleigh County, North Dakota; 2,165 feet east and 1,585 feet south of the northwest corner, sec. 5, T. 140 N., R. 81 W.

RANGE IN CHARACTERISTICS: The depth to carbonates is less than 10 inches. The 10- to 40- inch control section is mainly strata of loamy fine sand, fine sand or sand. One or more very thin layers of very fine sand, loam or finer materials are in most pedons; others contain thin layers of coarse sand and gravel. Some pedons have thin Ab horizons.

The A horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 3. Values of 2 or 3 moist are allowed if it is 3 inches or less in thickness or if it is 5 inches or less in thickness and has textures of loamy fine sand or coarser. Textures range from sand to silty clay. It is neutral or slightly alkaline. Some pedons have AC horizons.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is loamy fine sand, fine sand or sand. It is slightly alkaline or moderately alkaline.

COMPETING SERIES: There are no other series in the family.

GEOGRAPHIC SETTING: Banks soils are on level to gently sloping levees, flood plains and low terraces of larger streams. Slopes are 0 to 6 percent. Most

areas have microtopographic small ridges, hummocks and hollows created by action of wind or floodwaters. The soils formed in recently deposited sandy alluvium. Mean annual temperature is 39 to 45 degrees F, and mean annual precipitation is 13 to 18 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Havrelon, Lallie, Lohler and Trembles soils. These soils commonly are on the more level floodplains farther from the stream channels. Havrelon soils are fine-loamy and Lallie and Lohler soils are fine. Trembles soils are coarse-loamy. In some areas, the land type, riverwash, is between the Banks soils and the stream channel.

DRAINAGE AND PERMEABILITY: Excessively or somewhat excessively drained. Slow or very slow runoff. Rapid permeability. The Banks soils are flooded nearly every time streams overflow, but they are under water only a short time.

USE AND VEGETATION: Native range and pasture are the main uses. Some is cropped to forage crops, small grains and corn. Cottonwoods, willows, sagebrush and other shrubs are widely spaced. Native grass vegetation is prairie sandreed, needleandthread and blue grama.

DISTRIBUTION AND EXTENT: Western North Dakota, northwestern South Dakota and northeastern Montana. They are of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: McKenzie County, North Dakota, 1932.

REMARKS: Revised 3/94.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface of the soil to a depth of 4 inches (A horizon); irregular decrease in organic carbon with depth (strata in 30 to 60 inches layer (C2 horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION BARNES ND+MN SD

Established Series
CJH
04/1999

BARNES SERIES

The Barnes series consists of very deep, well drained, moderately or moderately slowly permeable soils that formed in loamy till. These soils are on till plains and moraines and have slopes ranging from 0 to 25 percent. Mean annual air temperature is about 42 degrees F, and mean annual precipitation is about 17 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Barnes loam in a cultivated field. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine pores; slightly alkaline; abrupt smooth boundary. (Combined A horizons 4 to 11 inches thick)

Bw1--7 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, firm, slightly sticky and slightly plastic; common medium pores; patches of clay on vertical faces of peds; slightly alkaline; clear wavy boundary.

Bw2--11 to 19 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common medium pores; slightly alkaline; clear wavy boundary. (Combined Bw horizons 4 to 23 inches thick)

Bk--19 to 37 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable, slightly sticky and slightly plastic; few medium pores; few masses of carbonates; violent effervescence; moderately alkaline; gradual wavy boundary. (7 to 24 inches thick)

C--37 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Pierce County, North Dakota; 8 miles east, 2 miles south of Wolford; 2100 feet west and 1450 feet north of the southeast corner, sec. 27, T. 158 N., R. 69 W.

RANGE IN CHARACTERISTICS: The mollic epipedon is 7 to 16 inches thick. The 10 to 40 inch particle-size control section is loam or clay loam and contains up to 10 percent by volume of rock fragments. It has more than 30 percent total sand

and more than 20 percent fine sand and coarser sand. Stony phases are recognized.

The A horizon has hue of 10YR, value of 2 or 3 and 3 or 4 dry, and chroma of 1; however, chroma of 2 is allowed below the Ap. It typically is a loam but includes fine sandy loam, sandy loam, clay loam, sandy clay loam and silt loam. It is moderately acid to slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 5, 3 to 6 dry, and chroma of 2 to 4. It is loam, clay loam or sandy clay loam. It is slightly acid to slightly alkaline.

The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6, 5 to 8 dry, and chroma of 2 to 4. It is loam or clay loam. It has 10 to 30 percent calcium carbonate equivalent. It is slightly alkaline or moderately alkaline. It has relict mottles in some pedons. Some pedons have a BCk horizon.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, 4 to 7 dry, and chroma of 2 to 4. It is loam or clay loam. It is not mottled in some pedons. It is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Doland, Edgeley, Formdale, Hibar, Vienna and Yeoman series. Doland soils have less than 20 percent fine sand and coarser sand in the upper part of the series control section. Edgeley soils have a relatively high shale content and have bedded shale within 40 inches. Formdale soils contain less than 30 percent total sand in the particle-size control section. Hibar soils are moderately deep to sandstone. Vienna soils have silty upper horizons. Yeoman soils have hues redder than 10YR and occur at higher elevations.

GEOGRAPHIC SETTING: Barnes soils are on level to hilly till plains and moraines. Slope gradients typically are 2 to 6 percent, but range from 0 to 25 percent. The soils formed in loamy till. The climate is cool subhumid with a mean annual air temperature of 36 to 48 degrees F, and mean annual precipitation of 15 to 25 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aastad, Buse, Forman, Hamerly, Langhei, Parnell, Svea and Tonka soils. Aastad and Svea soils are on concave and nearly level positions. They have mollic epipedons more than 16 inches thick. Buse and Langhei soils are on steeper convex slopes. Buse soils do not have a cambic horizon. Langhei soils do not have mollic epipedons. Forman soils are on similar positions to Barnes. They have an argillic horizon. Hamerly, Parnell and Tonka soils are on lower lying foot slopes and flats, and in depressions. They are wetter and have water tables at or near the surface.

DRAINAGE AND PERMEABILITY: Well drained. Runoff ranges from negligible to high depending on the slope. Moderately slow or moderate permeability.

USE AND VEGETATION: Cultivated areas are used for growing small grains, flax, hay and pasture. Native vegetation is western wheatgrass, needleandthread, green needlegrass and blue grama.

DISTRIBUTION AND EXTENT: Eastern North Dakota, northeastern South Dakota and western Minnesota. The soils are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: LaMoure County, North Dakota, 1914.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 11 inches (Ap and Bw1 horizons); cambic horizon - the zone from 11 to 19 inches (Bw2 horizon).

ADDITIONAL DATA: Soil Survey Investigation Report No. 2, North Dakota, pages 16 to 29.

National Cooperative Soil Survey
U.S.A.

LOCATION BEARDEN ND+MN SD

Established Series
Rev. KWT-CJH
06/1999

BEARDEN SERIES

The Bearden series consists of very deep, somewhat poorly drained, moderately to slowly permeable soils that formed in calcareous silt loam and silty clay loam lacustrine sediments. These soils are on glacial lake plains and have slopes of 0 to 3 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Bearden silty clay loam on a plane slope of less than 1 percent under cropland. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure parting to moderate fine granular; very hard, friable, slightly sticky and slightly plastic; common fine roots; many fine pores; few threads of carbonates; strong effervescence (8 percent calcium carbonate); slightly alkaline; abrupt smooth boundary. (Combined A horizons 6 to 14 inches thick)

ABk--7 to 18 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) and dark gray (10YR 4/1) dry, gray (10YR 6/1) dry in the lower part; weak coarse and medium subangular blocky structure; very hard, friable, sticky and plastic; common fine roots; many fine pores; few fine masses of carbonates; disseminated carbonates throughout with the amount increasing with depth; violent effervescence (15 to 20 percent calcium carbonate); moderately alkaline; clear irregular boundary. (0 to 14 inches thick)

Bk1--18 to 28 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many fine pores; violent effervescence (25 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk2--28 to 36 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine faint gray (5Y 5/1) and few fine and medium prominent very dark brown (10YR 2/2) redoximorphic depletions; weak coarse subangular blocky structure parting to moderate fine and very fine subangular blocky; hard, friable, sticky and plastic; few fine pores; few masses of carbonates; violent effervescence (15 percent calcium carbonate); moderately alkaline; clear wavy boundary. (Combined Bk horizons 0 to 54 inches thick)

C1--36 to 46 inches; light olive brown (2.5Y 5/4) laminated silty clay loam, light yellowish brown (2.5Y 6/4) dry; common medium and fine distinct gray (5Y 5/1) redoximorphic depletions and common medium prominent dark yellowish brown (10YR 4/4) redoximorphic concentrations; few black nonmanganese spots; massive; very hard, friable, sticky and plastic; masses of gypsum crystals; few

masses of carbonates; strong effervescence (15 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

C2--46 to 60 inches; light olive brown (2.5Y 5/4) laminated silty clay loam; light yellowish brown (2.5Y 6/4) dry; common distinct gray (5Y 5/1) redox depletions and many fine and medium prominent dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) redoximorphic concentrations; massive; very hard, firm, sticky and plastic; few masses of carbonates; strong effervescence (15 percent calcium carbonate); slightly alkaline.

TYPE LOCATION: Pembina County, North Dakota, about 2 miles north and 3 miles east of St. Thomas; 640 feet east and 160 feet south of the northwest corner, sec. 29, T. 160 N., R. 52 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 20 inches thick. The soil is slightly alkaline or moderately alkaline. Saline phases are recognized.

The Ap or A horizon has hue of 10YR, 2.5Y, 5Y, or is neutral, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or less. It typically is silty clay loam but some is loam, silt loam, clay loam or silty clay. The A horizon contains 1 to 10 percent carbonates. Some pedons have tongues of A horizon extending into Bk horizon.

The ABk horizon has hue of 10YR, 2.5Y or is neutral, value of 2 to 5 and 3 to 6 dry, and chroma of 2 or less. It is silt loam or silty clay loam. It is slightly alkaline or moderately alkaline.

The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 7 and 5 to 7 dry, and chroma of 1 to 4. It is silt loam or silty clay loam. It contains 15 to more than 30 percent carbonates. Most of this is disseminated. Some pedons contain few or common, faint to prominent redoximorphic features in this horizon. Some pedons have Bky or BCk horizons.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 and 5 to 8 dry, and chroma of 2 to 4. In some pedons below 30 inches the hue is neutral and the chroma is 1 or less. The texture of the C horizon typically is silty clay loam or laminated silt loam and silty clay loam. In some pedons below a depth of 40 inches the textures range from gravelly coarse sand to clay. Some pedons do not have a C horizon within a depth of 60 inches.

COMPETING SERIES: These are the Cubden, Gunclub, McIntosh and Saunders series. Cubden and McIntosh soils formed in a silt mantle over glacial till and have 2C horizons containing 15 percent fine sand and coarser. Gunclub soils have clay till within depths of 40 to 60 inches. Saunders soils are poorly drained and have silty clay and clay textures within a depth of 40 inches.

GEOGRAPHIC SETTING: Bearden soils are on level and nearly level glacial lake plains. Slopes are 0 to 3 percent. The soils formed in calcareous silt loam and silty clay loam lacustrine sediments. The climate is cool, subhumid. The mean annual air temperature ranges from 36 to 45 degrees F, and the mean annual precipitation from 15 to 24 inches. Frost-free period ranges from 90 to 145 days. Elevation ranges from 650 to 2000 feet above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Antler, Beotia, Colvin, Gardena, Glyndon, Hegne, Overly and Perella soils. Antler soils are on adjacent interbeach areas where lake sediments are moderately deep over till. They are

fine-loamy. Beotia, Colvin, Overly and Perella soils are in a drainage sequence with Bearden soils. Beotia and Overly soils are at higher elevations in the lake plain. They do not have calcic horizons within depths of 16 inches and have Bw horizons. Colvin and Perella soils are in swales and lower lying flats and basins. Colvin soils are poorly drained. Perella soils do not have calcic horizons within a depth of 16 inches. Glyndon soils are on adjacent areas. They are coarse-silty. Gardena soils are on nearby lake plains at higher elevations. They do not have calcic horizons within depths of 16 inches and are coarse-silty. Hegne soils are on adjacent lake plains. They are fine.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is negligible to high. Permeability is slow to moderate. A seasonal high water table is at depths of 1.5 to 3.5 feet at some time during the period of April through June.

USE AND VEGETATION: Soils are nearly all cropped to small grains and row crops such as sugar beets. Native vegetation was big bluestem, switchgrass, western wheatgrass, and a variety of forbs.

DISTRIBUTION AND EXTENT: The Red River Valley in eastern North Dakota and northwestern Minnesota, and in glacial lake plains in northeastern South Dakota and central North Dakota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Ransom County, North Dakota, 1906.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to the depth of 7 inches (Ap horizon); calcic horizon the zone from 7 to 36 inches (ABk, Bk1, and Bk2 horizons); characteristics associated with wetness - calcic horizon (ABk, Bk1, and Bk2 horizons).

Were the soil has previously correlated as moderately well drained it should be recorrelated to the Rondell series (Aquic Calciudolls).

ADDITIONAL DATA: Type location laboratory data S54NDak-34-1; additional data ND51-P-6, S53ND-9-5, S53ND-9-6, S57ND-18-1, and S54ND-34-2.

National Cooperative Soil Survey
U.S.A.

LOCATION BORUP MN+ND SD

Established Series
RBH-CJH
05/2000

BORUP SERIES

The Borup series consists of very deep, poorly and very poorly drained soils that formed in loamy calcareous lacustrine sediments on lake plains. These soils have moderate or moderately rapid permeability and slopes of 0 to 3 percent. Mean annual precipitation is about 20 inches. Mean annual temperature is about 40 degrees F.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Borup silt loam, with a slightly concave slope of less than 1 percent in a shallow depression on a glacial lake plain in a cultivated field. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; strong effervescence; slightly alkaline; abrupt smooth boundary.

A--7 to 12 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary. (Combined A horizons 4 to 14 inches thick)

Bkg--12 to 28 inches; gray (5Y 5/1) silt loam, light gray (5Y 6/1) dry; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; tongues of very dark grayish brown (10YR 3/2) material to a depth of 18 inches; common fine and medium masses of gypsum crystals in the lower part; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkyg--28 to 34 inches; dark gray (5Y 4/1) silt loam, light gray (10YR 6/1) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium masses of gypsum crystals; violent effervescence; moderately alkaline; gradual wavy boundary. (Combined Bkg horizons 6 to 30 inches thick)

Cg--34 to 60 inches; grayish brown (2.5Y 5/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; common medium and coarse distinct light yellowish brown (2.5Y 6/4) redoximorphic concentrations; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Grand Forks County, North Dakota; about 7 miles east and 4 miles north of Northwood; 1,000 feet west and 40 feet south of the northeast corner of sec. 22, T. 150 N., R. 53 W.

RANGE IN CHARACTERISTICS: The thickness of mollic epipedon ranges from 7 to 20 inches. This soil is typically slightly alkaline or moderately alkaline throughout but is strongly alkaline in the Bk horizon of some pedons. These

soils do not have rock fragments to depths of 40 inches or more. In the 10- to 40-inch particle-size control section, the average content of noncarbonate clay is less than 18 percent. The calcium carbonate content in that section ranges from 15 to 40 percent with the higher values being in the calcic horizon.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3, and chroma of 1 or less. Texture is very fine sandy loam, loam, silt loam or silty clay loam. Some pedons have an Ak or ABk horizon up to 10 inches thick.

The Bk horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. Texture is loamy very fine sand, very fine sandy loam, loam or silt loam. It does not have accumulations of gypsum in some pedons.

The C horizon has hue of 10YR, 2.5Y, 5Y or neutral, value of 4 to 6, and chroma of 3 or less and typically has redoximorphic features. Value of 7 is allowed below depths of 48 inches. Texture is very fine sand, loamy very fine sand, very fine sandy loam, loam or silt loam.

Some pedons have a Bg horizon and/or do not have a Cg horizon.

A 2C horizon of loamy till or clayey lacustrine sediments or sandy or gravelly sediments begins at depths as shallow as 40 inches in some pedons.

COMPETING SERIES: No other series is in this family.

GEOGRAPHIC SETTING: These soils are on flats and in depressions and swales on lake plains. Slope gradients are less than 3 percent. They formed in calcareous lacustrine sediments of Late Wisconsinan Age. Mean annual air temperature is 36 to 45 degrees F, and mean annual precipitation ranges from 15 to 24 inches. The frost-free days range from 90 to 145. Elevation above sea level ranges from 800 to 2000 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Augsburg, Glyndon and Wheatville soils. Augsburg and Wheatville soils have clayey material above 40 inches. Glyndon and Wheatville soils are on slightly higher lying terrain and are somewhat poorly drained.

DRAINAGE AND PERMEABILITY: Very poorly and poorly drained. Runoff is very slow or ponded. Permeability is moderate or moderately rapid. Depth to an apparent seasonal high water table is as high as +0.5 to 1.5 feet at some time from April through June in most years. Depressional areas have an apparent seasonal high water table as high as +1.0 to 1.0 feet some time during most years.

USE AND VEGETATION: Most of these soils are cropped to small grains, potatoes, sugar beets, and corn. Undrained areas are used for pasture or hay. Native vegetation was a wet-site community of the tall grass prairie.

DISTRIBUTION AND EXTENT: Northwestern and western Minnesota, eastern North Dakota, and northeastern South Dakota primarily in the Red River Valley. Moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizon and features recognized in this pedon are: mollic epipedon - from the surface of the soil to a depth of 12 inches (Ap and A

horizons); calcic horizon - 12 inches to 34 inches (Bkg and Bkyg horizons); aquic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION CASHEL ND+MN

Established Series
Rev. CJH
4/96

CASHEL SERIES

The Cashel series consists of very deep, somewhat poorly drained, moderately slowly and slowly permeable soils that formed in recent fine-textured alluvium. These soils are on flood plains and have slopes of 0 to 25 percent. Mean annual air temperature is 39 degrees F and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine, smectitic, calcareous, frigid Aquertic Udifluvents

TYPICAL PEDON: Cashel silty clay - on a level plane slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

C--7 to 29 inches; very dark grayish brown (2.5Y 3/2) and olive (5Y 4/3) silty clay, grayish brown (2.5Y 5/2) and pale olive (5Y 6/3) dry; common fine prominent dark reddish brown (5YR 3/4) redox concentrations; weak medium platy structure parting to moderate fine granular; hard, friable, sticky and very plastic; few fine roots; strata of silty clay loam and silty clay 1/2 to 1 inch thick; few fine masses of carbonates in the lower part; strong effervescence; moderately alkaline; abrupt smooth boundary.

Ab--29 to 35 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium granular structure; very hard, firm, very sticky and very plastic; few fine masses of carbonates; strong effervescence; moderately alkaline; clear smooth boundary.

C'--35 to 47 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) and light olive brown (2.5Y 5/6) mottles; massive; hard, firm, sticky and very plastic; few fine masses of carbonates; strong effervescence; moderately alkaline; clear smooth boundary.

A'b--47 to 60 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; few fine prominent dark reddish brown (5YR 3/4) redox concentrations; massive; extremely hard, very firm, very sticky and very plastic; few fine masses of carbonates; strong effervescence; slightly alkaline.

TYPE LOCATION: Cavalier County, North Dakota; about 6 miles east and 4 miles north of Vang; 750 feet east and 400 feet north of the southwest corner, sec. 2, T. 163 N., R. 57 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section typically is silty clay or clay in the major part averaging between 50 and 60 percent clay, but ranges from 35 to 60 percent clay including silty clay loam with or without thin strata of silt loam. The upper horizons are laminated or finely stratified.

The soil is slightly alkaline or moderately alkaline throughout. One or more Ab horizons are within depths of 60 inches in most pedons.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or 2. It is silty clay loam, silty clay or clay. It is finely stratified in uncultivated areas. Some pedons have a thin A horizon below the Ap horizon.

The C horizon has hue of 2.5Y, 5Y, 10YR or is neutral, value of 2 to 5 and 4 to 7 dry, and chroma of 3 or less. It is laminated silty clay or silty clay loam but includes clay with or without thin strata of silt loam. It contains 1 to 10 percent carbonates diffused throughout the soil; and some accumulations as threads or masses. Some pedons have fragments of snail shells. It does not have redox features in some pedons.

COMPETING SERIES: There are no other series in the same family.

GEOGRAPHIC SETTING: Cashel soils are on flood plains. Slope gradients range from 0 to 25 percent. Stream meanders and channels cut up the soil areas in places. The soil formed in recent alluvium washed from fine-textured soils high in organic matter. The mean annual air temperature ranges from 38 to 45 degrees F, and the mean annual precipitation ranges from 18 to 22 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Colvin, Fairdale, Fargo, Hegne, La Prairie, Ludden, Nutley, Overly and Wahpeton soils. Bearden, Colvin and Overly soils are on nearby lake plains higher on the landscape above the flood plain. These soils are fine-silty and have regular decrease in organic matter. Fairdale, La Prairie and Ludden soils are on the same flood plain as Cashel soils. Fairdale and La Prairie soils are fine-loamy. Ludden soils have mollic epipedon more than 24 inches thick and are poorly drained. Fargo, Hegne and Nutley soils are on adjacent lake plains higher on the landscape. Fargo soils have a regular decrease in organic matter and Bw horizons. Hegne soils have calcic horizons within depths of 16 inches. Nutley soils have a mollic epipedon and a regular decrease of organic carbon with depth. Wahpeton soils are on levees and less frequently flooded areas on the flood plains. They have a mollic epipedon more than 16 inches thick.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Moderately slow or slow permeability. Runoff is negligible to very high depending on slope. These soils are flooded early in the spring following snow melt and after severe summer storms. They have a seasonal high water table at depths of 2 to 4 feet during and immediately after periods of flooding.

USE AND VEGETATION: Some areas are cropped to spring seeded small grains. Native vegetation is tall prairie grasses, mixed hardwoods and shrubs.

DISTRIBUTION AND EXTENT: Eastern North Dakota and western Minnesota, mainly along the Red River. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, June 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: criteria for Aquertic subgroup - saturated with water between a depth of 50 cm and 1 m at some period during the year and an LE of 6 cm or more in the top 1 m..

Where the series was mapped in some older surveys and on slumping areas of 6 to 25 percent slopes the series has a deep water table and may consist dominantly of Vertic or Mollic Udifluvents.

National Cooperative Soil Survey
U.S.A.

LOCATION CAVOUR SD+ND

Established Series
Rev. DMH-BOK
10/98

CAVOUR SERIES

The Cavour series consists of very deep, moderately well and well drained soils formed in glacial till on uplands. The soils have slow or very slow permeability. Slopes range from 0 to 6 percent. Mean annual precipitation is about 21 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Calcic Natrudolls

TYPICAL PEDON: Cavour loam - on a nearly level glacial till plain under grassland. When described the soil was slightly moist to 38 inches and moist below. (Colors are for dry soil unless otherwise stated.)

A--0 to 6 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate fine and medium granular structure; slightly hard, friable; neutral; abrupt smooth boundary. (4 to 10 inches thick)

E--6 to 8 inches; gray (10YR 5/1 and 10YR 6/1) silt loam, dark gray (10YR 4/1) and very dark gray (10YR 3/1) moist; weak thin platy structure; slightly hard, very friable; neutral; abrupt wavy boundary. (0 to 4 inches thick)

Btn1--8 to 13 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; moderate coarse columnar structure parting to strong medium and fine blocky; extremely hard, very firm, sticky and plastic; thin light gray (10YR 6/1) caps about 1/4 inch thick on tops of columns; neutral; gradual irregular boundary.

Btn2--13 to 19 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; weak medium and fine prismatic structure parting to strong medium and fine blocky; extremely hard, firm, sticky and plastic; moderately alkaline; clear wavy boundary.

Btnyz--19 to 24 inches; dark gray (5Y 4/1) clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine and medium blocky structure; very hard, firm, sticky and plastic; common fine and medium accumulations of gypsum and other salts; moderately alkaline; gradual wavy boundary. (Combined thickness of Btn horizons is 9 to 24 inches.)

Byz--24 to 32 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium accumulations of gypsum and other salts; slight effervescence; moderately alkaline; gradual wavy boundary. (0 to 20 inches thick)

C1--32 to 43 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common fine distinct of gray (2.5Y 5/1) redox depletions and prominent yellowish brown (10YR 5/6) redox concentrations; massive; hard, firm, sticky and plastic; few to common fine and medium accumulations of gypsum and

other salts; strong effervescence; moderately alkaline; gradual wavy boundary. (0 to 16 inches thick)

C2--43 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common fine prominent yellowish red (5YR 5/8) and strong brown (7.5YR 5/6) redox concentrations and common medium distinct gray (5Y 5/1) redox depletions; massive; hard, firm, sticky and plastic; few to common fine and medium accumulations of gypsum and other salts; strong effervescence; slightly alkaline.

TYPE LOCATION: Roberts County, South Dakota; about 3 miles south of Wilmot; 162 feet east and 51 feet north of the southwest corner of sec. 19, T. 122 N., R. 49 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 14 to 35 inches. Depth to accumulations of gypsum and other salts ranges from 16 to 45 inches. Thickness of the mollic epipedon typically is over 16 inches but ranges from 7 to 35 inches. The natric horizon has an estimated SAR or ESP of 10 to 20.

The A horizon has hue of 10YR or is neutral, value of 3 to 5 and 2 or 3 moist. It typically is loam or silt loam, but is clay loam in some pedons. Some pedons have up to 25 percent stones on the surface. It ranges from slightly acid to slightly alkaline.

The E horizon has value of 3 to 7 and 2 to 5 moist, and chroma of 1 or 2. It is silt loam or loam, but is fine sandy loam in some pedons. It ranges from slightly acid to slightly alkaline. When cultivated, the A and E horizons become mixed.

The Btn and Btnyz horizons have hue of 10YR, 2.5Y, or 5Y; value of 3 to 5 and 2 to 4 moist; and chroma of 3 or less. They are clay loam, clay, silty clay, or silty clay loam averaging between 35 to 50 percent clay with more than 15 percent fine sand or coarser. Reaction ranges from neutral to strongly alkaline. Accumulations of gypsum and other salts are not present in the lower part of this horizon in some pedons.

The Byz horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6 and 4 or 5 moist; and chroma of 1 to 3. It is loam, clay loam, silty clay loam, silty clay, or clay and ranges from slightly alkaline to strongly alkaline. Some pedons do not have gypsum accumulations.

Some pedons have a Bk horizon. It is loam, clay loam, silty clay loam, silty clay or clay. Some Bk horizons have accumulations of gypsum and other salts.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 4 or 5 moist, and chroma of 1 to 4. It is loam or clay loam and ranges from slightly alkaline to strongly alkaline. Accumulations of gypsum and other salts are few to common in the C horizon.

COMPETING SERIES: These are the Nahon and Rich series. Nahon soils are varved within depths of 40 inches and typically contain more silt and very fine sand. Rich soils typically do not have E horizons and have a drier soil moisture control section.

GEOGRAPHIC SETTING: The Cavour soils are on uplands having plane and slightly convex slopes. Slope gradients typically are 0 to 3 percent but range from 0 to 6 percent. Cavour soils formed in firm loam and clay loam glacial till. The

mean annual air temperature ranges from 38 to 48 degrees F, and the mean annual precipitation ranges from 16 to 24 inches. Growing season is about 120 to 130 days; average growing season precipitation ranges from 14 to 18 inches; and growing degree days are about 2500 to 2800.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aastad, Cresbard, Forman, Miranda, Parnell, Peever, and Tonka soils. Cresbard and Miranda soils are on similar positions on the landscape. Aastad, Forman, Parnell, Peever, and Tonka soils do not have natric horizons. In addition, Aastad soils are in swales. Forman soils are on higher positions on the landscape. Peever soils are on similar nearby level landscapes and on slight rises. Parnell and Tonka soils are very poorly and poorly drained and are in closed depressions.

DRAINAGE AND PERMEABILITY: Moderately well and well drained. Runoff is low to very high. Permeability is slow or very slow.

USE AND VEGETATION: These soils are used for growing small grains, corn, feed grains, and alfalfa. Native vegetation mainly is western wheatgrass, green needlegrass, blue grama, buffalograss, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and eastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Beadle County, South Dakota, 1943.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 24 inches (A, E, Btn1, Btn2, Btnyz horizons); Natric horizon - the zone from about 8 to 24 inches (Btn1, Btn2, Btnyz horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION CLAIRE ND+MN

Established Series
Rev. HWO-MDS-CJH
3/89

CLAIRE SERIES

The Claire series consists of deep, excessively drained, rapidly permeable soils that formed in coarse sand. These soils are on glacial outwash or delta plains and have slopes ranging from 0 to 25 percent. Mean annual temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Mixed, frigid Typic Udipsamments

TYPICAL PEDON: Claire loamy coarse sand - on a south-facing convex slope of 1 percent under cropland. Where described the soil was dry to 20 inches and moist 20 to 60 inches. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; dark gray (10YR 4/1) loamy coarse sand, black (10YR 2/1) moist; very weak fine subangular blocky structure parting to single grained; loose; common roots; neutral; abrupt smooth boundary. (Combined A horizons 2 to 15 inches thick)

AC--8 to 14 inches; dark grayish brown (10YR 4/2) coarse sand, very dark grayish (10YR 3/2) moist; weak very coarse prismatic structure parting to single grained; loose; few roots; neutral; clear wavy boundary. (0 to 10 inches thick)

C1--14 to 19 inches; dark grayish brown (10YR 4/2) coarse sand, very dark grayish brown (10YR 3/2) moist; single grained; few roots; mildly alkaline; clear wavy boundary.

C2--19 to 48 inches; grayish brown (10YR 5/2) coarse sand, dark grayish brown (10YR 4/2) moist; single grained; mildly alkaline; abrupt smooth boundary.

C3--48 to 60 inches; light gray (10YR 7/1) fine sand, dark grayish brown (2.5Y 4/2) moist; common medium dark reddish gray (5YR 4/2) moist; mottles; single grained; slight effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 1 mile south and 5 miles west of Hamar; 2540 feet east and 670 feet north of the southwest corner, sec. 2, T. 150 N., R. 63 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section is typically coarse sand, sand, or loamy coarse sand. The soil ranges from slightly acid in the upper part to moderately alkaline in the lower part. Where the lower part of the surface layer has value of 5 or less dry and 3 or less moist it contains less than 1 percent organic matter.

The A horizon has hue of 10YR, value of 4 to 6 and 2 to 4 moist, and chroma of 1 or 2. It typically is loamy coarse sand or loamy sand, but some is coarse sand, sand, sandy loam, or coarse sandy loam. Some pedons have Ab horizons.

The AC horizon has hue of 10YR, value of 4 to 6 and 3 or 4 moist, and chroma of 2. It is loamy coarse sand, loamy sand or coarse sand.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 to 5 moist, and chroma of 1 to 6. It commonly does not have carbonates, but some peds have slight effervescence at depths of 30 to 50 inches. Some pedons have coarser or finer textured materials at depths of 40 to 60 inches.

COMPETING SERIES: These are Friendship, Grayling, Mahtomedi, Menahga, Nymore, Omega, Pelkie, Plainbo, Sartell, Serden, Shawano, and Sunday in the same family and the Blanchard, Hubbard, Lino, Lohnes, Poppleton, Redby, Seroco, and Yetull series. Friendship soils have distinct mottles within depths of 36 inches. Grayling, Menahga, Nymore, Sartell, and Sunday soils are medium to very strongly acid. Mahtomedi soils have a Bw horizon. Omega and Pelkie soils are more acid. Plainbo soils have bedrock within depths of 20 to 40 inches. Serden soils have fine sand in the series control section. Shawano soils have B horizons with hue of 7.5YR and chroma of 4 or higher. Blanchard series and Yetull soils are drier. In addition, Blanchard soils contain carbonates throughout the series control section. Hubbard and Lohnes soils have mollic epipedons. Lino, Poppleton, and Redby soils have seasonal water tables within depths of 30 to 50 inches and distinct mottling within depths of 30 inches.

GEOGRAPHIC SETTING: Claire soils are on level to hilly glacial outwash or delta plains. Slope gradients typically range from 0 to 4 percent but are as steep as 25 percent. The soils formed in coarse sand. The climate is subhumid, with short warm summers and long cold winters. Mean annual temperature ranges from 38 to 45 degrees F, and mean annual precipitation from 16 to 22 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Lohnes and Serden soils and the Hamar, Hecla, and Maddock soils. Lohnes soils are in less sloping and concave areas in the same plain as the Claire soils. Serden soils are on nearby plains. Hamar soils are in concave swales and basins and are poorly drained. Hecla and Maddock soils are on nearby plains and contain less coarse sand and more fine and very fine sand. Hecla and Maddock soils have mollic epipedons.

DRAINAGE AND PERMEABILITY: Excessively drained. Little or no runoff when the soil is not frozen. Permeability is rapid.

USE AND VEGETATION: Soils are cropped to small grains and tame grass and are used for range and pasture. Native vegetation is as prairie sandreed, sand bluestem, Pennsylvania sedge, sand dropseed, needleandthread, some forbs and shrubs.

DISTRIBUTION AND EXTENT: Eastern North Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Lamoure County, North Dakota, 1971.

REMARKS: Revised 2/89.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface of the soil to a depth of 14 inches (A and AC horizons); coarse sand texture between 10 and 40 inches (AC, C1, and C2 horizons).

ADDITIONAL DATA: Refer to S60ND-14-1 (1-6), North Dakota Agricultural Experiment Station.

National Cooperative Soil Survey
U.S.A.

LOCATION COLVIN ND+MN MT SD

Established Series
CJH
06/2001

COLVIN SERIES

The Colvin series consists of very deep, poorly and very poorly drained, moderately to slowly permeable soils formed in silt loam and silty clay loam sediments. These soils are in concave shallow swales and depressions on glacial lake plains, in outwash channels, on stream terraces and in drainageways on till plains. Slope ranges from 0 to 2 percent. Mean annual air temperature is 41 degrees F and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Colvin silty clay loam on a level concave slope less than 1 percent under native grass. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

A--0 to 10 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium granular; hard, friable, sticky and plastic; many roots; many fine pores; strong effervescence; slightly alkaline; clear wavy boundary. (6 to 16 inches thick)

Bkg1--10 to 20 inches; gray (5Y 6/1) and olive gray (5Y 5/2) silty clay loam, gray (N 6/0) and white (N 8/0) dry; very weak medium subangular blocky structure parting to weak fine granular; hard, friable, slightly sticky and plastic; common roots; common fine pores; few masses of carbonates; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg2--20 to 30 inches; light olive gray (5Y 6/2) and olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/1) and gray (5Y 6/1) dry; common medium prominent light olive brown (2.5Y 5/6) redoximorphic concentrations; very weak fine subangular blocky structure; hard, friable, slightly sticky and plastic; few roots; common pores; strong effervescence; moderately alkaline; gradual wavy boundary. (Combined Bkg horizons 8 to 54 inches thick)

Cg--30 to 60 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/8) and few medium prominent yellowish red (5YR 5/6) redoximorphic concentrations; massive; hard, friable, sticky and plastic; strong effervescence in upper part, gradually decreases to slight effervescence at 50 inches; moderately alkaline.

TYPE LOCATION: LaMoure County, North Dakota; about 1 mile south and 2 miles east of Marion; about 75 feet north and 65 feet east of the southwest corner, sec. 18, T. 136 N., R. 60 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 24 inches in thickness. The top of the calcic horizon is at depths of less than 16 inches. In some pedons the lower part of the mollic epipedon is part of the calcic horizon. The 10- to 40-inch particle-size control section typically has 20 to 30 percent noncarbonate clay and ranges from 18 to 35 percent. It contains less than 15 percent fine sand and coarser. Saline phases are recognized.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3 and 3 or 4 dry, and chroma of 1 or less. It typically is silt loam or silty clay loam, but the range includes clay loam and silty clay. It is neutral to moderately alkaline. Some pedons have an Ak or ABk horizon. Where present they have hue similar to the A horizon, and value of 3 or 4 and 4 to 6 dry, and chroma of 1 or 2.

The Bkg or Bk horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 3 to 7 and 5 to 8 dry, and chroma of 2 or less. Chroma of 3 is allowed below a depth of 30 inches. It is silt loam or silty clay loam, but clay loam is allowed below a depth of 25 inches. It is slightly alkaline to strongly alkaline. It typically has a calcium carbonate equivalent of 20 to 50 percent. Some pedons have Bky, Bkz or BC horizons.

The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 and 5 to 7 dry, and chroma of 1 to 4. It is silt loam or silty clay loam, but clay loam is allowed below a depth of 25 inches. The Cg horizon below depths of 40 inches typically has similar textures. However, in some pedons the texture ranges from sand to clay below a depth of 40 inches. The Cg horizon is massive, laminated or has weak grades of blocky structure. It typically contains few to many redoximorphic features with chroma of 3 to 8. It is slightly alkaline or moderately alkaline. Crystals of gypsum and other soluble salts are in some pedons. Some pedons do not have a C horizon within a depth of 60 inches.

COMPETING SERIES: These are the Bear Lake, Colake, Ojata, Regan and Winger series. Bear Lake soils have sola more than 60 inches thick and have lime nodules in the Bkg horizon. Colake soils do not have redoximorphic features within a depth of 40 inches. Ojata soils are strongly saline with conductivity exceeding 16 mmhos/cm. Regan soils contain more than 15 percent fine sand or coarser in the lower half of the control section. Winger soils have loamy glacial till in the lower part of the control section.

GEOGRAPHIC SETTING: Colvin soils are in level concave shallow swales and depressions on glacial lake plains, in outwash channels, on stream terraces and in drainageways on till plains. Slopes are 0 to 2 percent. The soils formed in silt loam and silty clay loam sediments. The mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation from 15 to 25 inches. Frost-free period ranges from 90 to 145 days. Elevation ranges from 650 to 2000 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Ojata soils and Antler, Bearden, Borup, Gardena, Hegne, Lamoure, Overly, Perella and Rauville soils. Ojata soils are on nearby saline swales and depressions. Antler soils are on nearby interbeach areas. They are fine-loamy and have 2C horizons within depths of 20 to 40 inches of firm glacial till. Bearden, Overly and Perella soils are in a drainage sequence with Colvin soils. Bearden and Overly soils are on higher elevations. Overly soils have Bw horizons and do not have carbonates or calcic horizons within depths of 16 inches. Borup soils are on nearby lake plains where sediments contain less clay and more very fine sand. Hegne soils are on nearby lake plains where sediments are clays. Lamoure and Rauville soils are on nearby bottom lands and flood plains of outwash valleys and streams. Perella soils are on similar landscapes as Colvin soils. Perella soils do not have calcic horizons within depths of 16 inches.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Runoff ranges from negligible to medium depending on slope and surface texture. Water runs onto

these soils and ponds for a time during wet seasons. The soils commonly are too wet to cultivate unless drained. Soils on stream terraces occasionally flood from stream overflow. Permeability is moderate to slow. An apparent seasonal high water table is at a depth of 0.0 to 1.5 feet at some time during the period of March through July in the poorly drained phase. It is at a depth of 1 foot above the surface to 1 foot below the surface at some time during the period of November through July in the very poorly drained phase.

USE AND VEGETATION: Soils are cropped to small grains. Undrained areas are used for pasture and hay. Native vegetation is slim sedge, wooly sedge, prairie cordgrass, and a variety of forbs and other sedges.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, western Minnesota and northeastern South Dakota. The soil is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 10 inches (A horizon); calcic horizon - the zone from 10 to 30 inches (Bkg1 and Bkg2 horizon); characteristics associated with wetness - calcic horizon (Bkg1 and Bkg2 horizons).

ADDITIONAL DATA: S66NDak-14-2; S66NDak-14-7; S66NDak-14-8; S67NDak-50- 3; S67NDak-50-4.

National Cooperative Soil Survey
U.S.A.

LOCATION CRESBARD SD+ND

Established Series
Rev. MWS-KFM-BOK
10/98

CRESBARD SERIES

The Cresbard series consists of very deep, moderately well and well drained soils formed in glacial till, or local alluvium over glacial till on lower back slopes, foot slopes in depressions, and flats on uplands. Permeability is slow or moderately slow. Slopes range from 0 to 6 percent. Mean annual precipitation is about 21 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Glossic Natrudolls

TYPICAL PEDON: Cresbard loam - on slope of less than 1 percent in an upland swale in native grass. When described the soil was moist to 14 inches and dry below. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; common very fine vesicular and few tubular pores; moderately acid; abrupt smooth boundary. (5 to 12 inches thick)

E--9 to 10 inches; light gray (10YR 6/1) loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium platy structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine vesicular and tubular pores; slightly acid; clear smooth boundary. (0 to 6 inches thick)

E/B--10 to 14 inches; 60 percent light gray (10YR 6/1) (E) and 40 percent dark gray (10YR 4/1) (B) clay loam, very dark grayish brown (10YR 3/2) (E) and black (10YR 2/1) (B) moist; moderate medium prismatic structure parting to moderate very fine and fine blocky; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular and common vesicular pores; slightly acid; clear smooth boundary. (0 to 7 inches thick)

Btn1--14 to 28 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine tubular pores; neutral; gradual wavy boundary.

Btn2--28 to 34 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to strong medium blocky; extremely hard, firm, moderately sticky and moderately plastic; common very fine and fine roots throughout; common very fine tubular pores; common prominent dark gray (10YR 4/1) continuous clay films on vertical and horizontal faces of peds; about 1 percent gravel; neutral; clear wavy boundary. (Combined thickness of Btn horizons is 7 to 25 inches.)

Bk--34 to 55 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many coarse faint gray (10YR 5/1) redox depletions and few fine prominent yellowish brown (10YR 5/6) redox concentrations; moderate medium

prismatic structure parting to weak very fine and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine tubular pores; common medium irregular masses of carbonates; about 3 percent gravel; strongly effervescent; slightly alkaline; gradual irregular boundary. (0 to 30 inches thick)

C--55 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many medium distinct light gray (10YR 6/1) reodx depletions and many fine prominent yellowish brown (10YR 5/6) redox concentrations; massive; hard, friable, slightly sticky and slightly plastic; many very fine vesicular and tubular pores; few fine rounded masses of carbonate; strongly effervescent; about 2 percent gravel; slightly alkaline.

TYPE LOCATION: Clark County, South Dakota; about 6 1/2 miles north and 2 miles east of Carpenter; 1300 feet south and 120 feet west of the northeast corner of sec. 35, T. 115 N., R. 59 W.

RANGE IN CHARACTERISTICS: The depth to carbonate ranges from 15 to 40 inches. Exchangeable sodium exceeds 15 percent in the lower part of the B horizon or in the C horizon. The particle size control section contains more than 15 percent fine sand or coarser.

The A horizon has value of 3 or 4 and 2 or 3 moist. In some pedons, the lower part has chroma of 2. It is silt loam or loam. It is moderately acid to neutral.

The E horizon has value of 5 or 6 and 2 to 4 moist, and chroma of 1 or 2. It is loam or silt loam and moderately acid to neutral. Some pedons have dark gray silt coatings on faces of peds.

In the E/B horizon, the E part has colors similar to the E horizon and the B part has colors similar to Bt horizon. It is clay loam or silty clay loam. Gray or light gray silt coatings are on faces of peds. Some pedons have relic round topped columnar peds that are degraded in color and structure with horizontal and vertical streaks of gray of light gray extending an inch or more into the columns. These peds part readily to medium through very fine subangular or angular blocks. The E/B horizon is moderately acid to neutral. Some pedons have B/E, EB, or BE horizons.

The Btn horizon has hue of 10YR or 2.5Y, value of 3 to 6 and 2 to 4 moist, and chroma of 1 to 3. It typically is silty clay, clay loam, or clay. It contains 35 to 50 percent clay and more than 15 percent fine sand or coarser. The Btn horizon is slightly acid or neutral in the upper part and ranges to moderately alkaline in the lower part. Some pedons have Btnz, Btnk, Btkn, or By horizons.

The Bk horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It is clay loam, loam, or silt loam. It has common to many accumulations of carbonate. Some pedons have accumulations of gypsum and other salts. It is slightly alkaline to strongly alkaline. Some pedons have By, Bz, or BCk horizons.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It is clay loam, loam, or silt loam. Some pedons have few or common fine nests and striations of gypsum and other salts. The C horizon is slightly alkaline to strongly alkaline. Some pedons have silt loam lenses below 40 inches. Some pedons have hue of 2.5Y or 5Y, value of 4 and 3 moist, and

chroma of 1 or 2 below a depth of 60 inches that are inherent from the parent material.

COMPETING SERIES: This is the Aberdeen series. Aberdeen soils contain less than 15 percent fine sand or coarser in the series control section.

GEOGRAPHIC SETTING: Cresbard soils are mainly on footslopes, backslopes, and in toeslopes on uplands. Slope gradients typically are less than 2 percent but range from 0 to 6 percent. The soils formed in glacial till, or local alluvium over glacial till. Mean annual air temperature ranges from 38 to 45 degrees, and mean annual precipitation from 17 to 25 inches. Most of the precipitation comes in the spring and summer. Growing season is about 110 to 140 days; average growing season precipitation ranges from 13 to 24 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aastad, Barnes, Cavour, Forman, Parnell, Peever, Svea, and Tonka soils. Aastad soils are in swales and do not have a natric horizon. Cavour soils do not have E/B horizons, have columnar structure in the upper Btn horizon, and are on the similar nearby landscapes. Barnes, Forman, Peever, and Svea soils are on adjacent uplands and do not have natric horizons. Parnell and Tonka are in nearby upland depressions and do not have a natric horizon.

DRAINAGE AND PERMEABILITY: Moderately well drained and well drained. Runoff is negligible to high. Permeability is slow or moderately slow. A water table at 4 to 6 feet is present in the moderately well drained phase in most years.

USE AND VEGETATION: Most areas of Cresbard soils are used to grow small grain or alfalfa. Native vegetation is mainly western wheatgrass, little bluestem, big bluestem, porcupinegrass, needleandthread, green needlegrass, sideoats grama, blue grama, and sedges.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, North Dakota, and possibly Minnesota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1954.

REMARKS: Diagnostic horizons and features recognized in this pedon: mollic epipedon - the zone from the surface of the soil to a depth of 28 inches (Ap, E, E/B, Btn1 horizons); Natric horizon - the zone from 14 to 34 inches (Btn1, Btn2 horizons); glossic horizon - the zone from 10 to 14 inches (E/B horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION DARNEN MN+ND SD

Established Series
Rev. TLP-JMK-AGG
07/2000

DARNEN SERIES

The Darnen series consists of very deep, well drained soils that formed in loamy colluvial-alluvial sediments from glacial drift on glacial moraines. These soils have slopes of 0 to 6 percent. They have moderate permeability. Mean annual air temperature is about 43 degrees F. Mean annual precipitation is about 22 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Cumulic Hapludolls

TYPICAL PEDON: Darnen loam on a 3 percent concave footslope at the base of the bluffs of a small river valley; ground moraine; cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary. (6 to 10 inches thick)

A--8 to 24 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; many fine pores; neutral; clear smooth boundary. (6 to 28 inches thick)

AB--24 to 29 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; many fine pores; neutral; clear smooth boundary. (0 to 10 inches thick)

Bw1--29 to 34 inches; very dark grayish brown (10YR 4/2) loam; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary. (0 to 25 inches thick)

Bw2--34 to 80 inches; dark grayish brown (2.5Y 4/2) loam; weak fine subangular blocky structure; friable; strong effervescence; slightly alkaline.

TYPE LOCATION: Swift County, about 6 miles north northwest of Holloway; about 1,900 feet west and 150 feet north of the southeast corner, sec. 29, T. 122 N., R. 42 W., USGS Hancock SW Minnesota quadrangle, 45 degrees 20 minutes 26 seconds N., lon. 95 degrees 57 minutes 37 seconds W., NAD27

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 24 to 48 inches in thickness. Depth to free carbonates is 20 to 60 inches. The control section has 18 to 30 percent clay and from 15 to about 35 percent fine sand and coarser. Pedons have fine strata from downslope soil movement. Pedons commonly are free of rock fragments, but some have as much as 5 percent of the volume, mostly below 30 inches. In some pedons thin lenses, less than 6 inches thick, of sand or loamy sand are in the lower part of the control section. The soil moisture control section is dry for 20 to 35 consecutive days at some time during the 120 days following the summer solstice.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Typically it is loam, silt loam, sandy loam, or clay loam.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 2 to 6. The lower value and/or chroma are mostly in the upper part of the B horizon. It is loam or clay loam. It is slightly acid to slightly alkaline. Redoximorphic feature are in some pedons below depths of 36 inches.

Some pedons have a Bk horizon and/or a C horizon.

COMPETING SERIES: These are the Everts, Frolic, La Prairie and Southhaven series. Everts soils have coarse textured material above depths of 60 inches. Frolic and Southhaven soils do not have carbonates above a depth of 60 inches. La Prairie soils have free carbonates throughout the control section.

GEOGRAPHIC SETTING: These soils are on nearly level to gently sloping foot slopes or toe slopes on glacial moraines. Slope gradients range from 0 to 6 percent. The soil formed in loamy, colluvial-alluvial sediments derived from loamy glacial till or drift. The mean annual temperature ranges from 38 to 46 degrees F. The mean annual precipitation is 18 to 24 inches. The frost-free days range from 90 to 150 days. Elevation above sea level is 670 to 1400 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the well drained Buse, Langhei and Barnes soils. The Barnes, Langhei and Buse soils are upland soils formed in glacial till, and they are on slopes above the Darnen soils. In some places they are associated with moderately well drained Svea, poorly drained Flom and very poorly drained Quam soils.

DRAINAGE AND PERMEABILITY: Well drained. Permeability is moderate. Surface runoff is medium. Depth to an apparent seasonal water table is 4 to 6 feet at some time from November to June in normal years.

USE AND VEGETATION: Most of these soils are cultivated. Corn, soybeans and small grains are the principal crops. Native vegetation is tall grass prairie.

DISTRIBUTION AND EXTENT: Western Minnesota, eastern North Dakota and eastern South Dakota. Moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Norman County, Minnesota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 29 inches (Ap, A, and AB horizons); Cumulic based on colluvium having fine strata from periodic sediment moving downslope with rainfall events. Often the color of the upper sediment is lighter than the original surface due to deposition; udic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION DICKEY ND+MN SD

Established Series
CJH
1/99

DICKEY SERIES

The Dickey series consists of very deep, well drained soils that formed in wind and water deposited sands over loam or clay loam till or lacustrine sediments. Permeability is moderately rapid or rapid in the upper part and moderate or moderately slow in the loamy material. These soils are on sand mantled till or glaciolacustrine plains and have slopes ranging from 0 to 25 percent. Mean annual air temperature is 40 degrees F and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Sandy over loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Dickey loamy fine sand on a convex north northeast-facing slope of 3 percent under grassland. When described the soil was moist above 12 inches and below 42 inches. (Colors are for moist soil unless otherwise stated)

A--0 to 12 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many fine roots; slightly alkaline; clear wavy boundary. (5 to 16 inches thick)

Bw1--12 to 20 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak very coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; clear wavy boundary.

Bw2--20 to 30 inches; dark brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; single grain; nonsticky and nonplastic; few fine roots; neutral; abrupt wavy boundary. (Combined Bw horizons 0 to 30 inches thick)

2Bk--30 to 42 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common soft masses of carbonates; violent effervescence; moderately alkaline; gradual wavy boundary. (6 to 30 inches thick)

2C--42 to 60 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Pierce County, North Dakota; about 1 mile west and 1 mile north of Orrin; 650 feet south and 100 feet west of the northeast corner, sec. 5, T. 153 N., R. 74 W.

RANGE IN CHARACTERISTICS: Depth to the loamy material commonly is 24 to 36 inches but ranges from 20 to 40 inches. The mollic epipedon is less than 16 inches thick.

The A horizon has hue of 10YR, value of 2 to 4 and 3 or 4 dry, and chroma of 1. It has chroma of 2 in the lower part of some pedons. It typically is loamy fine sand or loamy sand but some is fine sandy loam or sandy loam. It is slightly acid to slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 5 and 3 to 6 dry, and chroma of 1 to 4. It is loamy fine sand, fine sand, or loamy sand. It has weak grades of prismatic or subangular blocky structure. It is slightly acid to slightly alkaline. Some pedons have AC, BC, or C horizons above the 2C material. Some pedons have 2BC horizons.

The 2Bk and 2C horizons have hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 and 5 to 8 dry, and chroma of 2 to 4. They typically are loam or clay loam glacial till but some are silt loam or silty clay loam lacustrine sediments. They contain up to 10 percent by volume of rock fragments. They are slightly alkaline to moderately alkaline. The 2Bk horizon contains an estimated 10 to 30 percent calcium carbonate equivalent, but has more than 15 percent in some part. A thin stone, cobble or gravel line is at the upper boundary of the 2Bk horizon in some pedons.

COMPETING SERIES: This is the Towner series. Towner soils have mollic epipedons over 16 inches thick.

GEOGRAPHIC SETTING: Dickey soils are on level to hilly sand mantled till or glaciolacustrine plains. Slopes are convex or plain and range from 0 to 25 percent. The soils formed in wind and water deposited sands over loam or clay loam till or lacustrine sediments. The climate is cool, subhumid. Mean annual air temperatures range from 36 to 45 degrees F, and mean annual precipitation from 15 to 23 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Towner soils and the Barnes, Buse, Egeland, Esmond, Emrick, Hecla, Heimdal, Maddock, Serden and Swenoda soils. Towner and Swenoda soils are on nearby less sloping areas. Swenoda soils are coarse-loamy. Barnes, Buse, Esmond, Emrick and Heimdal soils are on nearby upland till plains. All are loamy throughout. Egeland soils are on nearby outwash plains and are coarse-loamy. Hecla and Maddock soils are on nearby delta and lacustrine areas where sands are thicker. They are sandy. Serden soils are on hilly sandy areas. They do not have mollic epipedons.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is negligible to medium depending on slope. Permeability is moderately rapid or rapid in the upper part and moderate or moderately slow in the loamy material.

USE AND VEGETATION: Soils are cropped to small grains and corn and used for hay and pasture. Native vegetation was needleandthread, prairie sandreed, sand bluestem, sun sedge, and a variety of forbs.

DISTRIBUTION AND EXTENT: Eastern North Dakota, northeastern South Dakota, and western Minnesota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Brookings County, South Dakota, 1956.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 12 inches (A horizon); calcic horizon - the zone from 30 to 42 inches (2Bk horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION DIMMICK ND+MT SD

Established Series
Rev. CJH
10/1999

DIMMICK SERIES

The Dimmick series consists of very deep, very poorly drained, very slowly permeable soils that formed in clayey sediments. These soils are in depressions on uplands and in lake basins and have slopes of 0 to 2 percent. Mean annual air temperature is 41 degrees F, and mean annual precipitation is 16 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Vertic Epiaquolls

TYPICAL PEDON: Dimmick clay in native grass. (Colors are for moist soil unless otherwise stated)

Oe--3 to 0 inches; roots and partly decomposed stems and leaves of plants; loose; abrupt smooth boundary. (0 to 4 inches thick)

A--0 to 3 inches; very dark gray (10YR 3/1) clay, gray (10YR 5/1) dry; moist; many very fine distinct dark yellowish brown (10YR 4/4) iron accumulations; strong fine and very fine angular blocky structure; hard, firm, very sticky and very plastic; many fine and medium roots; neutral; gradual wavy boundary.

Ag--3 to 20 inches; very dark gray (5Y 3/1) clay, gray (5Y 5/1) dry; many medium prominent dark yellowish brown (10YR 4/4) iron accumulations; weak fine angular blocky structure; hard, very firm, very sticky and very plastic; common fine and few medium roots; neutral; gradual smooth boundary. (Combined A horizon 12 to 24 inches thick)

BCg--20 to 40 inches; dark gray (5Y 4/1) clay, gray (5Y 6/1) dry; many medium prominent olive brown (2.5Y 4/4) iron accumulations; weak fine subangular blocky structure; hard, very firm, very sticky and very plastic; few roots; neutral; diffuse wavy boundary.

Cg--40 to 60 inches; dark gray (N 4/0) clay, gray (N 6/0) dry; many coarse prominent olive brown (2.5Y 4/4) iron accumulations; massive; hard, very firm, very sticky and very plastic; slightly alkaline.

TYPE LOCATION: Dunn County, North Dakota; 4 miles south, 3 miles east of Killdeer; 1056 feet south and 180 feet east of the northwest corner, sec. 11, T. 144 N., R. 95 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 20 to more than 40 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. The soil moisture control section is saturated for up to 21 days beyond the summer solstice in most years.

The A horizon has hue of 10YR, 2.5Y or 5Y or is neutral, value of 2 or 3, 4 or 5 dry, and chroma of 2 or less. It is silty clay, clay, or silty clay loam and is slightly acid to moderately alkaline. Some pedons have ABk or Bk horizons.

The BCg and Cg horizons have hue of 2.5Y, 5Y, or is neutral, value of 4 to 8, and chroma of 0 to 3. They are clay or silty clay, but some pedons have strata of silty clay loam or sandy clay loam. They are neutral to moderately alkaline. Some pedons do not have a BCg horizon. Some pedons are loam, silt loam or silty clay loam below 40 inches.

COMPETING SERIES: These are the Foxlake and Fulda series. Foxlake soils have rock fragments and formed in till. Fulda soils are not saturated beyond the summer solstice in most years. Series that competed prior to the classification change include the Mountmed soils. Mountmed soils have a mean annual precipitation of 35 inches most of which falls in the fall and winter. In addition, they have rock fragments and a mollic epipedon less than 14 inches thick.

GEOGRAPHIC SETTING: Dimmick soils are in level or nearly level, slightly concave depressions on uplands and in lake basins. The soil formed in clayey sediments. Slope ranges from 0 to 2 percent. Mean annual air temperature is 39 to 45 degrees F, and mean annual precipitation is 10 to 18 inches. Most of the precipitation falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arnegard, Belfield, Farland, Grail, Morton, Reeder, Savage, Sen and Vebar soils. Arnegard, Belfield, Farland, Grail and Savage soils are in nearby swales and on terraces and are well drained. Morton, Reeder, Sen and Vebar soils are on nearby uplands and are well drained.

DRAINAGE AND PERMEABILITY: Very poorly drained. Runoff is ponded. Water runs into the basins and remains for weeks at a time. Permeability is very slow.

USE AND VEGETATION: Some is in hay and pasture. Native vegetation is slough sedge, rivergrass and rushes.

DISTRIBUTION AND EXTENT: In small areas in western North Dakota, eastern Montana and northwestern South Dakota. The extent is moderate.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: McKenzie County, North Dakota, 1932.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 20 inches (A and Ag horizons); characteristics associated with wetness - chroma of 1 and distinct mottles in the lower part of the mollic epipedon (Ag horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION DIVIDE ND+MN SD

Established Series
Rev. CJH
06/1999

DIVIDE SERIES

The Divide series consists of very deep, somewhat poorly drained soils that formed in loamy sediment over sand and gravel. Permeability is moderate over rapid or very rapid. These soils are on slightly depressed areas in outwash plains, flood plains, terraces and interbeach areas and have slope ranging from 0 to 3 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Divide loam on a plane level slope of less than 1 percent under cropland. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

Ap--0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; about 5 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary. (A horizon 7 to 20 inches thick)

Ak--8 to 12 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; few fine masses of carbonates; violent effervescence; moderately alkaline; abrupt wavy boundary. (0 to 7 inches thick)

Bk--12 to 22 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; common medium masses of carbonates; violent effervescence; moderately alkaline; clear smooth boundary. (8 to 28 inches thick)

2C1--22 to 26 inches; light olive brown (2.5Y 5/4) gravelly loamy coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 20 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

2C2--26 to 60 inches; olive brown (2.5Y 4/4) very gravelly coarse sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; slight effervescence; moderately alkaline.

TYPE LOCATION: Nelson County, North Dakota; about 2 miles south of Pekin; 1,050 feet west and 315 feet south of the northeast corner, sec. 4, T. 149 N., R. 60 W.

RANGE IN CHARACTERISTICS: The depth to sand and gravel typically is 24 to 30 inches and ranges from 20 to 40 inches. The mollic epipedon ranges from 7 to 20

inches in thickness. The soil is slightly alkaline or moderately alkaline throughout. Saline and channeled phases are recognized.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1. Chroma of 2 is allowed in the lower part. The A horizon typically is loam, but the range includes sandy loam, sandy clay loam, silt loam, and clay loam. It does not have carbonates in the upper part of some pedons. Some pedons have an ABk horizon.

The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 7 and 5 to 8 dry, and chroma of 1 to 4. It is loam, clay loam, or sandy clay loam averaging between 18 and 30 percent clay. The calcium carbonate equivalent ranges from 15 to 35 percent. The lower part of the Bk horizon is gravelly loam in some pedons. Some pedons have 2Bk or 2BC horizons.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 and 5 to 7 dry, and chroma of 2 to 6. It contains a mixture of sand and granitic or shale gravel. It is stratified in some pedons. Some pedons have loamy till below a depth of 40 inches.

COMPETING SERIES: There are no other series in the family.

GEOGRAPHIC SETTING: Divide soils are on level and nearly level areas on outwash plains, flood plains, terraces and interbeach areas. Slope gradients are 0 to 3 percent. The soils formed in loamy sediments over sand and gravel. The climate is cool, subhumid. Mean annual air temperature ranges from 34 to 48 degrees F, and mean annual precipitation ranges from 12 to 24 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arvilla, Binford, Brantford, Fordville, Kensal, Marysland, Moritz, Osakis, Renshaw, Spottswood, Vang, Walum, Warsing and Wyrene soils. Arvilla and Osakis soils are on nearby sandy outwash and do not have calcic horizons at depths of less than 16 inches. In addition, Arvilla soils are somewhat excessively drained. Binford, Brantford, Kensal, Vang and Walum soils are on nearby outwash areas which contain large amounts of shale fragments in the sand and gravel. None of these soils have calcic horizons at depth of less than 16 inches. Fordville and Renshaw soils are on well drained, higher parts of the outwash plain at higher elevations than Divide soils. They do not have calcic horizons at depths of less than 16 inches and are well and somewhat excessively drained. Marysland soils are in lower lying swales and depressions. They have distinct or prominent redoximorphic features at depths of less than 20 inches and are poorly and very poorly drained. Moritz soils do not have sand and gravel within a depth of 40 inches. Moritz, Spottswood and Warsing soils are on landscape positions similar to Divide soils. Spottswood and Warsing soils are slightly better drained and do not have calcic horizons at depth of less than 16 inches. Wyrene soils are in similar positions in the landscape as Divide soils. They are sandy.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is slow. Permeability is moderate over rapid or very rapid (loamy substratum phases have moderately slow permeability below 40 inches). A seasonal high water table is at depths of 1.5 to 3.5 feet at some time during the period of April through June. Soils on flood plains are occasionally flooded for very brief periods.

USE AND VEGETATION: Mainly cropped to wheat and other small grains, hay, and some pasture. Native vegetation is big and little bluestem, prairie junegrass,

green needlegrass, western wheatgrass, bearded wheatgrass, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, northeastern South Dakota, and western Minnesota. The soil is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 12 inches (Ap and Ak horizons); calcic horizon - the zone from 8 to 22 inches (Ak and Bk horizons); characteristics associated with wetness - calcic horizon (Ak and Bk horizons) within 40 inches.

National Cooperative Soil Survey
U.S.A.

LOCATION DOVRAY MN+ND SD

Established Series
Rev. HRF-ELB
2/97

DOVRAY SERIES

The Dovray series consists of deep poorly and very poorly drained soils that formed in clayey glacial lacustrine sediments or till on glacial lake plains and moraines. These soils have slow and very slow permeability. They have slopes of 0 to 2 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 44 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Cumulic Vertic Epiaquolls

TYPICAL PEDON: Dovray clay with a nearly level concave slope in a depression on a glacial lake plain in a cultivated field. (Colors are for moist conditions unless otherwise stated.)

Ap--0 to 10 inches; black (N 2/0) clay; moderate fine subangular blocky structure; hard; mildly alkaline; clear smooth boundary.

A--10 to 33 inches; black (N 2/0) clay; few fine distinct dark yellowish brown (10YR 4/4) reodx concetrations; moderate very fine angular blocky structure; firm; few gypsum crystals in upper part; neutral; gradual smooth boundary. (Combined thickness of A horizon is 6 to 51 inches.)

ABg--33 to 43 inches; very dark gray (5Y 3/1) clay; moderate very fine angular blocky structure; firm; neutral; gradual smooth boundary. (0 to 20 inches thick)

Bg--43 to 56 inches; olive gray (5Y 5/2) clay; many medium prominent brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) redox concentrations; moderate fine subangular blocky structure; firm; neutral; clear smooth boundary. (0 to 32 inches thick)

Cg--56 to 60 inches; light olive gray (5Y 6/2) clay; many fine distinct dark yellowish brown (10YR 4/4) redox concetratuins; massive; firm; few streaks and threads of lime; strong effervescence; mildly alkaline.

TYPE LOCATION: Lac qui Parle County, Minnesota; about 9 miles east and 1 mile north of Madison; about 900 feet south and 25 feet west of the northeast corner, sec. 22, T. 118 N., R. 43 W.

RANGE IN CHARACTERISTICS: The sola are 28 to 60 inches thick. Free carbonates begin at depths of 20 to 60 inches. These soils typically lack coarse fragments. However, some pedons have as much as 5 percent of coarse fragments of mixed lithology in part to all of the solum or C horizon or both. Some pedons have an 0 horizon as thick as 4 inches. The mollic epipedon is 24 to 54 inches thick. The 10- to 40-inch section averages between 40 and 60 percent clay, and it has less than 15 percent sand. These soils typically have texture of silty clay or clay throughout the solum and C horizon, but they are loam, silt loam, clay loam, or silty clay loam below depths of 40 inches in some pedons. The A horizon has hue of 10YR through 5Y with value of 2 or 3 or is N 2/

or N 3/. It lacks redox features in some pedons. It has dark-colored iron or manganese oxide coatings or concretions in some pedons. It lacks gypsum crystals in many pedons. It is slightly acid through mildly alkaline.

The Bg horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2. It is neutral or mildly alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is neutral to moderately alkaline. It lacks secondary carbonates in some pedons.

COMPETING SERIES: These are the Crooked Creek and Hutton series in the same family and the closely related Parnell series. Crooked Creek and Hutton soils formed in alluvium and are in a climate that is drier and has a shorter growing season. Parnell soils have an argillic horizon.

GEOGRAPHIC SETTING: These soils have concave slopes with gradient of 0 to 2 percent in depressions and drainageways on ground moraines and glacial lake plains. They formed in clayey glacial lacustrine sediments, or in clayey till, or in clayey lacustrine sediments over clayey till. These deposits are Late Wisconsinian in age. Mean annual air temperature ranges from 40 to 45 degrees F, and mean annual precipitation from 18 to 26 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Nutley, Sinai, and Fulda soils which are members of a hydrosequence with the Dovray soils. The Nutley soils are well or moderately well drained and are on convex slopes. The Sinai soils are moderately well drained and are on plane to slightly concave slopes. The Fulda soils are poorly drained and are on flats. In some places the well drained Hattie and Forman, the moderately well drained Aastad, and the poorly drained Hegne soils are associates. The Hegne soils have a calcic horizon and developed in materials similar to Dovray. The Hattie, Forman, and Aastad soils formed in glacial till.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Permeability is slow and very slow. Runoff is ponded. Frequently ponded unless artificially drained.

USE AND VEGETATION: Most areas are drained and cultivated. Corn, soybeans, and small grains are the principal crops. Undrained areas commonly are used for growing hay or pasture. Native vegetation was tall prairie grass.

DISTRIBUTION AND EXTENT: Western Minnesota, eastern North Dakota, and South Dakota. Moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Marshall County, South Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 43 inches (Ap, A, and ABg horizons).

Classification only was changed 5/94. Competing series and other updates will be made later.

National Cooperative Soil Survey
U.S.A.

LOCATION ECKMAN ND+MN SD

Established Series
KAA-CJH
06/2000

ECKMAN SERIES

The Eckman series consists of very deep, well drained, moderately permeable soils that formed in calcareous stratified glaciolacustrine deposits. These soils are on glacial lake plains and stream terraces. Slopes ranges from 0 to 15 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Eckman silt loam - on a 5 percent convex southeast-facing slope in a cultivated field. When described the soil was moist throughout. (Colors are for moist soil unless otherwise indicated)

Ap--0 to 9 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure parting to moderate fine granular; friable, slightly sticky and slightly plastic; few very fine, fine and medium roots; common fine tubular pores; slightly alkaline; abrupt smooth boundary. (5 to 14 inches thick)

Bw1--9 to 14 inches; very dark grayish brown (10YR 3/2)silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine, fine and medium roots; common fine tubular pores; moderately alkaline; clear smooth boundary.

Bw2--14 to 20 inches; dark olive brown (2.5Y 3/3) silt loam, light olive brown (2.5Y 5/4) dry; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; common fine tubular pores; moderately alkaline; clear smooth boundary. (Combined Bw horizons 5 to 22 inches thick)

Bk1--20 to 32 inches; light olive brown (2.5Y 5/3) silt loam, pale yellow (2.5Y 7/3) dry; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; few fine and medium tubular pores; violently effervescence; moderately alkaline; clear smooth boundary.

Bk2--32 to 41 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; moderate medium subangular blocky structure; friable; slightly sticky and slightly plastic; few very fine roots; few fine and medium tubular pores; few fine carbonate masses; violently effervescence; moderately alkaline; clear smooth boundary. (Combined Bk horizons 6 to 24 inches thick)

C1--41 to 57 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent strong brown (7.5YR 5/8) redoximorphic concentrations along root channels; massive; friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; clear smooth boundary.

C2--57 to 80 inches; light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) stratified silt loam and very fine sandy loam, pale yellow (2.5Y 7/4) and light yellowish brown (2.5Y 6/4) dry; common medium prominent strong brown (7.5YR 5/8) redoximorphic concentrations and few medium prominent gray (2.5Y 6/1) redoximorphic depletions; massive; friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Richland County, North Dakota; about 9 miles west of Walcott; 1735 feet east and 495 feet north of the southwest corner of sec. 32, T. 126 N., R. 51 W.; USGS Power, ND quadrangle, latitude 46 degrees 32 minutes 42.98 seconds north, longitude 97 degrees 7 minutes 48.70 seconds west.

RANGE IN CHARACTERISTICS: The depth to carbonates ranges from 10 to 36 inches. The mollic epipedon is 7 to 16 inches thick and includes part or all of the Bw horizon in some pedons.

The A horizon has hue of 10YR, value of 2 or 3 and 3 to 5 dry, and chroma of 1 and 1 or 2 dry. It is silt loam, loam, or very fine sandy loam. It is neutral or slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 4 to 6 dry, and chroma of 2 to 4. Texture is silt loam, loam or very fine sandy loam. Structure is weak or moderate prismatic or subangular or angular blocky. It is neutral to moderately alkaline.

The Bk horizon has hue of 2.5Y or 10YR, value of 5 or 6 and 6 to 8 dry, and chroma of 2 to 4. It is silt loam, very fine sandy loam or loam. It has 15 to more than 20 percent calcium carbonate equivalent. Reaction is slightly alkaline or moderately alkaline.

The C horizon has hue of 2.5Y or 10YR, value of 4 to 6 and 6 to 8 dry, and chroma of 2 to 4. It is typically silt loam, very fine sandy loam or loam but may be stratified with very fine sand or fine sandy loam. Sandy to clayey glacial till or lacustrine materials are in the substrata in some pedons. Reaction is slightly alkaline or moderately alkaline.

COMPETING SERIES: This is the Rothsay series. The Rothsay soils do not have a calcic horizon.

GEOGRAPHIC SETTING: Eckman soils are on level to rolling glacial lake plains and glacial stream terraces. The slope gradient commonly is 1 to 6 percent, but the range is 0 to 15 percent. The soils formed in calcareous stratified glaciolacustrine deposits. The mean annual air temperature is 36 to 48 degrees F. Mean annual precipitation is 15 to 24 inches, most of which falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Egeland, Gardena, Great Bend, Overly and Zell soils. Egeland soils are on similar nearby landscapes. They are coarse-loamy. Gardena soils are on nearly level and concave areas of the lake plains. They have mollic epipedons more than 16 inches thick. Great Bend and Overly soils are on heavier textured lake plains. They are fine-silty. Zell soils are on steep side slopes of stream valleys. They do not have Bw horizons.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is negligible to medium depending on slope. Permeability is moderate.

USE AND VEGETATION: Nearly all areas cropped to small grains, potatoes, and flax. Native vegetation was mid and tall prairie grasses.

DISTRIBUTION AND EXTENT: Eastern North Dakota, western Minnesota, and northeastern South Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon- the zone from the surface of the soil to a depth of 14 inches (Ap and Bw1 horizons); cambic horizon - the zone from 14 to 20 inches (Bw2 horizon); calcic horizon - the zone from 20 to 41 inches (Bk1 and Bk2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION EDGELEY ND+SD

Established Series
Rev. CJH
10/98

EDGELEY SERIES

The Edgeley series consists of moderately deep, well drained, moderately permeable soils that formed in colluvium, till, or glaciofluvial deposits overlying soft shale bedrock, or material weathered from shale bedrock. These soils are on till plains, glaciofluvial plains, or in stream valleys and have slopes of 0 to 35 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Typic Hapludolls

TYPICAL PEDON: Edgeley loam - cultivated. (Colors are for dry soil unless otherwise stated)

Ap--0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; slightly acid; abrupt smooth boundary. (5 to 9 inches thick)

BA--6 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many roots; few fragments of shale; neutral; clear smooth boundary. (0 to 15 inches thick)

Bw--15 to 32 inches; brown (10YR 5/3) silty clay loam, dark grayish brown (2.5Y 4/2) moist; few fine faint light olive brown (2.5Y 5/4) redox concentrations; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; few roots; slightly alkaline; abrupt smooth boundary. (7 to 18 inches thick)

2Cr--32 to 60 inches; gray (5Y 5/1) soft shale bedrock, very dark gray (5Y 3/1) moist; segregations of carbonates along fractures; slight effervescence.

TYPE LOCATION: Nelson County, North Dakota; about 1 1/2 miles east and 4 miles south of McVille; 1,490 feet east and 1,150 feet north of the southwest corner, sec. 19, T. 149 N., R. 58 W.

RANGE IN CHARACTERISTICS: The depth to soft shale bedrock ranges from 20 to 40 inches. The mollic epipedon ranges from 7 to 16 inches in thickness.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 and 2 or 3 moist, and chroma of 1 or less. It typically is loam and some is clay loam, silt loam or silty clay loam. It is slightly acid or neutral.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 2 to 4 moist, and chroma of 1 to 3. It is loam, silt loam, silty clay loam, or clay loam and typically averages between 20 and 30 percent clay but ranges from 18 to 35

percent clay. It has up to 35 percent shale channers. It is slightly acid to moderately alkaline. Some pedons have a 2Bw or Bk horizon.

The 2Cr horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 3 to 5 moist, and chroma of 1 to 3. It is weathered shale bedrock. Some pedons have a C horizon above the 2Cr horizon.

COMPETING SERIES: These are the Barnes, Doland, Formdale, Hibar, Vienna and Yeoman series. These soils do not have shale bedrock within a depth of 40 inches. In addition, Hibar soils have an R horizon of sandstone bedrock at depths of 20 to 40 inches.

GEOGRAPHIC SETTING: Edgeley soils are on level to very steep till plains, glaciofluvial plains, or in stream valleys. Slope gradients mainly are 1 to 6 percent and range from 0 to 35 percent. The soils formed in a thin layer of till, glaciofluvial deposits, or colluvium overlying shale bedrock or material weathered from shale bedrock. The climate is cool subhumid. Mean annual air temperature ranges from 37 to 45 degrees F, and mean annual precipitation from 15 to 20 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Barnes soils and the Brantford, Buse, Cavour, Cresbard, Forman, Hamerly, Kloten, Miranda, Parnell, Svea, Tonka, Vallers and Walsh soils. None of the these soils, except the Kloten soils, have shale bedrock within a depth of 40 inches. Barnes, Buse, Cavour, Cresbard, Forman, Miranda and Svea soils are on nearby till plains. Buse soils do not have cambic horizons. Cavour, Cresbard and Miranda soils have natric horizons. Forman soils have an argillic horizon. Svea soils have mollic epipedons more than 16 inches thick. Brantford and Vang soils are on nearby outwash areas. They are fine-loamy over sandy or sandy-skeletal. Walsh soils are on nearby terraces, fans and foot slopes. Vang and Walsh soils have mollic epipedons more than 16 inches thick. Hamerly and Vallers soils are on nearby swales and lower areas on till plains. They have calcic horizons within depths of 16 inches. Kloten soils are on steep hills and edges of valleys. They have shale bedrock at a depth of 9 to 20 inches and do not have a cambic horizon. Parnell and Tonka soils are in kettles and basins. Parnell soils are very poorly drained and Tonka soils are poorly drained.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is negligible to high depending on slope. Permeability is moderate in the solum.

USE AND VEGETATION: Soils mainly are cropped to spring seeded small grains, corn, alfalfa, and grass for hay and pasture. Native vegetation was western wheatgrass, green needlegrass, needleandthread, and a variety of forbs.

DISTRIBUTION AND EXTENT: Northeastern and south-central North Dakota and northern South Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: LaMoure County, North Dakota, 1914.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 15 inches (Ap and BA horizons); cambic horizon - the zone from 15 to 32 inches (Bw horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION EGELAND SD+MN ND

Established Series
Rev. VFK-BOK-CJH
10/98

EGELAND SERIES

The Egeland series consists of very deep, well drained soils formed in glaciofluvial deposits. These soils are on terraces, outwash plains, and uplands. They have moderately rapid permeability. Slopes range from 0 to 20 percent. Mean annual air precipitation is about 22 inches, and mean annual temperature is about 44 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Egeland sandy loam - on a northeast-facing convex slope of 3 percent in cultivation. When described, the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 8 inches; dark gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak fine and medium granular structure; slightly hard, very friable; few fine roots; neutral; abrupt smooth boundary. (6 to 14 inches thick)

Bw1--8 to 13 inches; dark brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable; few fine roots; neutral; clear smooth boundary.

Bw2--13 to 30 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable; few fine roots; neutral; clear smooth boundary.

Bw3--30 to 35 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; soft, very friable; neutral; gradual wavy boundary. (Combined Bw horizons 7 to 35 inches thick)

Bk--35 to 48 inches; pale brown (10YR 6/3) loamy fine sand, yellowish brown (10YR 5/4) moist; weak coarse subangular blocky structure; soft, very friable; common fine accumulations of calcium carbonate; strong effervescence; slightly alkaline; gradual wavy boundary. (0 to 32 inches thick)

C--48 to 60 inches; pale brown (10YR 6/3) loamy fine sand; yellowish brown (10YR 5/4) moist; single grained; soft, very friable; few fine accumulations of calcium carbonate; strong effervescence; slightly alkaline.

TYPE LOCATION: Grant County, South Dakota; about 6 miles east and 1 mile north of Stockholm; 1,140 feet east and 114 feet south of the northwest corner, sec. 14, T. 119 N., R. 49 W.

RANGE IN CHARACTERISTICS: Depth to free calcium carbonate typically is about 35 inches, but ranges from 14 to 45 inches. Thickness of the mollic epipedon

ranges from 8 to 16 inches and extends into the B horizon in most pedons. The solum contains up to 10 percent coarse fragments.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1.5 or less. It typically is sandy loam or fine sandy loam but is loam in some pedons. It ranges from moderately acid to neutral.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 2 to 5 moist, and chroma of 1 to 4. It is sandy loam or fine sandy loam and typically is loamy sand or loamy fine sand below 30 inches. It is slightly acid to slightly alkaline. In some pedons the upper part is loam.

The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 or 5 moist, and chroma of 2 to 4. It typically is loamy sand or loamy fine sand, but some pedons are sandy loam, fine sandy loam, or loamy very fine sand. It ranges from neutral to moderately alkaline. Some pedons have a BCk horizon.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 or 5 moist, and chroma of 2 to 4. It typically is loamy sand or loamy fine sand, but some pedons are sandy loam, loamy very fine sand, very fine sandy loam, or fine sandy loam, or are stratified with loamy and sandy layers. It ranges from neutral to moderately alkaline. Loam and clay loam glacial till is between depths of 40 and 60 inches in some pedons. Gravelly loamy sand, gravelly sand or very gravelly sand is below a depth of 35 inches in some pedons.

COMPETING SERIES: These are the Dunnville, Heimdal, Kalispell and Lanona soils. Dunnville soils are strongly acid throughout the series control section and carbonates are at depths greater than 40 inches. Heimdal and Lanona soils contain less than 70 percent sand at depths of 30 to 40 inches. Kalispell soils have carbonates within depths of 12 inches and have a chroma of 2 in the A horizon.

GEOGRAPHIC SETTING: Egeland soils are on terraces, outwash plains, and uplands. Slope gradients typically are less than 6 percent, but range from 0 to 20 percent. Egeland soils formed in moderately coarse-textured glaciofluvial deposits and sandy materials of fans and beaches of lake plains. Mean annual air temperature ranges from about 36 to 48 degrees F, and mean annual precipitation ranges from 15 to 24 inches. Growing season is 120 to 155 days; average growing season precipitation ranges from 15 to 20 inches; and growing degree days are about 2500 to 3500.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Heimdal soils and the Arvilla, Eckman, Embden, Fordville, Forman, Maddock, Peever, Poinsett, Renshaw and Swenoda soils. The Arvilla, Eckman, Heimdal, and Maddock soils are on similar nearby landscapes. Arvilla soils have sand and gravel below depths of 14 and 25 inches. Eckman soils have a coarse-silty particle size control section. Maddock soils have a sandy particle size control section. Embden and Swenoda soils are on foot slopes below the Egeland soils. They have mollic epipedons more than 16 inches thick. Fordville and Renshaw soils are on nearby terraces and outwash plains. They are fine-loamy over sand and gravel. The Forman, Peever, and Poinsett soils are on nearby glacial till plains. Forman and Peever soils have an argillic horizon. Poinsett soils have a fine-silty series control section.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff ranges from negligible to low depending on slope. Permeability is moderately rapid.

USE AND VEGETATION: Largely used to grow corn, small grain, and alfalfa. Native vegetation includes little bluestem, big bluestem, prairie sandreed, needlegrass, needleandthread, sideoats grama, blue grama, western wheatgrass, prairie junegrass, porcupinegrass, forbs, and sedges.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Day County, South Dakota, 1952.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 13 inches (Ap and Bw1 horizons); cambic horizon - the zone from 13 to 35 inches (Bw2 and Bw3 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION EMBDEN ND+MN SD

Established Series
Rev. CJH
10/98

EMBDEN SERIES

The Embden series consists of very deep, well drained or moderately well drained, moderately rapidly permeable soils that formed in glaciofluvial and glaciolacustrine deposits. These soils are on lake plains, outwash plains, deltas and terraces and have slopes ranging from 0 to 9 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Embden fine sandy loam on a plane slope of less than 1 percent under tame grass pasture. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; many fine roots and pores; neutral; abrupt smooth boundary.

A--8 to 14 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; many fine roots and pores; neutral; gradual wavy boundary. (Combined A horizons is 8 to 22 inches thick)

Bw1--14 to 20 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common fine roots and pores; neutral; gradual wavy boundary.

Bw2--20 to 24 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine pores; neutral; gradual wavy boundary.

Bw3--24 to 30 inches; light brownish gray (2.5Y 6/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) moist; many medium faint grayish brown (2.5Y 5/2) redox concentrations; very weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine pores; slight effervescence; slightly alkaline; clear wavy boundary. (Combined Bw horizon is 6 to 32 inches thick)

Bk--30 to 44 inches; light gray (2.5Y 7/2) fine sandy loam, olive brown (2.5Y 4/4) moist; few fine prominent strong brown (2.5YR 6/6) redox concentrations; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary. (0 to 35 inches thick)

C--44 to 60 inches; pale yellow (2.5Y 7/3) fine sandy loam, olive brown (2.5Y 4/4) moist; common fine prominent reddish brown (5YR 4/4) redox concentrations massive; slightly hard, very friable, slightly sticky and nonplastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Cass County, North Dakota; about 10 miles south and 2.5 miles east of Embden; 2,640 feet east and 60 feet north of the southwest corner, sec. 21, T. 137 N., R. 53 W.

RANGE IN CHARACTERISTICS: The depth to carbonates ranges from 20 to 60 inches. The mollic epipedon ranges from 16 to about 40 inches in thickness. The 10 to 40 inch particle-size control section averages between 6 and 18 percent clay and 40 to 70 percent fine sand and coarser.

The A horizon has 10YR hue or is neutral, value of 3 or 4 and 2 or 3 moist, and chroma of 1 or less. It is fine sandy loam, sandy loam, very fine sandy loam or loam. It is slightly acid or neutral.

The Bw horizon has 10YR or 2.5Y hue, value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 4. It is fine sandy loam, loam, sandy loam or very fine sandy loam. It has thin layers of loamy fine sand less than five inches thick in some pedons. It is neutral or slightly alkaline. Few to common and faint to distinct redox features are in the lower part of the Bw horizon in many pedons.

The Bk horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 8 and 3 to 6 moist, and chroma of 1 to 4. It is fine sandy loam, sandy loam, loamy fine sand, very fine sandy loam or loamy sand. It is slightly alkaline or moderately alkaline. The calcium carbonate equivalent ranges for 6 to 20 percent and carbonates are disseminated or in masses. The Bk horizon does not have redox features in some pedons. Some pedons have a BCk horizon.

The C horizon typically has 2.5Y hue, and less commonly 10YR or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is fine sandy loam, sandy loam, loamy fine sand, or very fine sandy loam, but in some pedons below depths of 40 inches it has coarser or finer textures. It is neutral to moderately alkaline.

COMPETING SERIES: These are the Clontarf, Emrick, Flathead, Inkster, Malachy and Swenoda series. Clontarf soils have fine sand or coarser textures within the particle-size control section. Emrick soils have a loam series control section, formed in glacial till and have coarse fragments throughout. Flathead soils have a redder hue in the Bw horizon and formed in alluvium in intermountain valleys. Inkster soils have more than 50 percent shale in the sand size fraction of the 10 to 40 inch particle-size control section. Malachy soils contain carbonates throughout the particle-size control section. Swenoda soils have silt loam or loam 2C horizons at depths of 22 to 40 inches.

GEOGRAPHIC SETTING: The level to moderately sloping Embden soils are on lake plains, outwash plains, deltas and terraces. Slope gradients commonly are less than 3 percent but range from 0 to 9 percent. The soil formed in glaciofluvial and glaciolacustrine deposits. The mean annual air temperature ranges from about 36 to 48 degrees F, and the mean annual precipitation ranges from 15 to 24 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Swenoda soils and the Arveson, Egeland, Tiffany and Wyndmere soils. Swenoda soils are on nearby till plains or lake plains. Arveson soils are in nearby swales. They have calcic horizons within depths of 16 inches and are poorly drained. Egeland, Tiffany

and Wyndmere soils are in a drainage sequence with Embden soils. Egeland soils are on the convex well drained higher parts of the landscape. They have mollic epipedons less than 16 inches in thickness. Tiffany and Wyndmere soils are in swales and depressions. Tiffany soils are poorly drained and contain mottles in the lower part of the A horizon. Wyndmere soils have calcic horizons within depths of 16 inches.

DRAINAGE AND PERMEABILITY: Well drained or moderately well drained. Runoff ranges from negligible to low depending on slope. Permeability is moderately rapid. A seasonal high water table is at a depth of 3 to 5 feet at some time during the period April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Soils mainly are cropped to small grains; row crops as corn, potatoes; and hay or pasture. Native vegetation was prairie sandreed, needleandthread, prairie junegrass, sun sedge, threadleaf sedge and a variety of forbs.

DISTRIBUTION AND EXTENT: Eastern and central North Dakota, northwestern Minnesota, and northeastern South Dakota. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Cass County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: Mollic epipedon - the zone from the surface of the soil to a depth of 24 inches (Ap, A, Bw1, and Bw2 horizons).

ADDITIONAL DATA: Laboratory samples: S51NDak-5-6, and from North Dakota Agricultural Experiment Station S66Dak-9-1, S57NDak-9-2, ND53-P-13, ND-54-P-3.

National Cooperative Soil Survey
U.S.A.

LOCATION EMRICK ND

Established Series
CJH
01/2000

EMRICK SERIES

The Emrick series consists of very deep, well or moderately well drained, moderately permeable soils that formed in calcareous glacial till. These soils are on low relief positions on ground moraines and have slopes ranging from 0 to 9 percent. Mean annual temperature is 40 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Emrick loam - cropland. (Colors for dry soil unless otherwise stated)

Ap--0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A--7 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; very friable; many fine pores; neutral; gradual smooth boundary. (Combined A horizons 7 to 20 inches thick)

Bw--11 to 20 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; very friable; neutral; clear wavy boundary. (6 to 30 inches thick)

Bk1--20 to 40 inches; light olive brown (2.5Y 5/3) loam, olive brown (2.5Y 4/3) moist; very weak medium and coarse subangular blocky structure; very friable; few pebbles and cobbles to 5 inches in diameter at depths of 26 inches; common threads of carbonates; strong effervescence; slightly alkaline; gradual wavy boundary.

Bk2--40 to 46 inches; light yellowish brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure with some evidence of weak medium platy structure; friable; strong effervescence; moderately alkaline; gradual irregular boundary. (Combined Bk horizons 5 to 30 inches thick)

C--46 to 60 inches; olive gray (5Y 5/2) loam, olive brown (2.5Y 4/3) moist; weak medium platy and subangular blocky structure; friable; strong effervescence; some soft carbonate accumulations; moderately alkaline.

TYPE LOCATION: Wells County, North Dakota; about 6 1/2 miles east of Fessenden, North Dakota; 160 feet north and 115 feet east of southwest corner, sec. 9, T. 148 N., R. 69 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 16 to about 40 inches in thickness. The 10 to 40 inch control section typically is a loam averaging less than 18 percent clay. Sandy loam layers 2 to 10 inches thick are in some

pedons. Pebbles and stones are common throughout the profile. Stony phases are recognized. The soil is neutral to mildly alkaline in the A and Bw horizons and mildly or moderately alkaline in the Bk and C horizons.

The A horizon has a 10YR hue, value of 3 or 4 and 2 or 3 moist, and chroma of 1 in the upper part and 1 or 2 in the lower part. It is loam, silt loam, sandy loam, very fine sandy loam, or fine sandy loam.

The Bw horizon has 10YR or 2.5Y hue, value of 4 or 5 and 3 or 4 moist, and chroma of 2 or 3. It has a weak or moderate prismatic and subangular blocky structure. The lower part of the Bw horizon and the Bk and C horizons are mottled in some pedons.

The Bk horizon has hue of 2.5Y, value of 5 to 8 and 4 to 6 moist, and chroma of 2 to 4. It is loam and has 10 to over 25 percent calcium carbonate equivalent. Some pedons have a BCk horizon.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 4 or 5 moist, and chroma of 2 to 4. It is calcareous loam till with pockets of fine sand, silt and pebbles in some pedons.

COMPETING SERIES: These are the Clontarf, Embden, Flathead, Inkster, Malachy, and Swenoda series in the same family and the Gardena, Heimdal and Svea series. Clontarf, Flathead and Malachy soils have sand or loamy sand textures at depths of less than 40 inches. Inkster soils formed in glaciofluvial deposits and contain more than 50 percent shale in the sand size fraction of the 10 to 40 inches control section. Embden soils have fine sandy loam series control section and formed in glaciofluvial deposits. Swenoda soils have 2C horizons within depths of 40 inches that are higher in silt. Heimdal soils have mollic epipedons less than 16 inches thick. Gardena soils are coarse-silty. Svea soils are fine-loamy.

GEOGRAPHIC SETTING: Emrick soils are on level to gently rolling low relief ground moraines. They are on slightly concave positions. Slope gradients are commonly less than 2 percent but range from 0 to 9 percent. The soil formed in calcareous glacial till low in clay and containing pockets of silts, fine sands and other sorted materials. The climate is cool, subhumid, with a mean annual temperature ranging from 38 to 43 degrees F, and a mean annual precipitation ranging from 15 to 22 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Fram, Heimdal and Svea soils and the Barnes, Fram, and Tonka soils. Barnes soils are on adjacent till plains in the same geographic area. Fram soils have a calcic horizon within depths of 16 inches and are somewhat poorly drained. Tonka soils are in the enclosed poorly drained basins and have E and Bt horizons.

DRAINAGE AND PERMEABILITY: Well or moderately well drained. The moderately well drained phase has a seasonal high water table at depths of 3 to 5 feet at some time during the period of April through June. The water table is at a depth of 4 to 6 feet for the same period in the well drained phase. Surface runoff is slow. Permeability is moderate.

DISTRIBUTION AND EXTENT: North-central and eastern North Dakota. The soils are extensive.

USE AND VEGETATION: Nearly all areas cultivated for production of small grains. Native vegetation: green needlegrass, western wheatgrass, blue grama, prairie dropseed, and little bluestem.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: Wells County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: Mollic epipedon - the zone from the surface of the soil to a depth of 20 inches (Ap, A, and Bw horizons).

The pedon meets the color requirement for the aquic subgroup in the horizon immediately below the mollic epipedon (Bk1 horizon), however the soil does not have aquic conditions immediately below the mollic epipedon and does not meet the subgroup criteria. Saturation does not occur shallower than three feet.

National Cooperative Soil Survey
U.S.A.

LOCATION ENLOE ND+MN

Established Series
Rev. FS-CJH
02/97

ENLOE SERIES

The Enloe series consists of deep, poorly drained, slowly permeable lacustrine sediments. These soils are in shallow basins and swales in lake plains and have slopes of less than 1 percent. Mean annual temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Argiaquic Argialbolls

TYPICAL PEDON: Enloe silty clay loam - on a concave swale with less than 1 percent slope under cropland. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist throughout.)

Ap--0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; cloddy parting to strong fine and very fine granular structure; very hard, firm, sticky and very plastic; many fine roots; many fine pores; medium acid; abrupt smooth boundary. (6 to 14 inches thick)

E--8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) dry; weak coarse prismatic structure parting to moderate thin platy; hard, friable, sticky and plastic; common fine roots; common fine pores; dark gray (10YR 4/1) uncoated silt and sand grains on faces of peds; medium acid; abrupt wavy boundary. (2 to 10 inches thick)

Btg1--14 to 18 inches; black (5Y 2/1) clay, very dark gray (5Y 3/1) dry; very dark gray (5Y 3/1) crushed and rubbed, dark gray (5Y 4/1) dry, crushed; moderate very coarse prismatic structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; common fine roots; common fine pores; slightly acid; abrupt wavy boundary.

Btg2--18 to 29 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; dark gray (5Y 4/1) crushed, gray (5Y 5/1) dry, crushed; moderate very coarse prismatic structure parting to strong fine angular blocky; extremely hard, very firm, very sticky and very plastic; common fine roots in the upper part and few fine roots in lower part; common fine pores; faces of peds are shiny when moist; slickensides in lower part; neutral; clear wavy boundary. (8 to 12 inches thick)

Btg3--29 to 40 inches; dark gray (5Y 4/1) clay, gray (5Y 6/1) dry; moderate very coarse prismatic structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; few fine roots; few medium and fine pores; faces of peds have shiny pressure coatings, slickensides cross horizon at an angle of 10 degrees to 15 degrees from vertical; slight effervescence; mildly alkaline; gradual wavy boundary. (Combined Btg horizons 12 to 36 inches thick)

Bkg--40 to 60 inches; olive gray (5Y 4/2) clay, light olive gray (5Y 6/2) dry; few fine faint olive brown (2.5Y 4/4) and common fine faint light yellowish brown and gray (2.5Y 6/4 and 5Y 6/1) dry, mottles; moderate medium and fine

angular blocky structure; extremely hard, firm, very sticky, and very plastic; few fine roots; few fine pores; few fine masses of carbonates; slight effervescence; mildly alkaline. (0 to 25 inches thick.)

TYPE LOCATION: Richland County, North Dakota; about 4 miles north and 1 mile west of Abercrombie; 800 feet east and 310 feet north of the southwest corner, sec. 17, T. 135 N., R. 48 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon and the depth to the E horizon ranges from 7 to 14 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y; value of 1 to 3 and 3 or 4 dry; and chroma of 1. It is silty clay loam or silty clay. It has abrupt or clear, smooth or wavy lower boundary.

The E horizon has hue of 10YR, 2.5Y, or 5Y; value of 3 to 5 and 4 to 6 dry; and chroma of 1. It is silty clay loam or silty clay. In some pedons, the E horizon has distinct or prominent mottling. The thickness of the E horizon ranges widely within a short distance, and the lower boundary is abrupt or clear and wavy, irregular or broken.

The Btg horizon has hue of 2.5Y or 5Y, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2. It typically averages between 55 and 60 percent clay and ranges from 45 to 60 percent. It has weak or moderate very coarse to medium prismatic structure which parts to strong medium to very fine blocky.

The Bkg horizon has hue of 2.5Y or 5Y, value of 4 to 6 and 5 to 7 dry, and chroma of 1 to 3. It is massive, laminated or blocky silty clay or clay. It is mottled in many pedons. It contains 6 to 20 percent calcium carbonate. Some pedons have a Cg horizon. Some pedons contain clay loam or clay till below depths of about 40 inches.

COMPETING SERIES: These are the Tonka series in the same family and the Aberdeen, Dovray, Fargo, and Galchutt series. Tonka soils contain less clay in the Bt horizon and commonly contain more sand and some coarse fragments in the C horizons. In addition, they are formed in local alluvium from till. Aberdeen soils have a natric horizon and are not as wet. Dovray soils do not have E horizons and have mollic epipedons more than 24 inches thick. Fargo soils do not have E horizons. Galchutt soils have A and E horizons that contain less than 35 percent clay.

GEOGRAPHIC SETTING: Enloe soils are in shallow basins and swales in level lake plains. The soils formed in silty clay and clay glaciolacustrine sediments. The climate is cool subhumid. Mean annual temperature ranges from 38 to 45 degrees F, and mean annual precipitation from 17 to 22 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Aberdeen, Dovray, Fargo, and Galchutt soils and Hegne and Ryan soils. All of these soils are on nearby lake plains. Fargo and Hegne soils are on the higher parts of the lake plain. Hegne soils have a calcic horizon within a depth of 16 inches. Ryan soils have a thin A horizon and a natric horizon.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is ponded. Permeability is slow.

USE AND VEGETATION: Nearly all cropped to small grains and row crops. Native vegetation was slim sedge, wooly sedge, prairie cordgrass, northern reedgrass, and a variety of sedges and forbs.

DISTRIBUTION AND EXTENT: In the glacial Lake Aggasiz area of eastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 8 inches (Ap horizon), albric horizon - the zone from 8 to 14 inches (E horizon); orgillic horizon - the zone from 14 to 40 inches (Btg1, Btg2, and Btg 3 horizons); chroma of 2 or less in the albic horizon.

ADDITIONAL DATA: S64NDak-39-1, S65NDak-9-3, S64NDak-9-5 by Soils Department, North Dakota Agricultural Experiment Station.

National Cooperative Soil Survey
U.S.A.

LOCATION ENLOE ND+MN

Established Series
Rev. FS-CJH
02/97

ENLOE SERIES

The Enloe series consists of deep, poorly drained, slowly permeable lacustrine sediments. These soils are in shallow basins and swales in lake plains and have slopes of less than 1 percent. Mean annual temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Argiaquic Argialbolls

TYPICAL PEDON: Enloe silty clay loam - on a concave swale with less than 1 percent slope under cropland. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist throughout.)

Ap--0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; cloddy parting to strong fine and very fine granular structure; very hard, firm, sticky and very plastic; many fine roots; many fine pores; medium acid; abrupt smooth boundary. (6 to 14 inches thick)

E--8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) dry; weak coarse prismatic structure parting to moderate thin platy; hard, friable, sticky and plastic; common fine roots; common fine pores; dark gray (10YR 4/1) uncoated silt and sand grains on faces of peds; medium acid; abrupt wavy boundary. (2 to 10 inches thick)

Btg1--14 to 18 inches; black (5Y 2/1) clay, very dark gray (5Y 3/1) dry; very dark gray (5Y 3/1) crushed and rubbed, dark gray (5Y 4/1) dry, crushed; moderate very coarse prismatic structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; common fine roots; common fine pores; slightly acid; abrupt wavy boundary.

Btg2--18 to 29 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; dark gray (5Y 4/1) crushed, gray (5Y 5/1) dry, crushed; moderate very coarse prismatic structure parting to strong fine angular blocky; extremely hard, very firm, very sticky and very plastic; common fine roots in the upper part and few fine roots in lower part; common fine pores; faces of peds are shiny when moist; slickensides in lower part; neutral; clear wavy boundary. (8 to 12 inches thick)

Btg3--29 to 40 inches; dark gray (5Y 4/1) clay, gray (5Y 6/1) dry; moderate very coarse prismatic structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; few fine roots; few medium and fine pores; faces of peds have shiny pressure coatings, slickensides cross horizon at an angle of 10 degrees to 15 degrees from vertical; slight effervescence; mildly alkaline; gradual wavy boundary. (Combined Btg horizons 12 to 36 inches thick)

Bkg--40 to 60 inches; olive gray (5Y 4/2) clay, light olive gray (5Y 6/2) dry; few fine faint olive brown (2.5Y 4/4) and common fine faint light yellowish brown and gray (2.5Y 6/4 and 5Y 6/1) dry, mottles; moderate medium and fine

angular blocky structure; extremely hard, firm, very sticky, and very plastic; few fine roots; few fine pores; few fine masses of carbonates; slight effervescence; mildly alkaline. (0 to 25 inches thick.)

TYPE LOCATION: Richland County, North Dakota; about 4 miles north and 1 mile west of Abercrombie; 800 feet east and 310 feet north of the southwest corner, sec. 17, T. 135 N., R. 48 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon and the depth to the E horizon ranges from 7 to 14 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y; value of 1 to 3 and 3 or 4 dry; and chroma of 1. It is silty clay loam or silty clay. It has abrupt or clear, smooth or wavy lower boundary.

The E horizon has hue of 10YR, 2.5Y, or 5Y; value of 3 to 5 and 4 to 6 dry; and chroma of 1. It is silty clay loam or silty clay. In some pedons, the E horizon has distinct or prominent mottling. The thickness of the E horizon ranges widely within a short distance, and the lower boundary is abrupt or clear and wavy, irregular or broken.

The Btg horizon has hue of 2.5Y or 5Y, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2. It typically averages between 55 and 60 percent clay and ranges from 45 to 60 percent. It has weak or moderate very coarse to medium prismatic structure which parts to strong medium to very fine blocky.

The Bkg horizon has hue of 2.5Y or 5Y, value of 4 to 6 and 5 to 7 dry, and chroma of 1 to 3. It is massive, laminated or blocky silty clay or clay. It is mottled in many pedons. It contains 6 to 20 percent calcium carbonate. Some pedons have a Cg horizon. Some pedons contain clay loam or clay till below depths of about 40 inches.

COMPETING SERIES: These are the Tonka series in the same family and the Aberdeen, Dovray, Fargo, and Galchutt series. Tonka soils contain less clay in the Bt horizon and commonly contain more sand and some coarse fragments in the C horizons. In addition, they are formed in local alluvium from till. Aberdeen soils have a natric horizon and are not as wet. Dovray soils do not have E horizons and have mollic epipedons more than 24 inches thick. Fargo soils do not have E horizons. Galchutt soils have A and E horizons that contain less than 35 percent clay.

GEOGRAPHIC SETTING: Enloe soils are in shallow basins and swales in level lake plains. The soils formed in silty clay and clay glaciolacustrine sediments. The climate is cool subhumid. Mean annual temperature ranges from 38 to 45 degrees F, and mean annual precipitation from 17 to 22 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Aberdeen, Dovray, Fargo, and Galchutt soils and Hegne and Ryan soils. All of these soils are on nearby lake plains. Fargo and Hegne soils are on the higher parts of the lake plain. Hegne soils have a calcic horizon within a depth of 16 inches. Ryan soils have a thin A horizon and a natric horizon.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is ponded. Permeability is slow.

USE AND VEGETATION: Nearly all cropped to small grains and row crops. Native vegetation was slim sedge, wooly sedge, prairie cordgrass, northern reedgrass, and a variety of sedges and forbs.

DISTRIBUTION AND EXTENT: In the glacial Lake Aggasiz area of eastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 8 inches (Ap horizon), albric horizon - the zone from 8 to 14 inches (E horizon); orgillic horizon - the zone from 14 to 40 inches (Btg1, Btg2, and Btg 3 horizons); chroma of 2 or less in the albic horizon.

ADDITIONAL DATA: S64NDak-39-1, S65NDak-9-3, S64NDak-9-5 by Soils Department, North Dakota Agricultural Experiment Station.

National Cooperative Soil Survey
U.S.A.

LOCATION ESMOND ND+MN

Established Series
Rev. CJH
2/99

ESMOND SERIES

The Esmond series consists of very deep, well drained, mode
rately and moderately rapid permeable soils that formed in loamy calcareous glacial till. These soils are on convex positions on moraines and till plains. They have slopes ranging from 2 to 45 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Typic Calciudolls

TYPICAL PEDON: Esmond loam on a north-facing convex slope of 20 percent under native grass. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

A--0 to 5 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many fine pores; few pebbles; slightly alkaline; clear wavy boundary. (4 to 9 inches thick)

ABk--5 to 9 inches; dark gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common roots; common fine pores; few pebbles; common fine masses of carbonates; strong effervescence; moderately alkaline; clear wavy boundary. (0 to 7 inches thick)

Bk--9 to 20 inches; light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) loam, olive (2.5Y 4/4) and light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; slightly sticky and slightly plastic; few roots; common fine pores; few pebbles; common masses of carbonates; violent effervescence; moderately alkaline; gradual wavy boundary. (4 to 30 inches thick)

C--20 to 60 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; few fine prominent dark reddish brown and yellowish brown (2.5YR 3/4 and 10YR 5/6) moist redoximorphic concentrations; massive; hard, friable, slightly sticky and slightly plastic; few stones; strong effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 1 1/2 miles south and 2 1/2 miles east of Sheyenne, North Dakota; 800 feet south and 120 feet west of the northeast corner, Sec. 23, T. 150 N. R. 66 W.

RANGE IN CHARACTERISTICS: The 10 to 40 inch particle-size control section is loam, sandy loam or fine sandy loam. It has 8 to 18 percent clay, 40 to 75 percent fine and coarser sand, and 1 to 10 percent rock fragments. In some pedons, it contains mixed pockets of sand, fine sand, loam, silt loam and occasional lenses of gravel. The soil is slightly alkaline or moderately alkaline throughout. Stony phases are recognized.

The A horizon has hue of 10YR, value of 3 to 5 and 2 or 3 moist, and chroma of 1. In some plowed fields it has hue of 2.5Y and/or chroma of 2. It typically is loam, but in some pedons it is sandy loam, fine sandy loam or silt loam.

The ABk horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 or 2. It is sandy loam or loam.

The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It has a calcium carbonate equivalent of 10 to 30 percent. It is loam, fine sandy loam or sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 4 or 5 moist, and chroma of 2 to 4. It is loam, fine sandy loam, sandy loam or silt loam. It is laminated, massive or stratified till. Below depths of 40 inches in some pedons it is loamy sand or clay loam.

COMPETING SERIES: There are no competing series. Other similar series are the Buse, Heimdal and Zell series. Buse soils are fine-loamy. Zell soils are coarse-silty.

GEOGRAPHIC SETTING: Esmond soils are on convex positions on nearly level to very steep till plains and moraines. Slope gradients typically are 6 to 15 percent, but range from 2 to 45 percent. The soils formed in loamy calcareous glacial till. The climate is cool, subhumid. Mean annual air temperature ranges from 37 to 45 degrees F, and mean annual precipitation from 15 to 22 inches. Most of the moisture falls in the spring and summer. Frost-free days range from 95 to 140. Elevation above sea level ranges from 900 to 2000 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Emrick, Fram and Heimdal soils. These soils are on a toposequence with Esmond soils. Esmond soils are on summits and convex shoulder slopes; Emrick soils are on concave foot slopes and toe slopes and in swales; Fram are in swales and on flats; and Heimdal soils are on convex and plane side slopes. Emrick soils have mollic epipedons more than 16 inches thick. Fram soils have an aquic moisture regime. Heimdal soils have a cambic horizon.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is very low to medium depending on slope. Permeability is moderate and moderately rapid.

USE AND VEGETATION: These soils are generally used for range and pasture. Less sloping areas are used to grow small grains, flax and hay. Native vegetation is little bluestem, plains muhly, sideoats grama, plains reedgrass, thickspike wheatgrass, western wheatgrass, upland sedges, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota and western Minnesota. It is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 9 inches (A and ABk horizons); calcic horizon - the zone from a depth of 5 to 20 inches (ABk and Bk horizons).

National Cooperative Soil Survey

U.S.A.

LOCATION EXLINE SD+ND

Established Series
Rev. LDS-WJB
02/1999

EXLINE SERIES

The Exline series consists of very deep, somewhat poorly drained or moderately well drained soils formed in lacustrine and alluvial deposits on lake plains and terraces. These soils have very slow permeability. Slopes are 0 to 3 percent. Mean annual precipitation is about 21 inches and mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Leptic Natrudolls

TYPICAL PEDON: Exline silt loam - in a slightly depressed shallow basin on a west-facing slope of less than 1 percent in native vegetation. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

A--0 to 2 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine and very fine granular structure; soft, friable, slightly sticky; slightly acid; clear smooth boundary. (0 to 3 inches thick)

E--2 to 3 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak very thin platy structure; soft, friable, slightly sticky; slightly acid; abrupt smooth boundary. (0 to 3 inches thick)

Btn--3 to 7 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; strong medium columnar structure parting to strong fine and medium blocky; very hard, very firm, very sticky and very plastic; gray (10YR 5/1) coatings on tops of columns and faces of peds; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Btnz--7 to 11 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to strong very fine and fine blocky; very hard, very firm, very sticky and very plastic; continuous shiny films on vertical faces of peds; common fine and medium accumulations of salts; moderately alkaline; clear wavy boundary. (Combined thickness of Bt horizon is 5 to 26 inches thick)

Btknz--11 to 19 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak very coarse prismatic structure parting to moderate very fine and fine blocky; very hard, very firm, very sticky and very plastic; continuous shiny films on vertical faces of peds; many fine and medium accumulations of salts; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary. (0 to 20 inches thick)

Bkz--19 to 23 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak very fine blocky structure; very hard, very firm, very sticky and very plastic; common fine tongues of very dark brown (10YR 2/2) moist; common fine accumulations of salts; common fine and medium accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary. (0 to 32 inches thick.)

Bk--23 to 34 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common fine prominent yellowish brown (10YR 5/6) redox concentrations and gray (5Y 5/1) redox depletions; weak fine and very fine blocky structure; very hard, firm, sticky and plastic; many coarse tongues of very dark grayish brown (2.5Y 3/2) moist; few fine accumulations of salts; few fine accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary. (0 to 20 inches thick)

C--34 to 60 inches; light gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; many fine and medium prominent yellowish brown (10YR 5/6) redox concentrations and gray (5Y 5/1) redox depletions; varved; very hard, firm, sticky and plastic; common fine and medium accumulations of carbonate in the upper part; strong effervescence; moderately alkaline.

TYPE LOCATION: Brown County, South Dakota; about 4 miles south of Aberdeen; 484 feet south and 120 feet east of the northwest corner of sec. 11, T. 122 N., R. 64 W.

RANGE IN CHARACTERISTICS: Salts are above horizons with accumulations of carbonate and are at depths of 6 to 16 inches. Exchangeable sodium percentage exceeds 15 percent above a depth of 16 inches. Depth to carbonates ranges from 8 to 28 inches.

The A horizon, where present, has value of 3 to 5 and 2 or 3 moist, and chroma of 1.5 or less. It is silt loam, loam, or silty clay loam but is silty clay in some pedons where cultivated. It is slightly acid or neutral. The Ap horizon is 6 to 10 inches thick and is slightly acid to slightly alkaline.

The E horizon has value of 5 or 6 and 3 to 5 moist. It commonly is silt loam but in some pedons it is loam or silty clay loam and is slightly acid or neutral. When cultivated the E horizon commonly is absent.

The Btn and Btnz horizons have hue of 10YR or 2.5Y, value of 3 to 5 and 2 to 4 moist, and chroma of 1 or 2. It typically is silty clay, clay, or silty clay loam but is clay loam in some pedons. Clay content is between 35 and 55 percent. In most pedons the lower part of this horizon contains few or common nests of gypsum and other salts. Reaction ranges from neutral to strongly alkaline.

The Btknz, Bkz, and Bk horizons have hue of 10YR or 2.5Y, value of 4 to 7 and 3 or 6 moist, and chroma of 1 to 3. They typically are silty clay, clay or silty clay loam but is clay loam in some pedons. They are moderately alkaline or strongly alkaline. Most pedons have few to many accumulations of carbonate and salts.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 and 3 to 7 moist, and chroma of 2 to 4. It is silt loam or silty clay loam and typically is varved with thin strata of very fine sand to clay. It is moderately alkaline or strongly alkaline. It has few or common, fine or medium accumulations of carbonate. Some pedons have sandy material or loamy glacial till below depths of 40 inches.

COMPETING SERIES: These are the Adger, Ferney, Mekinock, and Rhoades series. Adger and Rhoades soils have E horizons with chroma of 2 and are drier in the soil moisture control section during the 120 days following the summer solstice. Ferney soils have more than 15 percent fine sand or coarser throughout, and

formed in glacial till. Mekinock soils have a paralithic contact of shale bedrock at a depth of 20 to 40 inches.

GEOGRAPHIC SETTING: Exline soils are nearly level to level on flats of the glacial lake plain and terraces. Microdepressions are common in most areas. Slope gradients are 0 to 3 percent. The soils formed in calcareous lacustrine and alluvial deposits of silt, fine sand, and clay. Mean annual air temperature ranges from 34 to 45 degrees, and mean annual precipitation ranges from 17 to 24 inches. Most of the precipitation comes in the spring and summer. Growing season is about 120 to 130 days; average growing season precipitation ranges from 13 to 18 inches; and growing degree days are about 2500 to 2800.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aberdeen, Beotia, Harmony, Nahon, and Putney soils. Aberdeen soils do not have columnar structure in the Bt horizon and have tonguing of A horizon material into the Bt horizon. Aberdeen and Nahon soils are on broad smooth flats on nearby landscapes. Beotia, Harmony, and Putney soils are on slightly higher positions and do not have natric horizons. In addition, Beotia and Putney soils are fine-silty. Nahon soils have salts below 16 inches and have thicker sola.

DRAINAGE AND PERMEABILITY: Somewhat poorly or moderately well drained. Runoff is negligible to high depending on slope. Permeability is very slow.

USE AND VEGETATION: Used mainly for native hay and pasture. Some areas are cultivated when in complex with other soils. Native vegetation includes western wheatgrass, blue grama, buffalograss, inland salt grass, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and southeastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Day County, South Dakota, 1952.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 19 inches (A, E, Btn, Btnz, and Btknz horizons); Natric horizon - the zone from a depth of about 3 to 19 inches (Btn Btnz, and Btknz horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION FAIRDALE ND+MN MT SD WY

Established Series
Rev. CJH
2/97

FAIRDALE SERIES

The Fairdale series consists of very deep, moderately well drained, moderately permeable soils that formed in recent alluvium. These soils are on low terraces and on flood plains and have slopes ranging from 0 to 15 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, calcareous, frigid Mollic Udifluvents

TYPICAL PEDON: Fairdale silt loam - on a plane slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated. When described the soil was moist throughout.)

Ap--0 to 7 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; many fine pores; slight effervescence; slightly alkaline; abrupt smooth boundary. (Combined A horizons 6 to 15 inches thick)

C1--7 to 10 inches; fine strata of dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; few large root channels; few worm casts; few fragments of snail shells; slight effervescence; slightly alkaline; abrupt smooth boundary.

C2--10 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine, fine, and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; few large root channels; many fine pores; few worm casts; few snail shells; slight effervescence; slightly alkaline; clear smooth boundary.

C3--16 to 48 inches; dark grayish brown (2.5Y 4/2) and brown (10YR 5/3) stratified loam, silt loam and very fine sandy loam, light brownish gray (2.5Y 6/2) and very pale brown (10YR 7/3) dry; few fine prominent brown (7.5YR 5/4) redoximorphic concentrations in the lower part; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots, common fine pores; few fine white (10YR 8/1) irregularly shaped masses of carbonates; slight effervescence; moderately alkaline; clear smooth boundary.

Ab1--48 to 60 inches; very dark brown (10YR 2/2) and very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; few fine prominent brown (7.5YR 5/4) redoximorphic concentrations; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; few roots and fine pores; slight effervescence; moderately alkaline; clear smooth boundary.

Ab2--60 to 67 inches; black (10YR 2/1) and olive brown (2.5Y 4/3) silty clay loam, dark gray (10YR 4/1) dry; massive; hard, friable, sticky and plastic; many fine white (10YR 8/1) irregularly shaped masses of carbonates; slight effervescence; moderately alkaline; clear smooth boundary. (Combined Ab horizons 0 to 20 inches thick)

C'1--67 to 80 inches; dark brown (10YR 4/3) and grayish brown (2.5Y 5/2) silty clay loam, light yellowish brown (2.5Y 6/3) dry; massive; hard, firm, sticky and plastic; many fine white (10YR 8/1) irregularly shaped masses of carbonates; strong effervescence; moderately alkaline.

TYPE LOCATION: Walsh County, North Dakota; about 1/2 mile west and 1 mile south of Minto; 1850 feet south and 250 feet east of the northwest corner, sec. 6, T. 155 N., R. 52 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch particle size control section averages between 18 and 30 percent clay and 15 to 50 percent fine sand or coarser.

The Ap horizon has hue of 10YR or 2.5Y, value of 4 or 5 and 2 or 3 moist, and chroma of 1 or 2. It is silt loam, loam, fine sandy loam, very fine sandy loam, silty clay loam, silty clay or clay loam. It is slightly alkaline. Ab horizons, where present, are at depths of more than 12 inches.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 to 5 moist, and chroma of 1 to 4. It is stratified with average texture of loam or silt loam. It may contain thin layers of fine sandy loam, very fine sandy loam, clay loam or silty clay loam. It is slightly or strongly effervescent, and contains few accumulations of carbonates. It is slightly alkaline or moderately alkaline. Some pedons have sand below a depth of 40 inches.

COMPETING SERIES: There are no other series in the same family.

GEOGRAPHIC SETTING: Fairdale soils are on low terraces and flood plains. Slope gradients are mainly less than 1 percent, but range to 15 percent along channels and edges of terraces. The soils formed in stratified, loamy recent alluvium. The mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation from 15 to 25 inches, most of which falls in the spring and summer. Frost-free period ranges from 90 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cashel, LaDelle, Lamoure, La Prairie, Ludden, Neche and Wahpeton soils. All of these soils except Wahpeton soils are on low terraces and floodplains. Wahpeton soils are on higher levees. Cashel soils are fine and somewhat poorly drained. LaDelle and Neche soils are fine-silty. In addition, LaDelle soils have a mollic epipedon more than 20 inches thick and Neche soils have redoximorphic concentrations within depths of 20 inches. Lamoure soils are fine-silty. Ludden and Wahpeton soils are fine. In addition, Lamoure and Ludden soils are poorly drained. In addition, Wahpeton have a mollic epipedon more than 16 inches thick. La Prairie soils have mollic epipedons more than 30 inches thick.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff ranges from negligible to medium depending on slope. Permeability is moderate. These soils have rare or common flooding early in the spring when the snow melts, and during severe summer storms. A seasonal high water table is at a depth of 3 to 5 feet at some time during the period of April through June.

USE AND VEGETATION: Most of the soils are used for cropland, hay and pasture. Native vegetative is mid and tall prairie grasses such as big bluestem, green needlegrass, porcupinegrass, western wheatgrass, a variety of forbs, shrubs, and trees such as boxelder, chokecherry, cottonwood, elm and prairie rose.

DISTRIBUTION AND EXTENT: Eastern North Dakota and western Minnesota, mainly along the Red River of the North and its tributaries. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, Tri-County Soil Survey, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: criteria for Mollic Udifluvents - Ap horizon with moist value of less than 4 and dry value less than 6.

National Cooperative Soil Survey
U.S.A.

LOCATION FARGO ND+MN MT

Established Series
Rev. NDP-CJH
03/1999

FARGO SERIES

The Fargo series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in calcareous. clayey lacustrine sediments. These soils are on glacial lake plains, floodplains, and gently sloping side slopes of streams within glacial lake plains. Slopes range from 0 to 6 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Epiaquerts

TYPICAL PEDON: Fargo silty clay on a level plane slope of less than 1/10 percent under cropland. When described the soil was dry from 0 to 8 inches and moist from 8 to 60 inches. (Colors are for moist soil unless otherwise stated)

Ap--0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to strong fine granular; very hard, blocks friable, granules firm, very sticky and very plastic; many fine roots; many fine pores; neutral (pH 7.2); abrupt smooth boundary. (Combined A horizons 5 to 15 inches thick)

Bw1--8 to 13 inches; black (10YR 2/1) and very dark gray (10YR 3/1) crushed and rubbed silty clay, very dark gray (10YR 3/1) and dark gray (10YR 4/1) crushed and rubbed, dry; moderate medium subangular blocky structure parting to strong very fine angular blocky; extremely hard, firm, very sticky and very plastic; many fine roots; many fine pores; faces of peds have shiny waxy sheen when moist; cracks filled with A material throughout; neutral (pH 7.0); abrupt wavy boundary.

Bw2--13 to 21 inches; very dark grayish brown (2.5Y 3/2) and very dark gray (2.5Y 3/1) silty clay, dark grayish brown (2.5Y 4/2) and gray (2.5Y 5/1) dry; dark grayish brown (2.5Y 4/2) crushed and rubbed, grayish brown (2.5Y 5/2) dry; moderate coarse prismatic structure parting to strong fine and very fine angular blocky; extremely hard, firm, very sticky and very plastic; common fine roots; common pores; slickensides on vertical faces of peds; faces of blocks have waxy sheen when moist; slight effervescence in lower part, noneffervescent on tongues; cracks filled with A material throughout; slightly alkaline (pH 7.6); abrupt irregular boundary. (Combined Bw horizons 8 to 27 inches thick)

Bkg--21 to 32 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/2) dry; weak medium subangular blocky structure parting to moderate fine angular blocky and granular; hard, friable, sticky and plastic; few roots; common fine pores; cracks filled with A material extend into this horizon; common fine masses of carbonates; strong effervescence; moderately alkaline (pH 8.0); clear wavy boundary. (0 to 26 inches thick)

Cg1--32 to 48 inches; grayish brown (2.5Y 5/2) silty clay, light gray (2.5Y 7/2) dry; common medium distinct brown (10YR 4/3) redox concentrations and gray (5Y 5/1) redox depletions; weak medium subangular blocky structure parting to

moderate very fine angular blocky and granular; very hard, firm, very sticky and very plastic; few fine roots; common pores; strong effervescence; moderately alkaline (pH 8.0); gradual wavy boundary.

Cg2--48 to 60 inches; olive (5Y 4/3) and pale olive (5Y 6/3) silty clay, pale olive (5Y 6/3) and pale yellow (5Y 8/3) dry; many medium prominent dark yellowish brown (10YR 4/4) redox concentrations; laminated, fractures to moderate very fine blocky structure; very hard, firm, very sticky and very plastic; few medium masses of carbonates; slight effervescence; moderately alkaline (pH 8.0).

TYPE LOCATION: Traill County, North Dakota; about 9 miles south and 6 miles east of Hillsboro; 1170 feet south and 410 feet east of the northwest corner, sec. 29, T. 144 N., R. 49 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch particle size control section averages between 40 and 60 percent clay and less than 15 percent fine sand and coarser. It is free of rock fragments. The mollic epipedon ranges from 8 to 40 inches in thickness. The depth to carbonates ranges from 11 to 42 inches. Saline phases are recognized.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 and 3 or 4 dry, and chroma of 1 or less. It is clay, silty clay or silty clay loam. It is neutral or slightly alkaline.

The Bw horizon has hue of 10YR, 2.5Y or 5Y, value of 2 to 4 and 3 to 5 dry, and chroma of 1 or 2. It is clay, silty clay or silty clay loam. It is neutral to moderately alkaline. It typically has weak or moderate prismatic structure which parts to strong fine and very fine blocky structure. Some pedons do not have the prismatic structure. Slickensides and shiny, waxy surfaces of peds are common. Cracks filled with A material commonly extend through the Bw horizon and range from l/2 inch to 5 inches in width. The lower part of the Bw horizon has redoximorphic features in some pedons. Some pedons have a Bg horizon.

The Bkg horizon, where present, has hue of 10YR, 2.5Y or 5Y, value of 3 to 6 and 5 to 8 dry, and chroma of 1 or 2. It is clay, silty clay or silty clay loam. It is moderately alkaline. It contains 10 to 25 percent calcium carbonate equivalent diffused or in masses. Where it has more than 15 percent calcium carbonate equivalent, it does not have more than 5 percent as masses or decrease by more than 5 percent in a lower horizon.

The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 and 5 to 8 dry, and chroma of 1 to 3. It is clay, silty clay or silty clay loam. It is moderately alkaline. It typically contains common to many distinct or prominent low to high chroma redox features. Where the Cg horizon has chroma of 2 or 3, it contains redox depletions with chroma of 1. Some pedons contain gypsum crystals in the Cg horizons. Sediments are laminated in the lower part of the Cg horizon at depths of 36 to 60 inches in most pedons. Textures of silt loam are in some pedons below depths of 40 inches.

COMPETING SERIES: This is the Clearwater series. The Clearwater series has 2 to 8 percent rock fragments throughout and formed in till.

GEOGRAPHIC SETTING: Fargo soils are on level and nearly level glacial lake plains and flood plains and gently sloping side slopes of streams within glacial lake plains. Slope gradients commonly are less than 1 percent but range from 0 to 6 percent. The soils formed in calcareous, clayey lacustrine sediments. The

climate is cool subhumid. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation from 15 to 23 inches. Most of the moisture falls in the spring and summer. Frost-free period ranges from 90 to 140 days. Elevation above sea level ranges from 650 to 1800 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Cashel, Dovray, Grano, Hegne, Ludden, Overly, Ryan and Wahpeton soils. Bearden and Overly soils are on nearby lake plains and are fine-silty. Cashel soils are on floodplains of larger streams and have fine stratification below the Ap horizon. Dovray and Grano soils are in concave swales and depressions on lake plains. Ludden soils are on floodplains of larger streams. Dovray do not have cracks filled with A material that extend through the Bw horizon. Grano and Ludden soils have carbonates at depths of less than 10 inches. Hegne soils are on slight rises and have calcic horizons within depths of 16 inches. They usually are in complex with Fargo soils. Ryan soils are on nearby areas where the lake sediments contain more salts and have natric horizons. Wahpeton soils are on levees and low terraces of large streams, commonly at slightly higher elevations than the lake plain and are moderately well drained.

DRAINAGE AND PERMEABILITY: Poorly drained and very poorly drained. Runoff is negligible to high depending on slope. Permeability is slow. A system of legal drains, section lines, road ditches, and field drains remove surface water from most Fargo soils. A seasonal high water table is at the surface to 3.0 feet below the surface at some time during the period of March through July. It is 1.0 foot above the surface to 2.0 feet below the surface at some time during the period of February through August in the ponded, depressional or very poorly drained phases.

USE AND VEGETATION: The soils are nearly all cropped to small grains, soybeans and sugar beets. Native vegetation is western wheatgrass, Kentucky bluegrass and a variety of forbs.

DISTRIBUTION AND EXTENT: Mainly in the Red River Valley of the North in North Dakota and Minnesota; smaller areas in glaciolacustrine areas and in west-central Montana. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Grand Forks Area, North Dakota, 1902.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 21 inches (Ap, Bw1 and Bw2 horizons); Vertisol criteria - cracks filled with A material extend through the Bw horizons and range from 1/2 to 5 inches in width, slickensides in the 13 to 21 inch layer (Bw2 horizon); the site will be redescribed in the future to better document the Vertisol criteria.

ADDITIONAL DATA: S51NDak-5-3; S51NDak-5-4; S51NDak-5-8; S51NDak-5-9; S53NDak-9-3; S53NDak-9-4; S54NDak-50-1; S54NDak-50-2; Soil Survey Investigation No. 2, pages 72 to 87. Also S64NDak-9-1; S64NDak-9-4; S64NDak-50-3; S64NDak-50-4; S65NDak-39-1; S65NDak-39-2; S65NDak-39-3; and S65NDak-39-4; and S65NDak-49-1 (Type Location 15 feet to the west of this lab sample) by Soils Department, North Dakota Agriculture Experiment Station.

National Cooperative Soil Survey
U.S.A.

LOCATION FORDVILLE SD+MN ND

Established Series
Rev. KFM-BOK
04/1999

FORDVILLE SERIES

The Fordville series consists of very deep, well drained soils formed in loamy sediments that are moderately deep over sand and gravel on outwash plains, terraces, and flood plains. Permeability is moderate in the solum and very rapid in the underlying sand and gravel. Slopes range from 0 to 9 percent. Mean annual precipitation is about 22 inches, and mean annual temperature is 41 degrees F.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Fordville loam - on a plane slope of 1 percent in a cultivated field. When described the soil was dry throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 6 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary. (The A horizon is 6 to 14 inches thick.)

Bw1--6 to 12 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; moderate coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable; neutral; clear wavy boundary.

Bw2--12 to 17 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium and coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable; neutral; clear wavy boundary.

Bw3--17 to 24 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, rubbed dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure; slightly hard, very friable; neutral; clear wavy boundary. (Combined thickness of Bw horizons is 9 to 30 inches)

2C1--24 to 27 inches; grayish brown (10YR 5/2) gravelly loamy sand, dark grayish brown (10YR 4/2) moist; single grain; thick crusts of calcium carbonate on undersides of pebbles; about 15 percent gravel; strong effervescence; slightly alkaline; gradual wavy boundary.

2C2--27 to 60 inches; grayish brown (2.5Y 5/2) gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; thick crusts of calcium carbonate on undersides of pebbles in upper part; about 25 percent gravel; strong effervescence; slightly alkaline.

TYPE LOCATION: Codington County, South Dakota; about 3 miles west of Rauville; 600 feet west and 114 feet north of the southeast corner, sec. 21, T. 118 N., R. 52 W. on Sisseton-Wahpeton Indian Reservation.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from 16 to 30 inches and commonly includes the Bw horizon. Depth to sand and gravel typically is about 24 to 30 inches and ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1 moist and 1 or 2 dry, but some pedons have chroma of 2 moist below the Ap horizon. It typically is loam but is silt loam, stony loam, or very stony loam in some pedons. It is slightly acid or neutral.

The Bw horizon has value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 4. It is loam, silt loam, or clay loam averaging between 18 and 30 percent clay. It ranges from slightly acid to slightly alkaline.

The BC or Bk horizon, where present, has hue of 10YR or 2.5Y, values of 4 to 8 and 3 to 6 moist, and chroma of 2 or 3. They typically are loam or clay loam, but in some places, are sandy clay loam, fine sandy loam, or sandy loam. The BC horizon is neutral or slightly alkaline and the Bk horizon is slightly or moderately alkaline.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is loamy sand, sand, gravelly loamy sand, gravelly sand, gravelly coarse sand, very gravelly sand, very gravelly loamy sand and contains up to 50 percent gravel. Thin strata of finer textures are in some pedons. It is slightly or moderately alkaline.

COMPETING SERIES: These are the Spottswood and Vang series. The Spottswood soils are mottled within depths of 40 inches and are moderately well drained. Vang soils have 50 percent or more coarse shale fragments within depths of 20 to 40 inches.

GEOGRAPHIC SETTING: Fordville soils are on outwash plains, terraces, and flood plains of streams that dissect the glacial till plains. Surfaces are plane to convex. Slope gradients range from 0 to 9 percent. The soil formed in loamy alluvium over stratified sand and gravel. Mean annual temperature ranges from 38 to 48 degrees F, and mean annual precipitation ranges from 16 to 24 inches. The growing season is about 120 to 140 days; the average growing season precipitation ranges from 13 to 17 inches. The growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: This is the competing Spottswood series and the Divide, Marysland, Renshaw, and Sioux soils. Spottswood, Divide, and Marysland soils are on lower and wetter parts of the outwash plains and terraces. Renshaw soils have a mollic epipedon less than 16 inches thick, are shallow to gravel, and are on slightly higher positions. Divide and Marysland soils have calcic horizons within depths of 16 inches. Sioux soils have sand and gravel at depths of less than 14 inches and are higher convex positions.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is medium or low. Permeability is moderate in the solum and very rapid in the underlying sand and gravel. Soils on flood plains are flooded for short periods.

USE AND VEGETATION: Primarily used to grow corn, flax, and alfalfa. Native vegetation consists mainly of big bluestem, little bluestem, needlegrass, western wheatgrass, blue grama, sideoats grama, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Rock County, Minnesota, 1945.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 24 inches (Ap, Bw1, Bw2, Bw3 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION FOSSUM MN+ND SD

Established Series
RTD-HRF-CJH
07/2000

FOSSUM SERIES

The Fossum series consists of very deep, poorly and very poorly drained soils that formed in calcareous sandy glaciolacustrine or outwash sediments on lake and outwash plains. These soils have rapid permeability. They have slopes of 0 to 2 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Sandy, mixed, calcareous, frigid Typic Endoaquolls

TYPICAL PEDON: Fossum sandy loam with a slightly concave slope of less than 1 percent on a glacial lake plain in a cultivated field. (Colors are for moist soil unless otherwise stated)

Ap--0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slight effervescence; moderately alkaline; abrupt smooth boundary. (6 to 9 inches thick)

A1--8 to 13 inches; very dark gray (N 3/0) loamy sand; dark gray (N 4/0) dry; massive; very friable; strong effervescence; moderately alkaline; clear smooth boundary. (0 to 6 inches thick)

A2--13 to 21 inches; very dark grayish brown (2.5Y 3/2) sand, dark grayish brown (2.5Y 4/2) dry; common fine faint gray (5Y 5/1) redoximorphic depletions and common fine distinct brown (10YR 5/3) redoximorphic concentrations; single grain; loose; strong effervescence; moderately alkaline; clear smooth boundary. (0 to 9 inches thick)

Cg1--21 to 26 inches; olive gray (5Y 5/2) fine sand; common medium distinct light olive brown (2.5Y 5/6) redoximorphic concentrations; single grain; loose strong effervescence; moderately alkaline; clear wavy boundary.

Cg2--26 to 60 inches; light olive gray (5Y 6/2) fine sand; common coarse prominent brownish yellow (10YR 6/8) redoximorphic concentrations; single grain; loose strong effervescence in upper part and slight effervescence in lower part; moderately alkaline; clear wavy boundary.

Cg3--60 to 80 inches; light olive gray (5Y 6/2) fine sand; single grain; loose; common coarse prominent yellowish brown (10YR 5/6) redoximorphic concentrations; slight effervescence; slightly alkaline.

TYPE LOCATION: Swift County, Minnesota; about 1.5 miles south and 0.75 miles east of Clontarf; 1100 feet east and 160 feet south of the northwest corner, sec. 25, T. 122 N., R. 40 W.; USGS Hancock SW Minnesota Quadrangle, latitude 45 degrees, 21 minutes, 15 seconds north, longitude 95 degrees, 38 minutes, 20 seconds west, NAD27.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 10 to 24 inches thick. The depth to loamy fine sand or coarser sediments is less than 20

inches. The average texture in the control section has greater than 55 percent fine sand and very fine sand, less than 30 percent medium sand and coarser, and less than 15 percent silt plus clay. These soils typically have carbonates in all parts, except the upper 10 inches of the A horizon in some pedons. A slight accumulation of carbonates commonly is in the A horizon or Bk horizon or both, but the maximum content of carbonates is less than 15 percent. Typically they are nonsaline, but some areas range to 15 mmhos/cm. They typically do not have rock fragments, but a few pedons contain as much as 5 percent by volume of rock fragments or very fine gravel, in the lower part of the C horizon. The soil is slightly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3, and chroma of 2 or less. It commonly has redoximorphic features in some part. It is loamy sand, loamy fine sand, sandy loam, fine sandy loam or loam. Coarser textures of sand and fine sand are in the lower part of some pedons. Some pedons have a Bk horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 6, and typically a chroma of 1 or 2. However, part of the C horizon in some pedons has chroma of 3. The C horizon has few to many redoximorphic features. It is sand, fine sand, loamy sand or loamy fine sand. Sandy loam or fine sandy loam is in the upper part of some pedons.

2C horizons of loamy glacial till or with up to 35 percent gravel are as shallow as 40 inches in some pedons.

COMPETING SERIES: These are in the Verendrye series. The Verendrye soils have more than 30 percent medium sand and coarser in the series control section.

GEOGRAPHIC SETTING: These soils have plane or concave slopes with gradient of 2 percent or less on glacial lake and outwash plains. They formed in calcareous sandy glaciolacustrine or outwash sediments of late Wisconsinan Age. Mean annual precipitation is 15 to 24 inches. Mean annual air temperature is 36 to 48 degrees F. Frost-free period ranges from 105 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Flaming, Hecla, Hamar, Maddock, Ulen and Venlo soils which formed in sediments similar to those of Fossum soils. The Flaming, Hecla and Ulen soils are somewhat poorly and moderately well drained and are on slightly higher lying terrain. The Maddock soils are well drained and are on higher lying terrain. The poorly drained Hamar soils are on flats. The very poorly drained Venlo soils are in depressions.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Runoff is negligible. Permeability is rapid. A seasonal high water table is at a depth of 0.5 to 1.5 feet.

USE AND VEGETATION: Mostly cropped to small grains, corn, and soybeans. Some areas are used for growing hay or pasture. Native vegetation was a wet site community of the tall grass prairie.

DISTRIBUTION AND EXTENT: Western Minnesota and eastern North Dakota. Moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Swift County, Minnesota, 1970.

REMARKS: Diagnostic horizons and features are: mollic epipedon - the zone from the surface to a depth of 21 inches (Ap, A1, and A2 horizons); aquic moisture regime - low chroma and redoximorphic features below the A horizon.

National Cooperative Soil Survey
U.S.A.

LOCATION FRAM ND+MN

Established Series
CJH
05/2001

FRAM SERIES

The Fram series consists of very deep, somewhat poorly drained, moderately permeable soils that formed in till or water sorted sediments over till. These soils are on till plains, moraines and lake plains. Slopes range from 0 to 3 percent. Mean annual air temperature is 40 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Fram loam on a convex north-northeast facing 1 percent slope in a cultivated field. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; slightly sticky and slightly plastic; common fine roots; about 1 percent pebbles; slight effervescence; slightly alkaline; abrupt smooth boundary. (6 to 16 inches thick)

Bk--7 to 18 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) and light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard, very friable; slightly sticky and slightly plastic; common fine roots; many fine pores; few thin tongues of A material; about 1 percent pebbles; violent effervescence; moderately alkaline; gradual irregular boundary. (6 to 30 inches thick)

BCk--18 to 38 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; very friable; slightly sticky and slightly plastic; few fine roots; common fine pores; few masses of carbonates; about 1 percent pebbles; strong effervescence; moderately alkaline; clear wavy boundary. (0 to 30 inches thick)

C--38 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; few fine reddish brown redoximorphic concentrations below 40 inches; weak medium subangular blocky structure; hard, friable; slightly sticky and slightly plastic; few small nests of gypsum crystals in upper part, more in lower part; about 5 percent pebbles; strong effervescence; moderately alkaline.

TYPE LOCATION: Wells County, North Dakota; about 5 miles east and 1 mile south of Fessenden; 385 feet west and 45 feet north of the southeast corner, Sec. 13, T. 148 N., R. 70 W.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from 7 to 20 inches. The top of the calcic horizon is at depths of less than 16 inches, and in some pedons the lower part of the mollic epipedon qualifies as part of the calcic horizon. The soil contains 1 to 10 percent rock fragments. Some pedons contain stones. Some pedons are saline. The soil is slightly alkaline or moderately alkaline throughout.

The A horizon has a hue of 10YR, value of 2 or 3, 3 to 5 dry, and chroma of 1 or 2. It is sandy loam, fine sandy loam, very fine sandy loam, loam or silt loam. Some pedons have Ak or ABk horizons.

The Bk horizon has a hue of 10YR or 2.5Y, value of 4 to 6, 5 to 8 dry, and chroma of 1 to 4. It typically is sandy loam, fine sandy loam or loam. Redoximorphic features are in some to all parts of the Bk and C horizons. Some pedons have Bky horizons.

The C horizon has a hue of 10YR or 2.5Y, value of 4 or 5, 5 to 7 dry, and chroma of 2 to 4. It is sandy loam, fine sandy loam or loam.

Some pedons have a 2C horizon. It typically has a coarse textured lag line at the top.

COMPETING SERIES: This is the Wyndmere series. Wyndmere soils do not have rock fragments and formed in lacustrine material.

GEOGRAPHIC SETTING: Fram soils are on level and nearly level till plains, moraines and lake plains. Slope gradients range from 0 to 3 percent. They formed in till or water sorted sediments over till. The climate is cool, subhumid, with a mean annual air temperature ranging from 36 to 45 degrees F, and mean annual precipitation ranging from 15 to 22 inches. The frost-free period ranges from 90 to 140 days. The elevation above sea level ranges from 750 to 2300 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Emrick, Hedman, Heimdal, Parnell and Tonka soils. Emrick and Heimdal soils are on better drained, higher lying positions. Hedman soils are on adjacent poorly drained flats. Parnell and Tonka soils occupy very poorly and poorly drained areas in depressions.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is negligible to medium depending on slope. Permeability is moderate. A seasonal high water table is at depths of 1.5 to 3.5 feet at some time during the period April through June.

USE AND VEGETATION: Most areas are cultivated with small grains and hay the principal crops. The original native grasses were big and little bluestem, wheatgrass, prairie dropseed, and blue grama.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota and western Minnesota. The soils are of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Wells County, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in the pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 7 inches (Ap horizon); calcic horizon - the zone from 7 to 18 inches (Bk horizon); characteristics associated with wetness - calcic horizon within 16 inches.

Where the soil has been previously correlated as moderately well drained or with slopes of more than 3 percent it should be recorrelated to Ortonville (Aquic Calciudolls).

National Cooperative Soil Survey

U.S.A.

LOCATION GALCHUTT ND+MN

Established Series
Rev. CJH
12/96

GALCHUTT SERIES

The Galchutt series consists of very deep, somewhat poorly drained, slowly permeable soils that formed in glacial lake sediments that are silty in the upper part and clayey in the lower part. These soils are on glacial lake plains and have slopes of 0 to 1 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Vertic Argialbolls

TYPICAL PEDON: Galchutt silt loam - on a level slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist throughout.)

Ap--0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak coarse and medium subangular blocky structure; slightly hard, very friable, very sticky and slightly plastic; many fine roots; common fine pores; slightly acid; abrupt smooth boundary.

A--8 to 16 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry, gray (10YR 5/1) dry in lower part; weak coarse prismatic structure parting to weak thin platy; hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; neutral; clear wavy boundary. (Combined A horizons 9 to 24 inches thick)

E--16 to 25 inches; dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) silt loam, light grayish brown (2.5Y 6/2) and grayish brown (2.5Y 5/2) dry; few fine distinct brown (10YR 4/3) and few fine prominent black (10YR 2/1) redox concentrations; weak very coarse prismatic structure parting to weak medium platy; hard, very friable, slightly sticky and slightly plastic; common fine roots; many fine pores; neutral; abrupt wavy boundary. (3 to 16 inches thick)

2Bt1--25 to 32 inches; olive brown (2.5Y 4/3) clay, light yellowish brown (2.5Y 6/3) dry; few fine faint gray (5Y 5/1) redox depletions; weak coarse prismatic structure parting to strong fine and very fine angular blocky; very hard, firm, sticky and plastic; few fine roots; common fine pores; neutral; gradual wavy boundary.

2Bt2--32 to 37 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; common medium distinct dark gray (5Y 4/1) redox depletions and common fine faint olive brown (2.5Y 4/4) redox concentrations; weak coarse prismatic structure parting to strong medium and fine angular blocky; very hard, firm, sticky and plastic; few fine roots; common fine pores; few irregular masses of carbonates; slight effervescence; slightly alkaline; gradual wavy boundary. (Combined 2Bt horizons 6 to 16 inches thick)

2C--37 to 60 inches; mixed gray (5Y 5/1) and olive brown (2.5Y 4/3) clay, gray (5Y 6/1) dry; common fine and medium distinct light yellowish brown (2.5Y 6/4) dry, redox concentrations; weak fine subangular blocky structure in the upper part and massive in lower part; very hard, firm, sticky and plastic; few medium irregular masses of carbonates; slight effervescence; slightly alkaline.

TYPE LOCATION: Richland County, North Dakota; about 7 miles west and 1 mile south of Wahpeton; 1,875 feet south and 175 feet west of the northeast corner, sec. 13, T. 132 N., R. 49 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 19 to 48 inches. Depth to the clayey 2Bt ranges from 12 to 30 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and 3 or 4 dry, and chroma of 1. It typically is silt loam, but it is loam, fine sandy loam or silty clay loam in some pedons. It is slightly acid or neutral. Faint redox features having chroma of 2 or higher are in the lower part in some pedons.

The E horizon has hue of 2.5Y or 10YR, value of 3 to 5 and 5 to 7 dry, and chroma of 1 to 3. It is silt loam, very fine sandy loam or loam. It is neutral. Redox features range from few to many, fine to large, and faint to prominent.

The 2Bt horizon has hue of 2.5Y or 5Y, value of 4 or 5 and 5 or 6 dry, and chroma of 2 or 3. It is silty clay or clay and averages between 45 and 60 percent clay. It is neutral or slightly alkaline. Redox features range from few to many, fine to large, and faint to prominent. It has weak or moderate prismatic structure and moderate or strong fine or very fine angular blocky structure. In some pedons tongues of A horizon extend into the 2Bt horizon. The lower part of the 2Bt has slight to strong effervescence and carbonates are diffused through the soil or in masses. Some pedons do not have carbonates in the lower part of the 2Bt horizon.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5 and 5 or 6 dry, and chroma of 1 to 4. It is silty clay or clay and has massive, laminated, or weak or moderate grades of blocky structure. It is slightly alkaline. It has few to common accumulations of carbonates in many pedons. Numerous distinct or prominent redox features make the 2C horizon appear multicolored in many pedons.

COMPETING SERIES: This is the Molas series as previously classified. Molas soils have a paralithic contact within depths of 40 inches.

GEOGRAPHIC SETTING: Galchutt soils are on level glacial lake plains. Slope gradients range from 0 to 1 percent. The soils formed in glacial lake sediments that are silty in the upper part and clayey in the lower part. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation from 19 to 23 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Enloe, Fargo, Hegne, Overly and Perella soils. Bearden, Overly and Perella soils are on nearby silty lake plains. They are fine-silty. Bearden soils have a calcic horizon within depths of 16 inches. Overly soils do not have an E horizon. Perella soils are poorly drained. Enloe, Fargo and Hegne soils are on nearby lake plains. Enloe soils do not have an abrupt textural change from the albic to the argillic horizon and are wetter. Fargo and Hegne soils are clayey throughout and do not have an albic or argillic horizon. In addition, Hegne soils have a calcic horizon within a depth of 16 inches.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is very slow. Permeability is moderate in the A and E horizons and slow in the 2Bt and 2C horizons. A seasonal high, perched water table is above the 2Bt horizon, at depths of 1 to 3 feet below the surface, after high rainfall and in the spring when snow melts.

USE AND VEGETATION: A large percent of this soil is cultivated. Small grains, soybeans, and flax are principal crops. Native vegetation was big bluestem, green needlegrass, western wheatgrass and a variety of forbs.

DISTRIBUTION AND EXTENT: Eastern North Dakota and western Minnesota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface of the soil to a depth of 16 inches (Ap and A horizon); albic horizon - zone from 16 to 25 inches (E horizons); argillic horizon - zone from 25 to 37 inches (2Bt1 and 2Bt2 horizons); features associated with wetness - redox features in the E and 2Bt horizons; abrupt textural change from albic to argillic horizon - silt loam (E horizon) to clay (Bt1 horizon); vertic criteria - LE of more than 6 cm in the upper 1 meter.

National Cooperative Soil Survey
U.S.A.

LOCATION GARDENA ND+MN MT SD

Established Series
Rev. CJH
10/98

GARDENA SERIES

The Gardena series consists of very deep, well drained and moderately well drained, moderately permeable soils that formed in calcareous silty and loamy glaciolacustrine sediments. These soils are on terraces, deltas and glacial lake plains and have slopes ranging from 0 to 9 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Gardena silt loam on a level plane slope of less than 1 percent under cropland. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 9 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; slightly alkaline; abrupt smooth boundary.

A--9 to 15 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; slightly alkaline; gradual wavy boundary. (Combined A horizons 9 to 25 inches thick)

Bw--15 to 22 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure; hard, friable, slightly sticky and slightly plastic; many fine roots; common pores; slightly alkaline; gradual wavy boundary. (5 to 18 inches thick)

Bk--22 to 33 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak coarse subangular blocky structure parting to weak fine granular; hard, friable, slightly sticky and slightly plastic; common fine roots; common pores; few krotovinas; a few small masses of segregated carbonates; violent effervescence; slightly alkaline; diffuse wavy boundary. (0 to 20 inches thick)

C1--33 to 56 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; few fine distinct grayish brown (2.5Y 5/2) redox depletions and dark brown (10YR 3/3) redox concentrations in lower part; weak fine and very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few roots; common fine pores; few krotovinas to 44 inches; strong effervescence; moderately alkaline; abrupt smooth boundary.

C2--56 to 60 inches; light yellowish brown (2.5Y 6/3) silt loam grayish brown (2.5Y 5/2) moist; many medium prominent dark yellowish brown (10YR 4/4) redox concentrations; laminated; hard, friable, slightly sticky and nonplastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Walsh County, North Dakota; about 5 1/4 miles west and 5 miles north of Grafton; 1,340 feet west and 430 feet north of the southeast corner, sec. 13, T. 158 N., R. 54 W.

RANGE IN CHARACTERISTICS: The depth to carbonates typically is 20 to 40 inches and ranges from about 14 to 40 inches. The mollic epipedon ranges from 16 to about 40 inches in thickness and includes part or all of the Bw horizon. The 10- to 40-inch particle-size control section is silt loam, loam, or very fine sandy loam and has more than 5 percent fine sand and coarser.

The A horizon has hue of 10YR, value of 3 or 4 and 2 or 3 moist, and chroma of 1. It has chroma of 2 in the lower part of some pedons. It is loam, silt loam or very fine sandy loam. Reaction is neutral or slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 3. It is loam, silt loam or very fine sandy loam. It has weak or moderate grades of prismatic and blocky structure. Faint redox features are in the lower part of the Bw horizon in some pedons. Reaction is neutral to moderately alkaline.

The Bk horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It is loam, silt loam or very fine sandy loam. It has 10 to 30 percent calcium carbonate equivalent. Reaction is slightly alkaline or moderately alkaline. Some pedons have BCk horizons.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It does not have redox features in some pedons. Reaction is slightly alkaline or moderately alkaline. The C horizon below depths of 40 inches commonly has texture similar to the control section, but in some pedons it contains coarser or finer textured glacial till or lacustrine sediments.

COMPETING SERIES: This is the Hantho series. Hantho soils formed in 3 to 6 feet of loess overlying glacial till and have less than 5 percent fine sand and coarser sand in the particle-size control section.

GEOGRAPHIC SETTING: Gardena soils are on level to sloping terraces, deltas and glacial lake plains. Slope gradients commonly average between 1 to 3 percent and range from 0 to 9 percent. The soils formed in calcareous silty and loamy glaciolacustrine sediments. The climate is cool, subhumid. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation ranges from 15 to 24 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Borup, Colvin, Eckman, Embden, Glyndon, Overly and Perella soils. Bearden, Colvin and Perella soils are on nearby lake plains. They are fine-silty. In addition, Colvin and Perella soils are poorly drained; and Bearden and Colvin soils have calcic horizons within depths of 16 inches. Borup, Eckman and Glyndon soils are in a drainage sequence with Gardena soils. Borup soils are in the swales, basins and low flats; Eckman soils are on the slopes and convex parts of the landscape; and Glyndon soils are on the level parts and lower elevations. Borup soils have calcic horizons within depths of 16 inches and are poorly drained. Eckman soils have mollic epipedons less than 16 inches thick. Glyndon soils do not have Bw horizons and have calcic horizons at depths of less than 16 inches. Embden and Overly soils are on nearby deltas and lake plains. Embden soils are coarse-loamy. Overly soils are fine-silty.

DRAINAGE AND PERMEABILITY: Well drained and moderately well drained. Runoff ranges from negligible to moderate depending on slope. Permeability is moderate. A seasonal high water table is at a depth of 3 to 5 feet at sometime during the period of April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Soils are cropped to small grains and row crops such as soybeans, potatoes, sugar beets, beans and sunflowers. Native vegetation was green needlegrass, bearded wheatgrass, western wheatgrass, prairie junegrass, needleandthread, blue grama and a variety of forbs.

DISTRIBUTION AND EXTENT: North-central and eastern North Dakota, northeastern South Dakota and west-central Minnesota. The series is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 22 inches (Ap, A, and Bw horizons).

ADDITIONAL DATA: Laboratory data: S51NDak-5-7, S50NDak-38-1 and North Dakota Agricultural Experiment Station, Soils Department S66ND-39-1 and S66ND-50-3.

National Cooperative Soil Survey
U.S.A.

LOCATION GLYNDON MN+ND SD

Established Series
Rev. RBH-CJH
06/1999

GLYNDON SERIES

The Glyndon series consists of very deep, somewhat poorly drained soils that formed in silty glacial lacustrine sediments and delta sediments on glacial lake plains. They have moderate permeability in the upper part and moderately rapid permeability in the lower part. They have slopes of 0 to 3 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Glyndon loam with a plane level slope on a glacial lake plain in a cultivated field. (Colors are for moist soil unless otherwise stated)

Ap--0 to 8 inches; black (10YR 2/1) loam, few masses of very dark gray (10YR 3/1); dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; many roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

A--8 to 11 inches; black (10YR 2/1) loam, common inclusions of very dark gray (10YR 3/1); dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; many roots; strong effervescence; moderately alkaline; gradual wavy boundary. (Combined A horizon 7 to 16 inches)

Bk1--11 to 16 inches; dark gray (10YR 4/1) loam; weak very fine subangular blocky structure; very friable; many roots; disseminated carbonates throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2--16 to 28 inches; light yellowish brown (2.5Y 6/3) loam; few fine faint light yellowish brown (2.5Y 6/4) redoximorphic concentrations; weak very fine subangular blocky structure; very friable; disseminated carbonates throughout; violent effervescence; moderately alkaline; clear smooth boundary. (Combined Bk horizons 10 to 52 inches thick)

C--28 to 36 inches; light yellowish brown (2.5Y 6/4) loamy very fine sand; common fine distinct light olive brown (2.5Y 5/6) redoximorphic concentrations; massive; very friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg--36 to 60 inches; light brownish gray (2.5Y 6/2) loamy very fine sand; many medium prominent brownish yellow (10YR 6/8) redoximorphic concentrations; massive with some weak bedding planes; very friable; strong effervescence; moderately alkaline.

TYPE LOCATION: Norman County, Minnesota; about 4 miles north and 2 miles east of Ada; 665 feet east and 210 feet south of the northwest corner of Sec. 25, T. 145 N., R. 46 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 7 to 16 inches. The calcic horizon begins within a depth of 16 inches. These soils have less than 15 percent fine sand or coarser in the upper part of the particle-size control section. These soils do not have rock fragments at least to a depth of 40 inches. The calcium carbonate equivalent typically ranges from 15 to 40 percent in the 0- to 40-inch section. Calcium carbonate contents higher than 40 percent are in the calcic horizon in some pedons and some pedons are saline.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Texture is very fine sandy loam, loam, silt loam, sandy clay loam or silty clay loam. Reaction is slightly alkaline to strongly alkaline. Some pedons have an ABk horizon.

The Bk horizon has hue of 10YR to 5Y, value of 3 to 7, and chroma of 1 to 4. Redoximorphic features are present in some pedons. Texture is loamy very fine sand, very fine sandy loam, loam, sandy clay loam, silt loam, or silty clay loam. Sandy clay loam and silty clay loam textures are possible because of the large amounts of clay size calcium carbonate in this horizon. Some pedons have Bky or BCk horizons. Reaction is slightly alkaline to strongly alkaline.

The C horizon has hue of 10YR to 5Y, value of 4 to 7, and chroma of 2 to 4. Redoximorphic features are present in some to all parts. Texture is very fine sand, loamy very fine sand, very fine sandy loam, loam, or silt loam. Reaction is slightly alkaline to strongly alkaline. A 2C horizon with sandy, coarse-loamy, fine-loamy, or fine-silty particle-size begins at depths as shallow as 40 inches in some pedons.

COMPETING SERIES: These are the Bohnsack series. Bohnsack soils contain more than 15 percent fine sand or coarser in the upper part of the particle-size control section and contain 2 to 10 percent rock fragments.

GEOGRAPHIC SETTING: These soils have plane or slightly convex slopes with gradient of 0 to 3 percent on glacial lake plains. They formed in 40 inches or more of late Wisconsian age glacial lacustrine sediments and delta sediments. Mean annual air temperature is 36 to 45 degrees F. Mean annual precipitation ranges from 15 to 24 inches. Frost-free days range from 90 to 150. Elevation above sea level ranges from 800 to 1500 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Borup, Eckman, Gardena and Wheatville soils. Bearden soils are fine-silty. The poorly drained Borup soils are in shallow depressions and lower-lying flats. Eckman and Gardena soils are better drained and are on higher lying areas. Wheatville soils have clayey 2C horizons within 40 inches.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Surface runoff is negligible to moderate depending on slope. Permeability is moderate in the upper part and moderately rapid in the lower part. An apparent seasonal high water table is at depths of 1.5 to 3.5 at some time from April through June in most years.

USE AND VEGETATION: These soils are cultivated. Small grains are the principal crops, but sugar beets and potatoes are important crops. Native vegetation is tall grass prairie.

DISTRIBUTION AND EXTENT: Mainly in the Red River Valley of northwestern Minnesota and eastern North Dakota. It is also in smaller glacial lake basins

of western Minnesota, central North Dakota, and northeast South Dakota. It is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, in 196l.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface to 11 inches (Ap and A horizons); calcic horizon - zone from 11 to 28 inches (Bk1 and Bk2 horizons); aquic moisture regime.

Where the soil has been previously correlated as moderately well drained or on slopes of more than 3 percent, a new series should be established (Aquic Calciudolls).

ADDITIONAL DATA: Refer to MAES Central File Code Nos. 2, 3, 4, 107, 122, 125, and 931 for results of some laboratory analyses of pedons of this series. No. 122 is the typical pedon of this series.

National Cooperative Soil Survey
U.S.A.

LOCATION GREAT BEND SD+ND

Established Series
Rev. LDS-WJB
10/98

GREAT BEND SERIES

The Great Bend series consists of very deep, well drained soils formed in glaciolacustrine sediments on lake plains. Permeability is moderate in the solum and moderate to slow in the underlying material. Slopes range from 0 to 15 percent. Mean annual precipitation is about 19 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Great Bend silt loam - on a northwest-facing slope of 3 percent in a cultivated field. When described the soil was dry throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; many fine roots; neutral; abrupt smooth boundary. (5 to 10 inches thick)

Bw--8 to 13 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common fine roots; neutral; clear wavy boundary. (5 to 16 inches thick)

Bk1--13 to 17 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few roots; many fine pores; strong effervescence (17 percent calcium carbonate); slightly alkaline; clear wavy boundary.

Bk2--17 to 29 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few roots; many fine pores; few fine threads of gypsum; violent effervescence (24 percent calcium carbonate); moderately alkaline; gradual wavy boundary. (Combined Bk horizons is 6 to 26 inches thick.)

C1--29 to 46 inches; light gray (2.5Y 7/2) and light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) and olive brown (2.5Y 4/4) moist; massive, varved; slightly hard, friable; strong effervescence (16 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

C2--46 to 60 inches; white (2.5Y 8/2) silt loam, varved with thin layers of silty clay and very fine sandy loam, light yellowish brown (2.5Y 6/4) moist; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) redox concentrations; massive; slightly hard, friable; 1 to 3 mm thick varves; few fine dark concretions (iron and manganese oxides); few fine threads of gypsum crystals; strong effervescence (13 percent calcium carbonate); moderately alkaline.

TYPE LOCATION: Brown County, South Dakota; about 1 mile west and 3 miles north of Stratford; 1100 feet south and 130 feet east of the northwest corner of sec. 29, T. 122 N., R. 62 W.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from 7 to 16 inches and extends into the Bw horizon in most pedons. Depth to carbonate ranges from 10 to 32 inches thick. The particle size control section contains a uniform fine sand distribution and less than 15 percent fine sand or coarser.

The A horizon has value of 3 to 5 and 2 or 3 moist, and chroma of 1 or 2 and 1.5 or less moist. It is silt loam or silty clay loam and is slightly acid to slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 2 to 4. It is silt loam or silty clay loam averaging between 18 and 30 percent clay. It is neutral to moderately alkaline. Some pedons have relic mottles.

The Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 and 4 to 6 moist, and chroma of 2 to 4. It is silt loam or silty clay loam and is slightly or moderately alkaline. Some pedons have relic mottles.

The C horizon has 2.5Y hue, value of 5 to 8 and 4 to 6 moist, and chroma of 2 to 4. It is silt loam or silty clay loam and typically is varved with very thin strata of very fine sand to clay in the lower part. Stratified loamy sand or loamy glacial till is below a depth of 40 inches in some pedons. Varves range from less than 1 mm to 10 mm in thickness. Carbonate occurs as both disseminated and accumulations. Calcium carbonate equivalent ranges from 10 to 26 percent. It is slightly or moderately alkaline. Few to common salts are visible in some pedons. Many krotovina are in the Bk and C horizons of some pedons. Few to common mottles of high chroma typically are in the C horizon.

COMPETING SERIES: These are Brandt, Kranzburg, Poinsett, and Putney series in the same family. The Kranzburg soils have more than 15 percent fine sand or coarser between depths of 20 and 40 inches. Brandt and Poinsett soils have an uneven fine sand distribution in the particle size control section and contain more sand and coarse fragments in the series control section. Putney soils have gypsum and other salts within a depth of 20 inches.

GEOGRAPHIC SETTING: Great Bend soils are on glacial lake and delta plains. Slopes are convex and most have gradients of less than 6 percent, but range from 0 to 15 percent. Great Bend soils formed in silty, calcareous glaciolacustrine sediments of silt sized particles but with varves of very fine sand or clay sized particles. Mean annual air temperature ranges from 38 to 48 degrees F, and mean annual precipitation from 16 to 24 inches. Growing season is about 120 to 140 days; average growing season precipitation from 14 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aberdeen, Beotia, Exline, Harmony, Nahon, Tonka, and Zell soils. Aberdeen, Exline, Harmony, and Nahon soils are on broad flats. Aberdeen, Exline, and Nahon soils have a natric horizon, and Harmony soil has an argillic horizon. Beotia soils have mollic epipedons greater than 16 inches thick and are slightly lower on the landscape. The poorly drained Tonka soils have an albic horizon and are in closed depressions. Zell soils are coarse-silty and are on the steeper slopes, particularly along steep sides of stream valleys crossing the lake plain.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is negligible to medium depending on the slope. Permeability is moderate in the solum and moderate to slow in the underlying material.

USE AND VEGETATION: Most areas cropped to corn, small grains, and alfalfa. Small areas are in native range of blue grama, big bluestem, green needlegrass, western wheatgrass, sideoats grama, needleandthread, little bluestem, porcupinegrass, bearded wheatgrass, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and southeastern North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Day County, South Dakota, 1952.

ADDITIONAL DATA: NSSL data for the typical pedon of Great Bend silt loam is No. 74L1028-74L1034.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 13 inches (Ap, and Bw horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION HAMAR SD+MN ND

Established Series
LDS-CJH
10/2001

HAMAR SERIES

The Hamar series consists of very deep, poorly drained soils formed in eolian or lacustrine sands in upland swales and depressions. Permeability is rapid or moderately rapid. Slopes range from 0 to 3 percent. Mean annual precipitation is about 21 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Sandy, mixed, frigid Typic Endoaquolls

TYPICAL PEDON: Hamar loamy fine sand - in a basin area of less than 1 percent slope in native grass. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

A1--0 to 7 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; single grain; few fine prominent yellowish brown (10YR 5/6) redoximorphic concentrations; many fine and medium roots; slightly alkaline; clear wavy boundary.

A2--7 to 12 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; single grain; common fine distinct dark yellowish brown (10YR 4/4) and common fine prominent brown (7.5YR 4/4) redoximorphic concentrations; many fine and medium roots; slightly alkaline; clear wavy boundary. (Combined A horizons 10 to 30 inches thick)

AC--12 to 17 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; single grain; common fine distinct dark yellowish brown (10YR 4/4) redoximorphic concentrations; common fine and medium roots; moderately alkaline; clear wavy boundary. (0 to 10 inches thick)

C1--17 to 23 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; single grain; few fine distinct dark yellowish brown (10YR 4/4) and prominent yellowish brown (10YR 5/6) redoximorphic concentrations; slightly alkaline; clear wavy boundary.

C2--23 to 40 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; common fine prominent yellowish brown (10YR 5/6) redoximorphic concentrations; common fine and medium roots in upper part and few fine and medium roots in lower part; slight effervescence in the lower part; slightly alkaline; clear wavy boundary.

Ab--40 to 47 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; single grain; few fine distinct dark yellowish brown (10YR 4/4) redoximorphic concentrations; few fine and medium roots; strong effervescence; moderately alkaline; clear wavy boundary.

Cg--47 to 60 inches; olive gray (5Y 5/2) fine sand, light gray (5Y 7/2) dry; single grain; common fine prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) redoximorphic concentrations and few fine distinct

greenish gray (5G 5/1) redoximorphic depletions; few fine and medium roots; strong effervescence; moderately alkaline.

TYPE LOCATION: Marshall County, South Dakota; about 9 miles north and 4 miles west of Britton; 1190 feet west and 290 feet north of the southeast corner of sec. 6, T. 128 N., R. 58 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 10 to 20 inches; horizons with values less than 5.5 dry and 3.5 moist extend to depths greater than 20 inches are in some pedons, but contain less than 0.6 percent organic carbon. The control section is loamy fine sand, loamy sand, fine sand or sand. Textures of loamy coarse sand and coarse sand with less than 30 percent coarse and very coarse sand are allowed. Depth to carbonates typically is below depths of 30 inches, but ranges from 22 to 80 inches or more. Buried horizons are below depths of 30 inches in most pedons. Some pedons do not have Ab horizons.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or 2. It is loamy fine sand, loamy sand, sandy loam, or fine sandy loam. Textures of loamy coarse sand and coarse sandy loam with less than 30 percent coarse and very coarse sand are allowed. It is slightly acid to slightly alkaline. Typically, distinct or prominent redoximorphic concentrations are in the lower part of the A horizon, but are throughout the entire A horizon in some pedons.

The AC horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or 2. It is loamy fine sand, loamy sand, fine sand, and fine sandy loam. Textures of loamy coarse sand and coarse sand with less than 30 percent coarse and very coarse sand are allowed. It ranges from neutral to moderately alkaline.

Some pedons have a Bk horizon at depths below 25 inches.

The C horizon has hue of 2.5Y, 10YR or 5Y, value of 3 to 6 and 5 to 7 dry, and chroma of 1 to 4. It is loamy fine sand, loamy sand, or fine sand. Textures of loamy coarse sand and coarse sand with less than 30 percent coarse and very coarse sand are allowed. It is slightly alkaline or moderately alkaline. Clay loam, loam, or silty clay loam is between depths of 40 and 60 inches in some pedons.

COMPETING SERIES: These are the Garborg, Hangaard, Isan, Isanti, Medano and Venlo series. Garborg soils are somewhat poorly drained and do not have a water table within 1.5 feet of the soils surface during the period of March through July. Hangaard soils contain more than 10 percent rock fragments. Isan, Isanti and Venlo soils are more moist in the soil moisture control section during the 120 days following the summer solstice. In addition, Isanti soils are more acid. Medano soils have carbonates at or near the surface.

GEOGRAPHIC SETTING: The Hamar soils are on plane or concave slopes in swales and depressions. They are on sandy lacustrine and glacial outwash plains and till plains mantled by eolian sand. Slope gradients are less than 3 percent. Mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 16 to 24 inches. Growing season is about 120 to 130 days; average growing season precipitation ranges from 14 to 18 inches; and growing degree days are about 2500 to 3000. Frost-free period ranges from 90 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Garborg and Venlo soils and the Fossum, Hecla, Kratka, Maddock and Ulen soils. Garborg soils are on higher positions of the landscape. Venlo soils are on lower parts of the landform. Fossum and Ulen soils have carbonate at or near the surface. Kratka soils are medium or moderately fine textured between depths of 20 and 40 inches. Fossum, Kratka and Ulen soils are on similar landforms. Hecla soils are drier in the soil moisture control section, do not have distinct or prominent redoximorphic features in or immediately below the mollic epipedon, and are on slightly higher landforms. The well drained Maddock soils do not have redoximorphic features above depths of 40 inches and are on higher parts of the landform. Venlo soils are on lower parts of the landform.

DRAINAGE AND PERMEABILITY: Poorly drained. Surface runoff is negligible to low. Permeability is rapid or moderately rapid. A seasonal water table is at depths between 0 and 1.5 feet at some time during the period of March through July.

USE AND VEGETATION: Where artificially drained and cultivated, the principal crops are alfalfa, small grain, corn and tame pasture. Native range species are big bluestem, indiangrass, switchgrass, little bluestem, sedges and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The soil is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 17 inches (A, A2, and AC horizons); aquic suborder criteria - chroma of 1 in the lower part of the mollic epipedon and distinct redoximorphic concentrations (AC horizon).

Soils previously correlated as a somewhat poorly drained phase are now included with the Garborg series.

ADDITIONAL DATA: See laboratory data 74L1035-74L1042.

National Cooperative Soil Survey
U.S.A.

LOCATION HAMERLY ND+MN SD

Established Series
Rev. CJH
06/1999

HAMERLY SERIES

The Hamerly series consists of very deep, somewhat poorly drained soils that formed in calcareous loamy till. Permeability is moderate in the upper horizons and moderate or moderately slow in the lower horizons. These soils are on flats on lake plains and on convex slopes surrounding shallow depressions and on slight rises on till plains. They have slopes ranging from 0 to 3 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Hamerly loam - cultivated. (Colors are for moist soil unless otherwise stated)

Ap--0 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure parting to moderate medium granular; friable; slightly sticky; strong effervescence; abrupt smooth boundary. (Combined A horizons 5 to 18 inches thick)

Bk1--8 to 18 inches; light brownish gray (2.5Y 6/2) loam; weak medium and fine subangular blocky structure; friable; violent effervescence; gradual wavy boundary.

Bk2--18 to 25 inches; light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; friable; few masses of carbonates; violent effervescence; gradual wavy boundary. (Combined Bk horizons 10 to 40 inches thick)

C--25 to 60 inches; light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) loam; common medium distinct gray (2.5Y 5/1) redoximorphic depletions and yellowish brown (10YR 5/6) redoximorphic concentrations; weak medium blocky structure; firm; strong effervescence.

TYPE LOCATION: Sargent County, North Dakota; about 1/2 mile south of Gwinner; 2,090 feet south and 95 feet west of the northeast corner, Sec. 26, T. 132 N., R. 56 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 18 inches in thickness. The top of the calcic horizon is at depths of less than 16 inches, and in some pedons the lower part of the mollic epipedon qualifies as part of the calcic horizon. The soil contains 1 to 10 percent by volume of rock fragments. The 10- to 40-inch particle-size control section has visible gypsum in some pedons. It has 18 to 35 percent noncarbonate clay. Saline and stony phases are recognized.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or 2. It commonly is loam but in some pedons it is silt loam, clay loam, silty clay loam or sandy clay loam. It is neutral to moderately alkaline.

Where the soil is in native grassland, the A horizon in some pedons does not have carbonates. Some pedons have an ABk horizon.

The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 7 and 4 to 8 dry, and chroma of 1 to 4. It is loam or clay loam. It is slightly alkaline or moderately alkaline. Mottling in the Bk horizon ranges from none to common. Some pedons have Bky, Bkyz, By or BCk horizons.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 and 5 to 8 dry, and chroma of 1 to 4. It is loam or clay loam. It is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Antler, Gilby, Moritz and Tetonview series. Antler soils have less than 15 percent fine sand and coarser in the upper horizons. Gilby soils have less than 18 percent clay in the upper horizons. Moritz soils do not have rock fragments in the particle-size control section and formed in alluvium. Tetonview soils have O horizons and occur at elevations above 3800 feet.

GEOGRAPHIC SETTING: Hamerly soils are on level and nearly level till plains. They are also on flats and slight rises on till plains and lake plains, and on slightly convex slopes surrounding shallow depressions on till plains. Slopes are short and commonly having gradients of less than 3 percent but range from 0 to 3 percent. The soil is formed in calcareous loamy till. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation ranges from 12 to 24 inches. Frost-free period ranges from 90 to 140 days. Elevation above sea level ranges from 650 to 2700 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: The Hamerly soils are most commonly in a toposequence with Barnes, Buse, Svea, Parnell, Vallers and Tonka soils. They are in intermediate positions between the better drained Barnes, Buse and Svea soils and the wetter Parnell, Vallers and Tonka soils. Parnell and Tonka soils are in depressions and Vallers soils are on lower lying flats.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is negligible to medium depending on slope and surface texture. Moderate permeability in the upper horizons and moderate or moderately slow in the lower horizons. Apparent seasonal high water table is at a depth of 1.5 to 3.5 feet at some time during the period April through June.

USE AND VEGETATION: Cultivated areas are used for growing small grains, flax, hay and pasture. Native vegetation is green needlegrass, little bluestem, big bluestem and western wheatgrass.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, northeastern South Dakota and northwestern Minnesota. The soils are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Clay County, South Dakota, 1953.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 8 inches (Ap horizon); calcic horizon -the zone from 8 to 25 inches (Bk1 and Bk2 horizons); characteristics associated with wetness - calcic horizon within 16 inches.

Where correlated as moderately well drained phase or with slopes of more than 3 percent should be recorrelated to the Balaton series (Aquic Calciudolls).

ADDITIONAL DATA: Laboratory data numbered S53NDak-32-1, S53NDak-32-2, S50NDak-38-4, and S50NDak-38-7 in Soil Survey Investigations Report No. 2, pp. 128-135.

National Cooperative Soil Survey
U.S.A.

LOCATION HARRIET ND+SD

Established Series
CJH
05/2001

HARRIET SERIES

The Harriet series consists of very deep, poorly drained, slowly and very slowly permeable soils that formed in calcareous alluvium. These soils are on low lying flats, terraces, drainageways and bottom lands. Slope ranges from 0 to 3 percent. Mean annual air temperature is about 42 degrees F, and mean annual precipitation is about 16 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Natraquolls

TYPICAL PEDON: Harriet loam - on a slope of less than 1 percent in native grassland. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

E--0 to 2 inches; very dark gray (N 3/0) loam, gray (N 5/0) and gray (N 6/0) dry; weak thick and medium platy structure; friable; many fine roots; common fine pores; few salt crystals visible when soil is dry; moderately alkaline; abrupt wavy boundary. (0 to 5 inches thick)

Btn--2 to 6 inches; black (N 2/0) clay loam, dark gray (N 4/0) dry; moderate medium columnar structure; extremely hard, firm; coatings of very dark gray (N 3/0) on faces of peds; gray (N 5/0) dry on tops and sides of columns; slight effervescence on inside of columns; strongly alkaline; clear wavy boundary.

Btnz--6 to 18 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate coarse prismatic and weak medium subangular blocky structure; very hard, firm; few roots; common medium pores; common fine white salt crystals; strong effervescence; strongly alkaline; gradual wavy boundary. (Combined Btn horizons 3 to 22 inches thick)

Bz1--18 to 28 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure; very hard, firm; few fine roots; few medium and fine pores; fine salt crystals visible when dry; violent effervescence; strongly alkaline; abrupt smooth boundary. (0 to 20 inches thick)

2Bz2--28 to 38 inches; light olive brown (2.5Y 5/3) very fine sandy loam, light yellowish brown (2.5Y 6/3) dry; weak coarse prismatic and weak coarse and medium subangular blocky structure; very hard, friable; few fine pores; common very fine salt crystals that are visible when dry; strong effervescence; strongly alkaline; abrupt smooth boundary. (0 to 26 inches thick)

3Ab--38 to 40 inches; very dark gray (N 3/0) clay loam, dark gray (N 4/0) dry; few medium distinct olive brown (2.5Y 4/3) redoximorphic concentrations; weak coarse prismatic structure; very hard, firm; few fine roots; strong effervescence; strongly alkaline; abrupt boundary. (0 to 10 inches thick)

3C--40 to 60 inches; olive brown (2.5Y 4/3) stratified loam and clay loam, light yellowish brown (2.5Y 6/3) dry; weak coarse and medium subangular blocky structure; very hard, friable; strong effervescence; strongly alkaline.

TYPE LOCATION: Burleigh County, North Dakota; 20 feet north of road right-of-way and 40 feet west of entrance to Cypert Park; 1650 feet east and 40 feet north of the southwest corner, sec. 34, T. 139 N., R. 79 W.

RANGE IN CHARACTERISTICS: Typically, the soil has carbonates and visible salt or gypsum crystals at depths of 4 to 11 inches but they are throughout the soil in some pedons. Some pedons have a dark A horizon 1 to 2 inches thick.

The E horizon has hue of 10YR, 2.5Y or is neutral, value of 2 to 5 moist and 4 to 7 dry, and chroma of 1 or less. It is loam, silt loam, or very fine sandy loam. It is neutral to moderately alkaline. It is absent in some cultivated pedons.

The Btn horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 to 4 moist and 3 to 5 dry, and chroma of 2 or less. It is dominantly clay loam or silty clay loam but the range includes silty clay and clay. It averages between 35 and 50 percent clay. It is slightly alkaline to very strongly alkaline. Some pedons have BC, Bkg, Bky, or Bkz horizons. The B horizon has redoximorphic features in some pedons.

The C horizon has hue of 10YR, 2.5Y, 5Y or 5GY, value of 3 to 5 moist and 4 to 7 dry, and chroma of 1 to 3. Some pedons have a chroma of 4 below a depth of 40 inches. The C horizon typically is stratified and has textures ranging from very fine sandy loam to clay. It is moderately alkaline to very strongly alkaline. Strata of coarser materials are below a depth of 30 inches in some pedons. Some pedons have faint to prominent redoximorphic features in the C horizon. Some pedons have salts and gypsum in the C horizon.

COMPETING SERIES: These are the Heil, Ranslo and Ryan series. Heil soils do not have salts or carbonates within depths of 12 inches and they are absent in the A, E and upper Btn horizons. Ranslo soils have combined A and E horizons of more than 5 inches thick. Ryan soils average 50 to 60 percent clay in the Btn horizon.

GEOGRAPHIC SETTING: Harriet soils are on level and nearly level, low lying flats, and low terraces and bottom lands along streams. Slopes are 0 to 3 percent. The soils formed in calcareous alluvium. The mean annual air temperature is 34 to 45 degrees F, and the mean annual precipitation is 12 to 20 inches. Most of the precipitation is in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Farland, Havrelon, Korchea, Lamoure, La Prairie, Lehr, Magnus, Ranslo, Savage, Shambo, Straw and Velva soils. None of these soils, except Ranslo, have natric horizons and all, except Lamoure and Ranslo soils, are better drained. Farland, Lehr, Savage and Shambo soils are adjacent to Harriet soils on low terraces. Havrelon, Korchea, Lamoure, La Prairie, Magnus, Ranslo, Straw and Velva soils are adjacent to Harriet soils on flood plains and bottom lands.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is negligible to medium depending on slope and surface texture. Permeability is slow or very slow.

USE AND VEGETATION: Almost all areas of Harriet soils are used for native rangeland or hayland. Native vegetation consists mainly of western wheatgrass, nuttall alkaligrass and inland saltgrass.

DISTRIBUTION AND EXTENT: Harriet soils occur in western and central North Dakota and northern South Dakota. They are of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Hand County, South Dakota, 1959.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 18 inches (E, Btn1, and Btn2 horizons); natric horizon - the zone from 2 to 18 inches (Btn and Btnz horizons).

Placement of the Harriet soils with the Aquolls seems most appropriate although they do not always meet the morphological requirements of the Aquolls (i.e., redoximorphic features and/or low chroma).

National Cooperative Soil Survey
U.S.A.

LOCATION HECLA SD+MN ND

Established Series
LDS-BOK-CJH
03/2000

HECLA SERIES

The Hecla series consists of very deep, moderately well drained soils formed in sandy sediments on lake plains and glacial outwash plains. Permeability is moderately rapid or rapid. Slopes range from 0 to 6 percent. Mean annual precipitation is about 19 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Sandy, mixed, frigid Oxyaquic Hapludolls

TYPICAL PEDON: Hecla loamy fine sand - on a plane slope of 2 percent in native grass. When described the soil was dry to 30 inches and moist below. (Colors are for dry soil unless otherwise stated.)

A1--0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many fine and medium roots; neutral; clear smooth boundary.

A2--6 to 20 inches; dark gray (10YR 4/1) fine sand, very dark gray (10YR 3/1) moist; single grain; loose; common fine and medium roots; neutral; clear wavy boundary. (Combined thickness of the A horizons is 16 to 30 inches.)

AC--20 to 30 inches; dark gray (10YR 4/1) fine sand, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; loose, very friable; few fine and medium roots; neutral; gradual wavy boundary. (0 to 15 inches thick)

C1--30 to 46 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; few fine distinct dark yellowish brown (10YR 4/4) moist redoximorphic concentrations; single grain; loose; few very fine bands of very dark grayish brown (10YR 3/2) moist; few fine and medium roots; slightly alkaline; gradual wavy boundary. (8 to 20 inches thick)

C2--46 to 54 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) moist redoximorphic concentrations; single grain; few fine and medium roots; slightly alkaline; clear wavy boundary. (6 to 12 inches thick)

2Ab--54 to 62 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist, common fine prominent dark yellowish brown (10YR 4/4) moist redoximorphic concentrations; massive; soft, very friable; few fine and medium roots; slightly alkaline; clear wavy boundary. (0 to 10 inches thick)

2C--62 to 72 inches; light brownish gray (2.5Y 6/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; common fine prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) moist redoximorphic concentrations; single grain; loose; few medium roots; slightly alkaline.

TYPE LOCATION: Brown County, South Dakota; about 8 miles south and 2 miles east of Hecla; 510 feet west and 130 feet north of the southeast corner of sec. 36, T. 127 N., R. 61 W.

RANGE IN CHARACTERISTICS: The mollic epipedon is 10 to 20 inches thick. Mollic colors extend to depths of more than 18 inches, however horizons with mollic colors below depths of 20 inches and extending to depths of 40 inches contain less than .6 percent organic carbon. Typically, a few faint or distinct redoximorphic features are below the lower part of the A horizon or the AC horizon and distinct or prominent redoximorphic features are in the lower part of the C horizon. Buried horizons are below depths of 30 inches in most pedons. Depth to carbonates ranges from 20 to 80 inches or more. The particle-size control section averages more than 45 percent fine sand and very fine sand, less than 35 percent medium and coarser sand, and less than 15 percent coarse and very coarse sand.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1 or 2. It is loamy fine sand, loamy sand, sandy loam, or fine sandy loam in the upper part and loamy fine sand, loamy sand, or fine sand in the lower part. It is slightly acid to slightly alkaline.

The AC horizon has value of 3 to 5 and 2 or 3 moist, and chroma of 1 or 2. It is loamy fine sand, fine sand, or loamy sand. It ranges from slightly acid to slightly alkaline. Some pedons have a Bw horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 7 and 3 to 5 moist; and chroma of 2 to 4. The C horizon is loamy fine sand, loamy sand, or fine sand. It ranges from slightly acid to moderately alkaline. Clay loam or loam till is between depths of 40 and 60 inches in some pedons. Very fine sandy loam and silt loam material is between depths of 40 and 60 inches in some pedons.

COMPETING SERIES: These are the Duelm, Falsen, Flaming, Osakis, Radium, Walum and Weeding series in the same family. Duelm soils have less than 40 percent fine and very fine sand. Falsen soils have a particle-size control section that averages less than 45 percent fine sand and very fine sand, more than 35 percent medium and coarser sand, and more than 15 percent coarse and very coarse sand. Flaming soils have mollic colors less than 18 inches thick. Osakis soils have a loamy mantle over a 2C horizon of sand and/or gravel. Radium soils have more than 10 percent rock fragments. Walum soils contain more than 50 percent sand size shale fragments. Weeding soils occur at elevations of over 4,200 feet, contain carbonates at or near the surface and are in a drier climate.

GEOGRAPHIC SETTING: Hecla soils are on plane and convex surfaces of sandy lacustrine and glacial outwash plains and nearby sand-mantled till plains. Slope gradients typically are less than 3 percent and range from 0 to 6 percent. Hecla soils formed in reworked sands. Mean annual temperature ranges from 34 to 48 degrees F, and mean annual precipitation from 14 to 24 inches. Growing season is about 110 to 140 days; average growing season precipitation ranges from 13 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Fossum, Hamar, Ulen, Venlo and Maddock soils. Fossum, Hamar and Venlo soils have an aquic soil moisture regime. Ulen soils have a calcic horizon within depths of 16 inches. Fossum, Hamar, Ulen and Venlo soils are in the lower wetter positions. Maddock soils do not have redoximorphic features within depths of 40 inches and typically are on slightly steeper slopes at higher elevations.

DRAINAGE AND PERMEABILITY: Moderately well drained. Surface runoff is very low. Permeability is moderately rapid or rapid. A seasonal water table is at depths of 2.5 to 5 feet.

USE AND VEGETATION: Most areas cropped to corn, alfalfa, and small grains. Some areas are in tame pasture. Native grasses are big bluestem, prairie sandreed, little bluestem, needleandthread, switchgrass, forbs, and sedges.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Brown and Marshall Counties (Brown-Marshall S and WCD), South Dakota, 1940.

REMARKS: Diagnostic horizons and feature recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 20 inches (A1 and A2 horizons). The AC horizon has the color, but not the organic carbon content to be mollic.

The zone immediately below the mollic epipedon (AC horizon) meets the color requirement for the aquic subgroup, but does not have aquic conditions.

The pedon meets the color requirement for the aquic subgroup in the horizon immediately below the mollic epipedon (AC horizon), however the soil does not have aquic conditions immediately below the mollic epipedon and does not meet the subgroup criteria. Saturation does not occur shallower than 2.5 feet.

ADDITIONAL DATA: Laboratory data for the typical pedon of Hecla loamy fine sand is No. 74L1051-74L1059.

National Cooperative Soil Survey
U.S.A.

LOCATION HEGNE MN+MT ND SD

Established Series
Rev. HRF-RBH-CJH
2/99

HEGNE SERIES

The Hegne series consists of very deep, poorly drained soils that formed in clayey calcareous lacustrine sediments on glacial lake plains. These soils have slow or very slow permeability. They have slopes of 0 to 2 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Calciaquerts

TYPICAL PEDON: Hegne silty clay, from a Hegne-Fargo complex, on a slightly convex slope of about 0.5 percent on a glacial lake plain in a cultivated field. (Colors are for moist soil unless otherwise stated)

Ap -- 0 to 10 inches; black (5Y 2.5/1) silty clay, very dark gray (5Y 3/1) dry; strong fine and medium subangular blocky structure; firm; common fine distinct olive gray (5Y 4/2) redoximorphic depletions; firm; few fine and medium roots; many fine rounded light gray (10YR 7/2) masses of carbonate; slightly effervescent; slightly alkaline (pH 7.6); clear wavy boundary. (7 to 16 inches thick)

Bkssg1 -- 10 to 18 inches; about 60 percent olive gray (5Y 4/2), and 40 percent dark gray (5Y 4/1) silty clay; light gray (5Y 6/1) and gray (5Y 5/1) dry; moderate medium subangular blocky structure; firm; few fine roots; few distinct intersecting slickensides tilted less than 45 degress from horizontal; cracks filled with A material 1/4 to 3 inches wide and 2 to 4 feet apart; many fine masses of carbonate; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bkssg2 -- 18 to 34 inches; olive gray (5Y 5/2) silty clay; light olive gray (5Y 6/2) dry; moderate fine and medium subangular blocky structure; firm; common fine faint dark gray (5Y 4/1) redoximorphic depletions; few very fine roots; few distinct intersecting slickensides tilted less than 60 degress from horizontal; cracks filled with A material 1/4 to 2 inches wide and 2 to 4 feet apart; many fine masses of carbonate; violently effervescent; moderately alkaline (pH 8.3); clear wavy boundary. (Combined Bkg horizons 10 to 30 inches thick)

Bg -- 34 to 50 inches; olive gray (5Y 4/2) silty clay; weak fine and medium subangular blocky structure; friable; common medium distinct light olive brown (2.5Y 5/4) redoximorphic concentrations; few fine masses of carbonate; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (0 to 20 inches thick)

Cg1 --50 to 68 inches; olive gray (5Y 5/2) silty clay; weak fine and medium subangular blocky soil fragments parting to weak fine platy; firm; common medium distinct gray (5Y 5/1) redoximorphic depletions and medium prominent strong brown (7.5YR 4/6) and common fine reddish yellow (7.5YR 6/6) redoximorphic concentrations; few medium carbonate coats on faces of peds; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Cg2 -- 68 to 80 inches; olive (5Y 5/3) laminated silty clay; laminates part to weak fine platy fragments which part to weak fine subangular blocky fragments; firm; common medium distinct gray (5Y 5/1) redoximorphic depletions and common medium prominent strong brown (7.5YR 5/6) and (7.5YR 5/8) redoximorphic concentrations; few medium irregular light gray (2.5Y 72) carbonate coats on faces of peds; strongly effervescent; moderately alkaline (pH 8.2).

TYPE LOCATION: Marshall County, Minnesota; about 5 miles west and 2 miles north of Stephen; 600 feet south and 2100 feet east of the northwest corner of Sec. 22, T. 157 N., R. 49 W.; USGS STEPHEN quadrangle; Latitude 48 degrees 24 minutes 25 seconds N. and Longitude 96 degrees 59 minutes 22 seconds W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 7 to 16 inches. These soils have free carbonates in all parts with calcium carbonate equivalent of 10 to 30 percent throughout. The higher values are in the calcic horizon. The depth to the calcic horizon is less than 16 inches. Typically most pedons do not have rock fragments. The particle-size control section ranges from 40 to 60 percent noncarbonate clay, with an average of 50 percent and less than 5 percent sand. The average linear extensibility is estimated to be about 10.7 centimeters in the upper 40 inches.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3, and chroma of 0 or 1. Texture is silty clay, clay or silty clay loam. Effervescence is slight to violent. Reaction is slightly alkaline or moderately alkaline. Tongues of A horizon extend to depths as much as 36 inches in some pedons.

The Bkssg horizon has hue of 2.5Y, 5Y or 10YR, value of 3 to 6, and chroma of 1 or 2. Chroma of 2 is allowed if there are distinct or prominent redoximorphic concentrations. Texture is clay or silty clay. Effervescence is strong or violent. Reaction is slightly alkaline or moderately alkaline.

The Bg horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2. Chroma of 2 is allowed if there are distinct or prominent redoximorphic concentrations. Texture is clay or silty clay. Effervescence is slight to violent. Reaction is slightly or moderately alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. Distinct or prominent high chroma redoximorphic concentrations are present in most pedons. Texture is clay or silty clay. Silty clay loam textures with more than 35 percent noncarbonate clay are allowed. Effervescence is slight to strong. Reaction is slightly alkaline or moderately alkaline. Masses of gypsum crystals are in the B and C horizon in some pedons.

COMPETING SERIES: These are in the Reis series. Reis soils have more than 5 percent sand in the particle-size control section and formed in clayey glacial till.

GEOGRAPHIC SETTING: The Hegne soils have slightly convex to slightly concave slopes of less than 2 percent on glacial lake plains and in a few places these soils are on flood plains. These soils commonly are on the higher lying positions of microrelief topography. They formed in clayey lacustrine sediments of Late Wisconsinan age. Mean annual air temperature ranges from 38 to 45 degrees F. Mean annual precipitation ranges from 15 to 27 inches. Frost-free

days range from 90 to 140. Elevation above sea level ranges from 650 to 1800 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the poorly drained Fargo soils which formed in similar sediments on glacial lake plains soils. The Hegne soils are found in a complex with these associated soils on slightly higher positions. Fargo soils do not contain a calcic horizon within 16 inches of the surface.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is low or medium. Permeability is slow or very slow. Depth to an apparent seasonal high water table when undrained is as high as 0.5 to 1.5 feet at some time from April to June in most years.

USE AND VEGETATION: Nearly all of these soils are cultivated. Principal crops are small grains and sugar beets. Native vegetation is tall grass prairie.

DISTRIBUTION AND EXTENT: Principally in the Red River Valley of northwestern Minnesota and eastern North Dakota, also in smaller glacial lake basins in western Minnesota and north-central North Dakota. These soils are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: The classification of these soils is in question as to whether they should be in the Typic or Aeric subgroup of Calciaquerts. This needs further investigation. This series was previously classified in the Typic Calciaquolls subgroup.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to 18 inches (Ap and A portion of A/Bkg horizons); calcic horizon - the zone from 10 to 34 inches (B portion of A/Bkg and Bkg horizons); vertic criteria - slickensides and cracks filled with A material in the zone from 10 to 34 inches (Bkssg1 and Bkssg2 horizons); aquic moisture regime.

ADDITIONAL DATA: Soil Interpretation Record number is MN0053.

National Cooperative Soil Survey
U.S.A.

LOCATION HEIMDAL ND+MN SD

Established Series
Rev. CJH
10/98

HEIMDAL SERIES

The Heimdal series consists of very deep, well drained, moderately permeable soils that formed in calcareous glacial till. These soils are on glacial till plains and moraines. Slope ranges from 0 to 40 percent. Mean annual air temperature is 40 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Heimdal loam - cropland. (Colors for dry soil unless otherwise stated)

Ap--0 to 5 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; very friable; many pores; neutral; abrupt boundary. (5 to 10 inches thick)

Bw1--5 to 14 inches; grayish brown (10YR 5/2) loam, very dark grayish (10YR 3/2) moist; moderate coarse and medium prismatic structure parting to weak coarse subangular blocky; very friable; many fine pores; neutral; gradual boundary.

Bw2--14 to 19 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate coarse and medium prismatic structure parting to weak coarse subangular blocky; very friable; many fine pores; slightly alkaline; clear wavy boundary. (Combined Bw horizons 6 to 16 inches thick)

Bk--19 to 34 inches; light yellowish brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; very friable; common threads and nodules of carbonates; violent effervescence; moderately alkaline; gradual boundary. (6 to 25 inches thick)

C--34 to 60 inches; pale yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/4) moist; few coarse distinct gray (5Y 6/1) redox depletions and a few fine prominent dark yellowish brown (10YR 4/4) redox concentrations; weak subangular blocky and platy structure; few white carbonate nodules; violent effervescence; moderately alkaline.

TYPE LOCATION: Wells County, North Dakota; 1,340 feet west and 150 feet south of northeast corner, Sec. 14, T. 148 N., R. 70 W.

RANGE IN CHARACTERISTICS: The depth to carbonates ranges from 12 to 26 inches. The mollic epipedon ranges from 7 to 16 inches in thickness. The control section commonly is loam averaging less than 18 percent clay. In some pedons it is sandy loam that has less than 55 percent total sand. Pebbles and stones are common throughout the pedon. The soil contains up to 10 percent rock fragments throughout. Stony phases are recognized.

The Ap horizon has 10YR hue, value of 3 or 4, 2 or 3 moist, and chroma of 1. It typically is a loam, but silt loam, very fine sandy loam, fine sandy loam and sandy loam are within the range. It is slightly acid or neutral.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6, 2 to 5 moist, and chroma of 2 to 4. It is loam, sandy loam, fine sandy loam or very fine sandy loam. It is slightly acid to slightly alkaline.

The Bk horizon has hue of 10YR, 2.5Y, value of 5 to 7, 4 to 6 moist, and chroma of 2 to 4. It is loam, fine sandy loam, sandy loam or silt loam. It is slightly alkaline or moderately alkaline. It commonly has more than 15 percent calcium carbonate equivalent. Some pedons have a BCk horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It typically is calcareous loam glacial till, but fine sandy loam, sandy loam, silt loam and very fine sandy loam are within the range. It is slightly alkaline or moderately alkaline. In some pedons it has strata of fine sand to sandy clay loam. Some pedons have a sandy 2C horizon below 40 inches.

COMPETING SERIES: These are the Dunnville, Egeland, Kalispell and Lanona series. Dunnville soils are acid throughout the solum and occur in more moist areas. Egeland soils have more than 55 percent sand in the 10- to 40 inch control section and formed in glacial outwash. Kalispell soils are shallower to carbonates (see remarks). Lanona soils have a discontinuity with horizons having more than 18 percent clay between a depth of 20 and 40 inches.

GEOGRAPHIC SETTING: Heimdal soils are on level to very steep moraines and till plains. Slope gradients typically are from 2 to 5 percent but range from 0 to 40 percent. The soil is formed in calcareous glacial till. The climate is cool, subhumid, with a mean annual air temperature ranging from 38 to 48 degrees F, and mean annual precipitation ranging from 15 to 25 inches. Most of the moisture falls in the spring and summer. The frost-free period ranges from 90 to 140 days. The elevation ranges from 900 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Emrick, Esmond, Fram, Parnell and Tonka series in a drainage sequence. Emrick soils are on concave foot slopes; Esmond soils are on convex shoulder slopes; Fram soils on flats and rims surrounding depressions; and Parnell and Tonka soils are in depressions. Emrick soils have mollic epipedons more than 16 inches thick. Esmond soils do not have a cambic horizon. Fram soils have and aquic moisture regime. Parnell soils are very poorly drained and Tonka soils are poorly drained.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is negligible to high depending on slope. Permeability is moderate.

USE AND VEGETATION: Nearly all cultivated for production of small grains and flax. Native vegetation includes green needlegrass, western wheatgrass, blue grama and forbs.

DISTRIBUTION AND EXTENT: North central and east central North Dakota, west central Minnesota, and South Dakota. The series is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Wells County, North Dakota, 1970.

REMARKS: The official description for Kalispell is old (4/57) and does not have sufficient detail to clearly differentiate from the Heimdal series.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 14 inches (A and Bw1 horizon); cambic horizon - the zone from 14 to 19 inches (Bw2 horizon).

ADDITIONAL DATA: Laboratory sample numbers: S60ND-16-21, S60ND-16-22, SU67ND-16-2, SU67ND-16-3, SU67ND-16-4, SU67ND-16-5, S49ND-38-2, S53ND- 52-1 and S53ND-52-2.

National Cooperative Soil Survey
U.S.A.

LOCATION KRATKA MN+ND SD WI

Established Series
Rev. MNJ-RBH-AGG
06/2001

KRATKA SERIES

The Kratka series consists of very deep poorly and very poorly drained soils that formed in a mantle of sandy glacial lacustrine or outwash sediments over lacustrine sediments or loamy glacial till on glacial lake plains, glacial deltas of former glacial lakes, stream terraces, and moraines. These soils have moderately rapid or rapid permeability in the upper part and moderately rapid to moderately slow permeability in the lower part. Slopes range from 0 to 2 percent. Mean annual precipitation is about 22 inches. Mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Sandy over loamy, mixed, superactive, frigid Typic Endoaquolls

TYPICAL PEDON: Kratka fine sandy loam in a slightly concave area on a glacial lake plain in a cultivated field at an elevation of about 1072 feet, MSL. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 6 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; few medium and common very fine and fine roots; about 5 percent gravel; slightly alkaline; abrupt smooth boundary.

A--6 to 11 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak moderate subangular blocky structure parting to weak fine granular; friable; few fine and common very fine roots; about 5 percent gravel; slightly alkaline; clear smooth boundary. (Combined thickness of A horizons is 6 to 18 inches thick.)

Bg1--11 to 14 inches; dark grayish brown (2.5Y 4/2) fine sandy loam; weak medium subangular blocky structure; very friable; few very fine and fine roots; about 5 percent gravel; common medium distinct light olive brown (2.5Y 5/4) Fe concentrations; slightly alkaline; clear smooth boundary.

Bg2--14 to 18 inches; dark grayish brown (2.5Y 4/2) loamy fine sand; weak fine and medium subangular blocky structure; very friable; about 8 percent gravel; common medium distinct light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6) Fe concentrations; slightly alkaline; clear wavy boundary. (Combined thickness of the Bg horizons is 0 to 32 inches).

Cg1--18 to 25 inches; grayish brown (2.5Y 5/2) fine sand; single grain; loose; about 10 percent gravel; many coarse distinct light olive brown (2.5Y 5/6) Fe concentrations and common medium faint light brownish gray (2.5Y 6/2) Fe depletions and few medium prominent yellowish brown (10YR 5/6) Fe concentrations; slightly alkaline; abrupt wavy boundary. (0 to 12 inches thick)

2Cg2--25 to 31 inches; olive gray (5Y 5/2) loam; massive; friable; about 5 percent gravel; common medium prominent light olive brown (2.5Y 5/4) Fe concentrations; slightly effervescent; slightly alkaline; clear wavy boundary.

2Cg3--31 to 39 inches; olive gray (5Y 5/2) loam; massive; friable; about 5 percent gravel; common medium prominent light olive brown (2.5Y 5/4) and few fine prominent yellowish brown (10YR 5/6) Fe concentrations;strongly effervescent; slightly alkaline; clear smooth boundary.

2Cg4--39 to 80 inches; olive gray (5Y 5/2) clay loam; massive; friable; about 5 percent gravel; few medium prominent yellowish brown (10YR 5/6) and common medium prominent light olive brown (2.5Y 5/6) Fe concentrations; strongly effervescent; slightly alkaline.

TYPE LOCATION: Pennington County, Minnesota; about 11 miles northwest of Thief River Falls; 1420 feet north and 250 feet east of the southwest corner of Sec. 12, T. 154 N., R. 45 W., USGS Viking quadrangle, Lat. 48 degrees 10 minutes 04 seconds N., 96 degrees 23 minutes 02 seconds W., NAD27.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon typically is 6 to 18 inches. The depth to loamy glacial till or lacustrine sediments ranges from 20 to 40 inches. Some pedons have stratified sediments below 40 inches. The depth to free carbonates typically ranges from 16 to 45 inches but ranges to more than 60 inches in some pedons. The upper sediments have 0 to 5 percent gravel and the 2C horizon contains 0 to 8 percent by volume of gravel of mixed lithology. In pedons that have lacustrine sediments in the 2C horizons, rock fragments may not be present. A thin lag line ranging to as much as 6 inches in thickness and containing as much as 35 percent by volume of gravel is at the contact between the upper and lower material. The reaction ranges from moderately acid to slightly alkaline in the A and Bg horizons, slightly acid to slightly alkaline in the Cg horizons and slightly acid to moderately alkaline in the 2Cg horizons.

The A or Ap horizon has hue of 10YR or 2.5Y, value of 2 or 3, chroma of 1 or 2 or is neutral. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam.

Some pedons have an ABg horizon.

The Bg or Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2 in the upper part, and includes chroma of 3 or 4 in the lower part. It is loamy fine sand, fine sand, loamy sand, sand or fine sandy loam.

Some pedons have Bkg or 2Bkg horizons with 2.5Y or 5Y hue. They are slightly alkaline or moderately alkaline.

Some pedons have 2Bg horizons with hue of 2.5Y or 5Y, value of 4 to 6 and chroma of 1 to 3. Textures include loam or clay loam.

The Cg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Texture is sand, fine sand, loamy fine sand or loamy sand.

Some pedons have thin Ab horizons.

The 2Cg horizon has hue of 10YR to 5Y; value of 4 to 6; and chroma of 1 to 3. It is loam, clay loam, sandy loam, or fine sandy loam in the glacial till and silt loam, silty clay loam, or very fine sandy loam, with thin strata of loamy fine sand or fine sand in the lacustrine material.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: These soils have plane or slightly concave slopes on flats or in shallow depressions on stream terraces, glacial lake plains, glacial deltas of former glacial lakes, and glacial moraines. Slopes range from 0 to 2 percent. Kratka soils formed in a sandy mantle of lacustrine glacial outwash over loamy glacial till or lacustrine sediments of Late Wisconsinan Age. Mean annual air temperature ranges from 37 to 45 degrees F. Mean annual precipitation ranges from 19 to 33 inches. Frost-free days range from 88 to 150. Elevation above sea level ranges from 700 to 1500 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These typically include the Foldahl, Grimstad, Rockwell, Strathcona and Towner soils which formed in similar materials. The Foldahl and Grimstad soils are moderately well drained to somewhat poorly drained. Rockwell and Strathcona soils have a calcic horizon and the Towner soils are moderately well drained. They are also associated with Blomford and Braham soils in a few places. Blomford are poorly drained soils on plane slopes and Braham are well drained and moderately well drained soils on plane and convex slopes.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Permeability is moderately rapid or rapid in upper part and moderately rapid to moderately slow in the lower part. Surface runoff is negligible. Depth to an apparent seasonal high water table is 0.5 to 1.5 feet at some time from April to July in most years for the poorly drained phases and at plus 1 to 0.5 feet at some time from March to August in most years for the very poorly drained phase.

USE AND VEGETATION: Most areas of the Kratka series are used for hay and pasture or are cropped with small grains. Native vegetation is wet tall grass prairie and sedges with some scattered shrubs.

DISTRIBUTION AND EXTENT: Primarily northwestern Minnesota in the Glacial Lake Agassiz Plain and in eastern North Dakota, but is also recognized in other parts of northern Minnesota and Wisconsin. Moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota.

SERIES ESTABLISHED: Norman County, Minnesota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - from the surface to 11 inches (A horizons); aquic features per low chroma below mollic epipedon. Typical pedon was revisited 9/97 and described to 80 inches.

ADDITIONAL DATA: Refer to Minnesota Agricultural Experiment Station Central File Code number 3006 for laboratory data of the typical pedon. See also MAES CFC numbers 802 and 883 and NSSL S92MN-113-3 for laboratory data of representative pedons and Minnesota Department of Transportation data for SS81369-370 for engineering test data.

SIR #MN0072; MN0419, Depressional phase; MN0640, Stratified substratum phase; MN0641, Stratified substratum, depressional phase; MN0618, thick solum phase.

National Cooperative Soil Survey
U.S.A.

LOCATION LA PRAIRIE ND+MN SD

Established Series
Rev. CJH
10/98

LA PRAIRIE SERIES

The La Prairie series consists of very deep, moderately well drained, moderately permeable soil that formed in loamy alluvium. These soils are on terraces and bottom lands in stream valleys. Slope ranges from 0 to 6 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Cumulic Hapludolls

TYPICAL PEDON: La Prairie silt loam - on a flat slope of less than 1 percent in a cultivated field. (Colors are for moist soil unless otherwise stated. When described, the soil was moist throughout.)

Ap--0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium and fine granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; many worm casts; slightly alkaline; abrupt smooth boundary.

A--8 to 19 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; slightly alkaline; clear wavy boundary. (Combined A horizon 12 to 30 inches thick)

Bw--19 to 28 inches; very dark grayish brown and very dark brown (10YR 3/2 and 10YR 2/2) silt loam, grayish brown and dark grayish brown (10YR 5/2 and 4/2) dry: weak coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine roots; many fine pores; few fine masses of carbonates; slight effervescence; moderately alkaline; gradual wavy boundary. (0 to 35 inches thick)

C1--28 to 44 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few roots; common fine pores; several oval krotovinas 1 to 3 inches in diameter; few fine masses of carbonates; slight effervescence; moderately alkaline; gradual wavy boundary.

C2--44 to 60 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak thin platy structure; hard, friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Cass County, North Dakota; about 8 1/2 miles south and 1/2 mile east of Embden; 2,100 feet west and 1,920 feet north of the southeast corner, sec. 18, T. 137 N., R. 53 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 0 to 40 inches. The mollic epipedon ranges from 16 to over 40 inches in thickness. The 10- to 40-inch control section is loam, clay loam, silt loam or silty clay loam averaging

18 to 35 percent clay and 15 to 40 percent fine sand and coarser. The soil is neutral to moderately alkaline throughout. Channeled and nonflooded phases are recognized.

The A horizon has hue of 10YR or is neutral, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is loam, silt loam, clay loam or silty clay loam. Ab horizons are in some pedons.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is loam, clay loam, silt loam or silty clay loam. Secondary carbonates, as threads or fine to coarse masses, are in the lower B horizon in some pedons. Some pedons have a Bk horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 4. It is loam, clay loam, silt loam or silty clay loam. Sandy clay loam is allowed below 40 inches. The C horizon has faint or distinct redoximorphic concentrations in some pedons. Some pedons below a depth of 40 inches contain strata with up to 5 percent coarse fragments and textures of very coarse sand to clay.

COMPETING SERIES: There are no other series in the family.

GEOGRAPHIC SETTING: La Prairie soils are on level to gently sloping terraces, bottom lands and in swales of intermittent streams. Slope ranges from 0 to 6 percent. The soils formed in alluvium. The mean annual air temperature ranges from 37 to 45 degrees F, and the mean annual precipitation from 15 to 23 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aastad, Barnes, Cashel, Fairdale, Forman, Gardena, LaDelle, Lamoure, Ludden, Svea, Wahpeton and Walsh soils. Aastad, Barnes, Forman and Svea soils are on nearby till uplands and Gardena and Walsh soils are on nearby deltas, fans and lake plains. These soils have a regular decrease in organic matter content with depth. In addition, Barnes and Forman soils have mollic epipedons less than 16 inches in thickness and Gardena soils are coarse-silty. Cashel, Lamoure and Ludden soils are on nearby lower lying bottom lands. Cashel soils are somewhat poorly drained and have fine textures. Lamoure soils are poorly drained and are fine-silty. Ludden soils are poorly drained and have fine textures. Fairdale and LaDelle soils are on similar positions as La Prairie soils. Fairdale soils have fine stratification below the A horizon. LaDelle soils are fine-silty. Wahpeton soils are on higher lying levees and have fine textures.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is negligible to low depending on slope. Permeability is moderate. The soils are flooded for short periods when streams overflow. A seasonal high water table is at depth of 3 to 5 feet at some time during the period of April through June.

USE AND VEGETATION: Soils are cropped to spring seeded small grains, row crops hay and pasture. Native vegetation was big bluestem, green needlegrass, porcupinegrass, western wheatgrass, a variety of forbs; and scattered trees and shrubs as boxelder, chokecherry, cottonwood, elm and prairie rose.

DISTRIBUTION AND EXTENT: Eastern North Dakota and adjacent areas of northeastern South Dakota and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Revised 4/95.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 28 inches (Ap, A, and Bw horizons); the C1 horizon has the color but not the organic matter content to be part of the mollic epipedon.

National Cooperative Soil Survey
U.S.A.

LOCATION LADELLE SD+MN ND

Established Series
Rev. KFM-BOK-CJH
2/99

LADELLE SERIES

The LaDelle series consists of very deep, moderately well drained soils formed in alluvium on terraces and flood plains. Permeability is moderately slow or moderate. Slopes range from 0 to 9 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Cumulic Hapludolls

TYPICAL PEDON: LaDelle silt loam - on a 1 percent slope in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 7 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine and medium granular structure; soft, very friable; slight effervescence; slightly alkaline, abrupt smooth boundary.

A--7 to 20 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine and medium granular; slightly hard, very friable; strong effervescence; slightly alkaline; gradual wavy boundary. (Combined A horizons 12 to 25 inches thick)

Bk--20 to 35 inches; gray (2.5Y 5/1) silt loam, very dark gray (2.5Y 3/1) moist; weak medium and coarse subangular blocky structure; slightly hard, friable; common fine threads of calcium carbonate; strong effervescence; slightly alkaline; clear wavy boundary. (0 to 20 inches thick)

Akb--35 to 43 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium and coarse subangular blocky structure; slightly hard, friable; common fine and medium masses of calcium carbonate; strong effervescence; slightly alkaline, gradual wavy boundary.

C--43 to 60 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; common fine prominent dark brown (10YR 3/3) redox concentrations; massive; hard, friable; few to common fine and medium coats of calcium carbonate; strong effervescence; slightly alkaline.

TYPE LOCATION: Roberts County, South Dakota; about 3 miles north of Corona; 370 feet north and 270 feet west of the southeast corner, sec. 14, T. 122 N., R. 49 W.

RANGE IN CHARACTERISTICS: Depth to calcium carbonates ranges from 0 to more than 60 inches. Thickness of the mollic epipedon ranges from 17 to 50 inches. The control section is silt loam, silty clay loam or loam averaging between 25 and 35 percent clay and less than 15 percent fine and coarser sand. Buried horizons are below depths of 17 inches in most pedons. Some pedons have gypsum and other salts below 20 inches.

The A horizon has hue of 10YR or neutral, value of 3 or 4 and 2 or 3 moist, and chroma of 1 or less. It typically is silt loam or loam, but is silty clay loam in some pedons. It ranges from slightly acid to slightly alkaline. In some pedons the lower part of the A horizon has a value of 5 dry.

Bw or ABk horizons are in some pedons.

The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 and 2 to 5 moist, and chroma of 3 or less. It is silt loam, silty clay loam, or loam and is neutral to moderately alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 7 and 2 to 5 moist, and chroma of 1 to 4. It is silt loam, silty clay loam, or silty clay. Redox features are variable. It is slightly or moderately alkaline and has few to common fine threads or fine to coarse coats of carbonate. Some pedons have thin strata of sand, silt, clay loam, or clay below depths of 40 inches.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: The LaDelle soils are on nearly level stream terraces and flood plains adjacent to major streams and tributaries within the glacial till plains. Slope gradients are less than 2 percent, except along terrace escarpments that range up to 9 percent. They formed in silty alluvial sediments. Mean annual air temperature ranges from 36 to 48 degrees F., and mean annual precipitation ranges from 15 to 24 inches. Growing season is about 105 to 155 days; average growing season precipitation from 14 to 18 inches; and growing degree days are about 2600 to 3300. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Divide, Forman, La Prairie, Lamoure, Ludden, Peever, and Poinsett soils. Divide soils have calcic horizons within a depth of 16 inches and are on similar landscape positions as the LaDelle soils. Forman and Peever soils have argillic horizons. Poinsett soils have mollic epipedons less than 16 inches thick. Forman, Peever, and Poinsett soils are on adjacent uplands. La Prairie soils have a fine-loamy series control section. La Prairie soils are on similar landscape positions as the LaDelle soils. Lamoure and Ludden soils have a wetter soil moisture control section. In addition, Ludden soils have a fine textured particle size control section. Lamoure and Ludden soils are on slightly lower landscape positions than the LaDelle soils.

DRAINAGE AND PERMEABILITY: Moderately well drained. Surface runoff is low to medium. Permeability is moderately slow or moderate. These soils are flooded for short periods from stream overflow. A seasonal high water table is at a depth of 3.5 to 5.0 feet at some time during the period of April through June.

USE AND VEGETATION: Largely used to grow corn, soybeans, small grains, and alfalfa. Native grasses are green needlegrass, big bluestem, switchgrass, indiangrass, and sedges.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and adjacent parts of North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Nonflooded and flooded phases recognized.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 43 inches (Ap, A, Bk, Akb horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION LALLIE ND+MN MT SD

Established Series
MDS-CJH
06/2001

LALLIE SERIES

The Lallie series consists of very deep, poorly drained and very poorly drained, slowly permeable soils formed in lake basins and old oxbows. These soils have slopes of 0 to 2 percent. Mean annual air temperature is about 41 degrees F and mean annual precipitation is about 17 inches.

TAXONOMIC CLASS: Fine, smectitic, calcareous, frigid Vertic Fluvaquents

TYPICAL PEDON: Lallie silty clay loam - on a level slope under native grass. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

A--0 to 2 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard, friable, sticky and plastic; many roots; common fine flecks of salt; strongly effervescent; slightly alkaline; abrupt smooth boundary. (1 to 5 inches thick)

Cg--2 to 24 inches; dark gray (5Y 4/1) silty clay loam, light gray and gray (5Y 6/1) dry; common medium prominent dark yellowish brown (10YR 4/4) redoximorphic concentrations; weak coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; common fine roots; few fine flecks of salt; violently effervescent; slightly alkaline; abrupt wavy boundary. (8 to 26 inches thick)

Ab--24 to 32 inches; black (N 2/0) silty clay, very dark gray (5Y 3/1) dry; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, very sticky and very plastic; few fine roots; common fine flecks of salt; few snail shell fragments; strongly effervescent; moderately alkaline; gradual wavy boundary. (0 to 8 inches thick)

C'g--32 to 60 inches; olive gray (5Y 4/2) silty clay, light gray and gray (5Y 6/1) dry; common fine prominent yellowish brown (10YR 5/4) redoximorphic concentrations; massive; very hard, very firm, very sticky and very plastic; few flecks of salt; common snail fragments; strongly effervescent; slightly alkaline.

TYPE LOCATION: Nelson County, North Dakota; about 1 1/2 miles west and 4 miles north of Tolna; 2630 feet east and 1300 feet south of the northwest corner, sec. 21, T. 151 N., R. 61 W.

RANGE IN CHARACTERISTICS: The 10-to 40-inch particle-size control section averages between 35 and 60 percent clay. Typically, it is layered or varved in the lower part and contains one or more buried horizons. Some pedons have surface layers up to 15 inches thick consisting of recent sediments. Some pedons have an O horizon. Some pedons are nonsaline.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2. It is silty clay loam, silty clay, loam, silt loam, clay

loam, sandy loam, or clay. These textures in the ponded phase may have a mucky modifier. The A horizon is neutral to strongly alkaline.

The C horizon has hue of 2.5Y or 5Y, or is neutral, value of 3 to 6 and 4 to 8 dry, and chroma of 2 or less. Some pedons have higher chromas in the lower part. It typically is silty clay loam or silty clay, but it is clay in some pedons. It is massive or has weak or moderate grades of structure. It does not have snail shell fragments and salts in some pedons. It has gypsum in some pedons. Layers of coarser materials are at depths below 40 inches in some pedons. It is slightly alkaline to strongly alkaline. Silt loam strata up to 6 inches thick are in some pedons.

COMPETING SERIES: There are no series in the same family.

GEOGRAPHIC SETTING: Lallie soils are on level and nearly level lake basins and old oxbows of river channels. Slope gradients are 0 to 2 percent. The soils formed in stratified clayey lacustrine or alluvial sediments. The mean annual air temperature ranges from 34 to 45 degrees F and mean annual precipitation ranges from 12 to 23 inches. Frost-free period ranges from 105 to 140 days. Elevation above sea level ranges from 650 to 3600 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Colvin, Grano, Hegne and Minnewaukan soils on lake plains and Banks, Havrelon, Lohler and Trembles soils on floodplains. Banks, Havrelon, Lohler, Minnewaukan and Trembles soils are not as wet. In addition, Banks and Minnewaukan soils are sandy, Havrelon soils are fine-loamy, and Trembles soils are coarse-loamy. Colvin soils are fine-silty. Grano and Hegne soils have a mollic epipedon.

DRAINAGE AND PERMEABILITY: Poorly or very poorly drained. Runoff is ponded. Permeability is slow. A seasonal high water table is at the surface to 1 foot below the surface at some time during the period April through August. It is from one foot above the surface to one foot below the surface throughout the year in the ponded phase.

USE AND VEGETATION: Used for pasture, hay, and wildlife. A few areas are cropped. Native vegetation is slough sedge and rivergrass.

DISTRIBUTION AND EXTENT: North Dakota and parts of Montana and South Dakota. The soil is moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy and parts of Benson and Nelson Counties, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface of the soil to a depth of 2 inches; aquic suborder criteria - redoximorphic concentrations and chroma of less than 2 within 50 cm (Cg horizon); irregular decrease in organic carbon with depth - buried horizon in the zone from 24 to 32 inches (Ab horizon); Vertic criteria - LE of more than 6 cm in upper meter.

ADDITIONAL DATA: "Depth to Apparent Water Table in Selected North Dakota Soils." Soil Conservation Service.

National Cooperative Soil Survey
U.S.A.

LOCATION LAMOURE SD+MN MT ND

Established Series
Rev. KFM-WJB
02/97

LAMOURE SERIES

The Lamoure series consists of very deep, somewhat poorly drained or poorly drained soils formed in silty alluvium on flood plains. Permeability is moderate or moderately slow. Slopes are less than 2 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, calcareous, frigid Cumulic Endoaquolls

TYPICAL PEDON: Lamoure silty clay loam - on a slope of 1 percent in a cultivated field. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated.)

A1--0 to 15 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine granular structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear wavy boundary.

A2--15 to 27 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak medium and coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; gradual wavy boundary. (Combined A horizons 24 to 42 inches thick.)

Cg1--27 to 34 inches; dark gray (N 4/0) silty clay loam, gray (N 5/0) dry; vertical faces of peds very dark gray (N 3/0); weak fine subangular blocky structure; slightly hard, friable, slightly sticky; few fine prominent dark brown (10YR 3/3) redox concentrations; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2--34 to 43 inches; dark grayish brown (2.5Y 4/2) silt loam, grayish brown (2.5Y 5/2) dry; weak fine subangular blocky structure; slightly hard, friable; many fine distinct very dark gray (N 3/0) redox depletions and common fine prominent dark yellowish brown (10YR 4/4) redox concentrations; strong effervescence; moderately alkaline; clear wavy boundary.

Ab--43 to 52 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) rubbed, gray (10YR 5/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky; few fine faint dark brown (10YR 3/3) redox concentrations; slight effervescence; moderately alkaline; abrupt wavy boundary.

C'g--52 to 60 inches; dark grayish brown (2.5Y 4/2) sandy loam, grayish brown (2.5Y 5/2) dry; massive; soft, very friable; few fine distinct olive brown (2.5Y 4/4) redox concentrations; slight effervescence; moderately alkaline.

TYPE LOCATION: Brookings County, South Dakota; about 1 mile west and 1.5 miles north of Bushnell; 1930 feet south and 100 feet east of the northwest corner of sec. 12, T. 110 N., R. 49 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 0 to 10 inches. The soil is slightly alkaline or moderately alkaline throughout. The control section typically is a silty clay loam, but is silt loam in some pedons. Thickness of the mollic epipedon ranges from 24 to more than 60 inches. Buried A horizons are common below depths of 30 inches.

The A horizon is neutral or has hue of 10YR, 2.5Y, and 5Y; value of 2 or 3 and 3 to 5 dry; and chroma of 1 or less. It typically is silty clay loam, but is silt loam in some pedons.

The Cg horizon is neutral or has hue of 2.5Y or 5Y, value of 2 to 6 and 4 to 8 dry, and chroma of 2 or less. Chroma of 2 is only in the lower part. Redox features are variable, ranging from few fine faint to many prominent. In some pedons the Cg horizon contains few or common, fine to coarse accumulations of carbonates. The Cg horizon below depths of 40 inches has texture similar to the control section or is stratified loam, silt loam, sandy loam, silty clay loam, or clay. Some pedons are sand, gravelly sand, or loamy sand.

COMPETING SERIES: These are the Downata, Halleck, Inkom, Playmoor, and Rauville series. Downata soils have A horizons with chroma of 2 or 3. Halleck soils have mean annual precipitation of 10 to 12 inches and violent effervescence throughout. Inkom soils have cambic horizons. Playmoor soils contain more visible salts and have more exchangeable sodium. Rauville soils do not have mottles within depths of 40 inches and are very poorly drained.

GEOGRAPHIC SETTING: The Lamoure soils are on nearly level bottoms of glacial outwash valleys and on flood plains of major streams and tributaries within glacial till plains. Slopes are less than 2 percent. They formed in silty alluvium. Mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 16 to 24 inches. Growing season is about 120 to 135 days; average growing season precipitation from 14 to 20 inches; and growing degree days are about 2500 to 3100.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Playmoor and Rauville soils and the Dovray, Forman, LaDelle, Lowe, Ludden, and Poinsett soils. Ludden and Playmoor soils are in similar landscapes. Ludden soils have a fine textured series control section. Rauville soils are in more depressed and sluggish drainageways. Dovray soils are deeper to carbonates, have a fine textured series control section, and are on similar landscapes. The well drained Forman soils have an argillic horizon and on adjacent uplands. The moderately well drained LaDelle soils do not have mottles within depths of 40 inches and are on slightly higher positions on the landscape. Lowe soils have a calcic horizon within 16 inches of the surface and have a fine-loamy series control section. They are on similar landscapes to the Lamoure soil. The well drained Poinsett soils have mollic epipedons less than 16 inches thick and are on adjacent uplands.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained or poorly drained. Surface runoff is low. Permeability is moderate or moderately slow. The water table is at depths of 0 to 2 feet, except during the growing season. Lamoure soils frequently flood from stream overflow.

USE AND VEGETATION: Much is in native hay and pasture. The better drained areas are cropped to corn, small grain, alfalfa, and feed grains. Native vegetation is mainly big bluestem, switchgrass, indiangrass, kentucky bluegrass, prairie cordgrass, little bluestem, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Lamoure County, North Dakota, 1914.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 27 inches (A1 and A2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION LARSON ND+SD

Established Series
CJH
1/99

LARSON SERIES

The Larson series consists of very deep, moderately well and somewhat poorly drained soils that formed in calcareous, glacial till. Permeability is slow in the Btn horizon and moderately slow or moderate in the C horizons. These soils are on till plains and have slope ranging from 0 to 6 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Calcic Natrudolls

TYPICAL PEDON: Larson loam--cultivated. (Colors are for dry soils unless otherwise stated)

Ap--0 to 6 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; neutral; abrupt smooth boundary. (Combined A horizons 5 to 12 inches thick)

E--6 to 7 inches; gray (10YR 5/1) silt loam, black (10YR 2/1) moist; moderate medium subangular blocky structure parting to moderate thin platy; slightly hard, friable, slightly sticky and slightly plastic; many roots; neutral; abrupt wavy boundary. (0 to 4 inches thick)

Btn1--7 to 13 inches; dark gray (5Y 4/1) clay loam, black (5Y 2/1) moist; strong medium columnar structure parting to moderate, medium and fine angular blocky; hard, very firm, sticky and plastic; thin gray (5Y 5/1) coatings on tops of columns; slightly alkaline; gradual wavy boundary.

Btn2--13 to 16 inches; dark gray (5Y 4/1) clay loam, very dark gray (5Y 3/1) moist; strong medium prismatic structure parting to moderate medium angular blocky; hard, very firm, sticky and plastic; slight effervescence; slightly alkaline; gradual wavy boundary. (Combined Btn horizons 5 to 16 inches thick)

Bkyz--16 to 22 inches; olive gray (5Y 5/2) clay loam, dark olive gray (5Y 3/2) moist; moderate medium prismatic structure parting to moderate fine angular blocky; slightly hard, firm, sticky and plastic; common gypsum crystals and fine segregations of salts; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk--22 to 36 inches; light olive gray (5Y 6/2) clay loam, olive (5Y 4/3) moist; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, firm, sticky and plastic; violent effervescence; moderately alkaline; gradual wavy boundary. (Combined Bk horizons 6 to 40 inches thick)

C--36 to 60 inches; pale olive (5Y 6/3) clay loam, olive (5Y 4/3) moist; common medium distinct yellowish brown (10YR 5/4) moist redoximorphic concentrations; massive; hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 15 miles east and 4 1/2 miles north of New Rockford; 2140 feet south and 100 feet east of the northwest corner, sec. 1, T. 149 N., R. 64 W.

RANGE IN CHARACTERISTICS: The soil contains 0 to 10 percent by volume pebbles or stones and a few boulders.

The A horizon has 10YR or 2.5Y hue, value of 3 to 5 and 2 or 3 moist, and chroma of 1. It typically is loam, but included are fine sandy loam, silt loam or clay loam. It is slightly acid or neutral.

The E horizon has hue of 10YR or 2.5Y, value of 5 to 7 and 2 to 5 moist, and chroma of 1 to 3. It is fine sandy loam, very fine sandy loam, loamy fine sand, loam or silt loam. It is slightly acid to slightly alkaline.

The Btn horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 6 and 2 to 4 moist, and chroma of 1 to 3. It has a chroma of 4 in the lower part of some pedons. It typically is clay loam, but included are loam and silty clay loam. It typically contains 25 to 30 percent clay but ranges from 18 to 35 percent. It is neutral to strongly alkaline. It has moderate or strong columnar or prismatic structure which parts to angular or subangular blocky structure in many pedons. Some pedons have a Btk horizon. Bty horizons are allowed below a depth of 16 inches.

The By, Bz and Bk horizons have hue of 2.5Y or 5Y, value of 5 to 8 and 4 to 6 moist, and chroma of 1 to 4. They are loam or clay loam. They are moderately alkaline or strongly alkaline. The Bk horizon contains 10 to 25 percent calcium carbonate disseminated or in masses, but has 15 percent in some part. The By and Bz horizons contain few to many gypsum or salt crystals. Some pedons have a BC horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It typically is loam, but it is silt loam or clay loam in some pedons. It is moderately alkaline or strongly alkaline. It is stratified and has layers of coarser or finer textures below 40 inches in some pedons.

COMPETING SERIES: There are no competing series in the same family.

GEOGRAPHIC SETTING: Larson soils are on level to undulating till plains. Slope commonly is less than 3 percent, but ranges to 6 percent. The soils formed in calcareous, glacial till containing pockets of silt, fine sand and other sorted materials. Mean annual air temperature ranges from 37 to 45 degrees F, and mean annual precipitation from 15 to 20 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cathay Emrick, Fram, Heimdal, Miranda, Parnell, Swenoda and Tonka soils. Cathay and Miranda soils are on similar landscapes with Larson soils. Cathay soils have tonguing or interfingering of albic materials into the Btn horizon. Miranda soils have visible salt crystals within 16 inches of the surface. Emrick, Fram, Heimdal and Swenoda soils are on nearby till plains. They are in complex with Larson soils in some areas. They do not have natric horizons. In addition, Fram soils have calcic horizons within depth of 16 inches. Parnell and Tonka soils are in depressions. They are very poorly and poorly drained, respectively. In addition, they do not have natric horizons and are fine.

DRAINAGE AND PERMEABILITY: Moderately well and somewhat poorly drained. Runoff ranges from negligible to medium depending on slope. Permeability is slow in the Btn horizons and moderately slow or moderate in the C horizon. A seasonal high water table is at a depth of 2 to 4 feet at some time during the period of April through June in the somewhat poorly drained phase and at a depth of 3 to 5 feet at some time for the same period in the moderately well drained phase.

USE AND VEGETATION: Soils are cropped to small grains and used for hay and pasture. Native vegetation was western wheatgrass, green needlegrass, needleandthread, blue grama, sandberg bluegrass, inland salt grass, fringed sage, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, and northeastern South Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Wells County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 16 inches (Ap, E, Btn1, and Btn2 horizons); the Bkyz horizon has the color but not the organic matter content to be part of the mollic epipedon; natric horizon - the zone from 7 to 16 inches (Btn1 and Btn2 horizons); calcic horizon - the zone from 22 to 36 inches (Bk horizon).

ADDITIONAL DATA: Laboratory data for S49ND-38-1, S49ND-38-13, and 49ND- 48-14.

National Cooperative Soil Survey
U.S.A.

LOCATION LEMERT ND

Established Series
Rev. MDS-CJH
10/98

LEMERT SERIES

The Lemert series consists of very deep, somewhat poorly and moderately well drained, slowly permeable soil that formed in moderately coarse textured sediments overlying sand. These soils are on outwash and lake plains and have slopes ranging from 0 to 9 percent. Mean annual temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Leptic Natrudolls

TYPICAL PEDON: Lemert sandy loam - on a slightly concave slope of less than 1 percent under grassland. (Colors are for moist soil unless otherwise stated. Where described the soil was moist throughout.)

A--0 to 3 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary. (1 to 10 inches thick)

Bt1--3 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; strong medium columnar structure parting to strong medium subangular blocky; extremely hard, firm, sticky and plastic; common fine roots; many thin clay films on faces of peds and surface of pores; few pebbles up to 5 mm in size; strong effervescence; strongly alkaline; gradual wavy boundary.

Bt2--7 to 12 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; strong medium prismatic structure parting to strong medium subangular blocky; extremely hard, firm, sticky and plastic; few fine roots; common thin clay films on faces of peds; few coarse fragments as much as 5 mm in size; light gray (10YR 7/1) diffuse carbonates on interior of peds; strong effervescence; very strongly alkaline; clear wavy boundary. (Combined Bt horizons 6 to 16 inches thick)

Bky--12 to 17 inches; light gray (N 7/0) loam, white (N 8/0) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few fine roots; gray (N 5/0) coatings on faces of prisms; few pebbles; few nests of gypsum crystals; few nests of carbonates; violent effervescence; strongly alkaline; gradual wavy boundary.

Bkyz--17 to 22 inches; light brownish gray (2.5Y 6/2) loam, light gray (N 7/0) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and plastic; few small roots; few pebbles; common fine salt and gypsum crystals; few nests of carbonates; violent effervescence; very strongly alkaline; clear wavy boundary. (Combined Bk horizons 0 to 18 inches thick)

2C1--22 to 49 inches; olive brown (2.5Y 4/4) coarse sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; slight effervescence; strongly alkaline; clear wavy boundary. (0 to 35 inches thick)

3C2--49 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 10 miles east of New Rockford; 2540 feet north and 900 feet west of the southeast corner, sec. 36, T. 149 N., R. 65 W.

RANGE IN CHARACTERISTICS: The depth to sandy substratum ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 to 5 and 2 or 3 moist, and chroma of 1 or 2. It is sandy loam or fine sandy loam. Some pedons have an E horizon. It is sandy loam or fine sandy loam.

The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 or 3 moist, and chroma of 1 or 2. It is sandy loam, fine sandy loam, or loam. It has strong fine to coarse columnar or prismatic structure.

The Bky horizon has hue of 2.5Y or 5Y or is neutral, value of 5 to 8 and 4 to 7 moist, and chroma of 3 or less. It is loam or sandy loam. It has a CaCO3 equivalent of more than 15 percent. Some pedons have Bkz, Bz or BC horizons.

The 2C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 4. It is coarse sand, sand, loamy fine sand, or fine sand. In some pedons the 2C horizon is stratified and crossbedded with fine sandy loam or loamy fine sand. It contains as much as 20 percent gravel. Some pedons do not have the 2C and 3C horizons, and have a fine sandy loam C horizon.

COMPETING SERIES: There are no other series in the family. Other competing series are the Desart, Ekalaka, Letcher, and Miranda series. Desart, Ekalaka, and Letcher soils do not have visible gypsum or salt crystals within depths of 16 inches. Miranda soils are fine-loamy.

GEOGRAPHIC SETTING: Lemert soils are on level to moderately sloping outwash and lake plains. Slopes gradients range from 0 to 9 percent. The soils formed in moderately coarse textured over coarse textured sediments. The climate is cool and subhumid. Mean annual temperature ranges from 38 degrees to 45 degrees F, and the mean annual precipitation from 16 to 22 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Letcher soils and the Binford, Brantford, Embden, Fordville, Renshaw, Stirum, and Totten series. Lemert soils commonly are in complex with Letcher soils and are in the slightly lower depressions and swales. Stirum and Totten soils are on lower areas of outwash plains. These soils have an aquic moisture regime. In addition, Totten soils are fine-loamy over sandy or sandy skeletal. The Brantford, Binford, Embden, Fordville, and Renshaw soils do not have natric horizons, are on nearby outwash plains and are on higher lying and better drained areas.

DRAINAGE AND PERMEABILITY: Somewhat poorly and moderately well drained. Surface runoff is slow. Permeability is slow in the Bt horizon and moderately rapid or

rapid in the 2C horizon. The somewhat poorly drained phase has a water table within depths of 3 to 5 feet for a short time in the spring and during long wet seasons.

USE AND VEGETATION: Soils mainly are used for pasture and hay. Some are cropped to small grains. Native vegetation was western wheatgrass, blue grama, inland saltgrass, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central, eastern and southwestern North Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County, North Dakota, 1971.

REMARKS: Revised 5/90.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 12 inches (A, Bt1 and Bt2 horizons); natric horizon - the zone from 3 to 12 inches (Bt1 and Bt2 horizons); leptic criteria - visible gypsum in the 12 to 17 inch layer (Bky horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION LETCHER SD+ND

Established Series
Rev. EHE-BOK
02/1999

LETCHER SERIES

The Letcher series consists of very deep, somewhat poorly or moderately well drained soils formed in glacial outwash sediments and in loamy glacial till on uplands. Permeability is slow in the solum and moderate or moderately rapid in the underlying material. Slopes range from 0 to 6 percent. Mean annual precipitation is about 19 inches, and mean annual temperature is about 43 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Calcic Natrudolls

TYPICAL PEDON: Letcher fine sandy loam - on plane slope of less than 1 percent under native vegetation. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

A1--0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine and medium subangular blocky structure parting to weak fine and medium granular; slightly hard, very friable; strongly acid; clear smooth boundary.

A2--8 to 12 inches; dark gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak medium and coarse subangular blocky structure parting to very weak fine and medium granular; slightly hard, very friable; moderately acid; abrupt smooth boundary. (Combined A horizons is 5 to 15 inches thick.)

E--12 to 15 inches; light brownish gray (10YR 6/2) sandy loam, very dark grayish brown (10YR 3/2) moist; few fine faint mottles of yellowish brown (10YR 5/6); weak fine and medium subangular blocky structure parting to very thin platy; slightly hard, very friable; neutral; clear wavy boundary. (0 to 10 inches thick)

Btn--15 to 19 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; strong very coarse columnar structure; extremely hard, firm; light brownish gray (10YR 6/2) coatings on tops of columns; neutral; clear smooth boundary. (3 to 11 inches thick)

Btnk--19 to 25 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak very coarse prismatic structure; hard, very friable; common fine and medium accumulations of salt and carbonate; slight effervescence; strongly alkaline; clear smooth boundary. (0 to 12 inches thick)

BC--25 to 32 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, very friable; few fine striations and accumulations of carbonate; slight effervescence; strongly alkaline; abrupt smooth boundary. (0 to 12 inches thick)

Ab--32 to 40 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; very hard, firm; few fine striations

and accumulations of carbonate; slight effervescence; strongly alkaline; abrupt smooth boundary.

Bkb--40 to 48 inches; dark gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak fine and medium subangular blocky structure; very hard, friable; many fine striations and accumulations of carbonate; strong effervescence; strongly alkaline; abrupt smooth boundary. (Combined Ab and Bkb horizons are 0 to 20 inches thick.)

C--48 to 60 inches; light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) sandy loam, dark grayish brown (10YR 4/2) moist; common fine faint mottles of reddish yellow (7.5YR 6/8) moist; massive; hard, friable; strong effervescence; strongly alkaline.

TYPE LOCATION: Edmunds County, South Dakota; about 10 miles east and 9 miles north of Ipswich; 285 feet west and 120 feet north of the southeast corner of sec. 6, T. 124 N., R. 66 W.

RANGE IN CHARACTERISTICS: The depth to free carbonates ranges from 10 to 25 inches. Buried horizons of loam or sandy loam are in most pedons and are typically below 30 inches.

The A horizon has value of 3 to 5 and 2 or 3 moist, and chroma of 1.5 or 1. Typically it is loam, fine sandy loam, or sandy loam but is loamy sand and loamy fine sand in some pedons. It is strongly acid to slightly alkaline.

The E horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 2 to 5 moist, and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or sandy loam. It is lacking in some pedons when plowed. It ranges from strongly acid to slightly alkaline.

The Btn horizon has hue of 10YR or 2.5Y, value of 4 or 5 and 3 or 4 moist, and chroma of 2 or 3. It is sandy loam, fine sandy loam, or loam averaging less than 18 percent clay and more than 15 percent fine or coarser sand. It has strong or moderate, coarse or very coarse, columnar structure in the upper part, but is prismatic when the upper part is disturbed by plowing. It typically has accumulations of carbonates and salts in the lower part. It ranges from neutral to strongly alkaline.

The BC horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 3 or 4 moist, and chroma of 2 or 3. It is sandy loam, fine sandy loam, loam, or loamy sand. Some pedons do not have accumulations of carbonates and some pedons have accumulations of salt. It ranges from slightly to strongly alkaline. Some pedons do not have a BC horizon.

Some pedons have a Bk horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 and 3 to 6 moist; and chroma of 1 to 4. Typically it is sandy loam or fine sandy loam but is loam or loamy fine sand in some pedons. It ranges from slightly to strongly alkaline. The C horizon typically has common or many mottles. Clay loam glacial till or loamy and clayey lacustrine sediments are at depths between 40 and 60 inches in some pedons.

COMPETING SERIES: There are no other series in this family. Other similar soils are Cathay, Desart, Ekalaka, Larson, Lemert, Miranda, Noonan, Sorum, Stirum, and Whitelake soils. Cathay soils do not have columnar structure and

have a fine-loamy control section. Desart, Ekalaka, and Noonan soils have A horizons with chroma greater than 1.5. In addition, the Desart soils have combined A and E horizons thicker than 20 inches and are well drained. Larson, Miranda, Noonan, and Sorum soils have a fine-loamy control section. Lemert soils have a combined thickness of A and E horizons less than 5 inches and have visible salt or gypsum crystals within a depth of 16 inches. Stirum soils have an aquic soil moisture regime. Whitelake soils have a warmer soil temperature regime.

GEOGRAPHIC SETTING: Letcher soils are on nearly level to undulating, outwash, delta, and till plains. Surfaces are plain or slightly hummocky, and slope gradients range from 0 to 6 percent. The soil formed in sandy and loamy glacial outwash materials and in loamy glacial till. Mean annual temperature ranges from 34 to 45 degrees F, and mean annual precipitation ranges from 14 to 21 inches. Growing season is about 120 to 130 days; average growing season precipitation from 13 to 18 inches; and growing degree days are about 2600 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Larson, Lemert, Miranda, and Noonan soils and Parshall soils. Larson and Noonan soils are on similar landscapes. Lemert soils are in slight depressions and swales. Miranda soils are on similar landscapes and are in the lows of the microrelief. Parshall soils do not have a natric horizon and are on convex positions above the Letcher soils.

DRAINAGE AND PERMEABILITY: Somewhat poorly or moderately well drained. Surface runoff is low to high. Permeability is slow in the Btn horizon and moderate or moderately rapid in the underlying material. A temporary water table is at a depth of 3.5 to 6 feet in the spring of most years.

USE AND VEGETATION: Used for pasture, hay, and small grain. Native vegetation includes little bluestem, needleandthread, prairie sandreed, western wheatgrass, blue grama, big bluestem, prairie junegrass, and sedges.

DISTRIBUTION AND EXTENT: North-central and northeastern South Dakota and central and eastern North Dakota. It is moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 12 inches and from 15 to 32 inches (A1, A2, Btn, Btnk, BC horizons); albic horizon- the zone from 12 to 15 inches (E horizon); argillic (natric) horizon - the zone from about 15 to 25 inches (Btn, Btnk horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION LINDAAS ND+MN

Established Series
Rev. NDP-CJH
11/96

LINDAAS SERIES

The Lindaas series consists of very deep, poorly drained, slowly permeable soils that formed in glacial lake sediments or local alluvium from glacial till. These soils are in shallow depressions and on broad flats on glacial lake plains, till plains and moraines. They have slopes of 0 to 2 percent. Mean annual air temperature is 40 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Argiaquolls

TYPICAL PEDON: Lindaas silty clay loam - on a concave slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist throughout.)

Ap--0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine granular; hard, friable, sticky and plastic; common fine roots; common pores; neutral; abrupt smooth boundary.

A--7 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate medium platy; hard, friable, sticky and plastic; common fine roots; common pores; neutral; clear wavy boundary. (Combined A horizon 9 to 17 inches)

Bt--15 to 27 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate fine blocky; hard, firm, very sticky and very plastic; few fine roots; few pores; organic stains and clay films on faces of prisms and pores; slightly alkaline; clear irregular boundary. (10 to 20 inches thick)

Bk--27 to 37 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct very dark gray (10YR 3/1) and yellowish brown (10YR 5/4) redox concentrations; weak coarse prismatic structure; slightly hard, friable, sticky and plastic; violent effervescence; moderately alkaline; gradual wavy boundary. (0 to 12 inches thick)

Cg--37 to 60 inches; light olive gray (5Y 6/2) silt loam, light gray (5Y 7/2) dry; few fine distinct very dark gray (10YR 3/1) and many medium prominent strong brown (7.5YR 5/6) redox concentrations; weak very coarse prismatic structure parting to weak medium platy; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Traill County, North Dakota; about 6 miles south and 8 miles east of Hillsboro; 1,745 feet west and 290 feet north of the southeast corner, sec. 4, T. 144 N., R. 49 W.

RANGE IN CHARACTERISTICS: The depth to carbonates ranges from 18 to 35 inches. The mollic epipedon is more than 16 inches thick and may include part or all of the Bt horizon. LE is less than 6 cm in the upper meter.

The A horizon has hue of 10YR, 2.5Y or is neutral, value of 2 or 3, and chroma of 2 or less. It is silt loam, clay loam or silty clay loam averaging 25 to 35 percent clay. It is neutral.

The Bt horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay or clay ranging from 35 to 60 percent clay. It is neutral or slightly alkaline. Clean sand and silt grains coat faces of peds in some pedons. In some pedons the lower part of the Bt horizon contains carbonates or distinct redox features or both.

The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. It has distinct or prominent redox features and is silt loam or silty clay loam. It is slightly alkaline or moderately alkaline.

The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 1 to 4. It is silt loam, clay loam or silty clay loam. In some pedons clayey material is below a depth of 40 inches. The C horizon is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Badger and Parnell series. These soils have carbonates at depths of 35 to 80 inches. In addition, Parnell soils generally have thicker sola and Bt horizons with lower color values and are very poorly drained.

GEOGRAPHIC SETTING: Lindaas soils are in shallow depressions and on broad flats on glacial lake plains, till plains and moraines. Slope gradients are 0 to 2 percent. The soils formed in calcareous silt loam, clay loam and silty clay loam glacial lake sediments or local alluvium from till. Mean annual air temperature is 36 to 45 degrees F, and the mean annual precipitation is 19 to 27 inches. Most of the moisture falls in the spring and summer. Frost-free period ranges from 90 to 135 days. Elevation above sea level ranges from 650 to 1600 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Colvin, Enloe, Overly and Perella soils. Bearden, Colvin, Overly and Perella soils do not have argillic horizons and are fine-silty. In addition, Bearden and Colvin soils have a calcic horizon within a depth of 16 inches. Bearden soils are somewhat poorly drained. Overly soils are moderately well drained. Enloe soils have albic horizons. All the associated soils are above the Lindaas soils on the landscape.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is ponded. Permeability is slow.

USE AND VEGETATION: Cropped to small grains, row crops and legumes. The original vegetation was tall prairie grasses.

DISTRIBUTION AND EXTENT: Eastern North Dakota and western Minnesota. The series is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Traill County, North Dakota, 1974.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 27 inches (Ap, A and Bt horizons); argillic horizon - the zone from 15 to 27 inches (Bt horizon); features associated with wetness; chroma of 1 in the lower part of the mollic epipedon (Bt horizon) and value of 4 or more moist, hue of 2.5Y, chroma of 2, and distinct redox concentrations immediately below the mollic epipedon (Bk horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION LISMORE SD+MN ND

Established Series
Rev. MWS-KFM-BOK
04/1999

LISMORE SERIES

The Lismore series consists of very deep, moderately well drained soils formed in silty sediments over glacial till on uplands. Permeability is moderate in the upper part and moderately slow in the glacial till. Slope ranges from 0 to 6 percent. Mean annual temperature is 44 degrees F, and mean annual precipitation is 23 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Aquic Cumulic Hapludolls

TYPICAL PEDON: Lismore silty clay loam - on a concave slope of 1 percent in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; very hard, friable, slightly sticky, slightly plastic; slightly acid; abrupt smooth boundary.

A--8 to 17 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; slightly acid; clear wavy boundary. (Combined A horizons is 10 to 20 inches thick.)

2Bw1--17 to 24 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many worm casts and channels of light olive brown (2.5Y 5/4); neutral; gradual wavy boundary.

2Bw2--24 to 32 inches; light olive brown (2.5Y 5/4) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine faint mottles of light gray (10YR 6/1); weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few worm casts of dark gray (10YR 4/1); slight effervescence in spots; slightly alkaline; clear wavy boundary. (Combined 2Bw horizons is 10 to 24 inches thick.)

2Bk--32 to 48 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common fine distinct mottles of light olive brown (2.5Y 5/6) and light gray (10YR 6/1) moist; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine accumulations of carbonate; violent effervescence; slightly alkaline; gradual wavy boundary. (0 to 30 inches thick)

2C--48 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common fine faint mottles of light yellowish brown (2.5Y 6/4), light olive brown (2.5Y 5/6), and light gray (10YR 6/1) moist; massive; hard, friable; few medium and fine accumulations of carbonate; few fine concretions of lime, violent effervescence; slightly alkaline.

TYPE LOCATION: Brookings County, South Dakota; about 4 miles west and 1 mile south of Elkton; 2600 feet south and 135 feet east of northwest corner, sec. 26, T. 109 N., R. 48 W.

RANGE IN CHARACTERISTICS: Depth to carbonate typically is greater than 20 inches, but some pedons have calcareous spots at shallower depths due to worm activity. The thickness of the silty surface layer ranges from 10 to 20 inches. Most pedons have slight or moderate worm activity in the solum. The thickness of the mollic epipedon typically is 20 to 25 inches, but ranges from 16 to 30 inches or more and extends into the 2Bw horizon.

The A horizon has hue of 10YR, value of 3 or 4 and 2 or 3 moist, and chroma of less than 1.5. It has a chroma of 2 in the lower part of some pedons. It is silty clay loam or silt loam containing less than 15 percent fine sand or coarser. It is slightly acid or neutral.

Some pedons have a Bw horizon similar in texture to the A horizon. It has hue of 10YR, value of 3 or 4 and 2 or 3 moist, and chroma of 2 or less.

The 2Bw horizon has hue of 10YR or 2.5Y, value of 3 to 6 and 2 to 4 moist, and chroma of 1 to 4. It is clay loam or loam and is neutral or slightly alkaline.

The 2Bk horizon has color of the C horizon. It is clay loam or loam and is slightly alkaline or moderately alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay loam or loam and is slightly alkaline or moderately alkaline. It has common or many, faint through prominent mottles.

COMPETING SERIES: These are the Aastad, Darnen, Delette, Lankin, Svea, and Walsh series in the same family and the Athelwold, Beotia, Brookings, Fordville, Overly, Spottswood, Tara, Vienna, Vang, and Waubay series. Aastad, Darnen, Delette, Lankin, and Svea soils contain more fine sand or coarser in the upper part of the sola. In addition, Darnen and Delette soils formed in alluvial-colluvial sediments and Lankin soils formed in lacustrine sediments over glacial till. Walsh soils formed in alluvium derived from shale or glacial till containing a high amount of shale. Athelwold soils are fine-silty over sandy or sandy-skeletal. Beotia, Brookings, Overly, Tara, and Waubay are fine-silty. Fordville, Spottswood, and Vang soils are fine-loamy over sandy or sandy skeletal. Vienna soils have mollic epipedons less than 16 inches thick.

GEOGRAPHIC SETTING: Lismore soils are on nearly level to gently sloping upland flats and in upland swales in glacial till plains. Surfaces are plane or concave. Slope gradients typically are less than 2 percent but range to 6 percent. These soils formed in 10 to 20 inches of silty mantle over glacial till. Mean annual temperature ranges from 39 to 48 degrees, and mean annual precipitation from 16 to 24 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Athelwold, Brookings, Fordville, and Vienna soils and the Kranzburg and Leota soils. Athelwold and Brookings soils are on similar positions in the landscape. Fordville and Vienna soils are on higher nearby landscapes. Kranzburg soils are fine-silty and are in nearby landscapes. Leota soils are somewhat poorly drained and in similar positions as Lismore soils.

DRAINAGE AND PERMEABILITY: Moderately well drained; surface runoff is low to medium; moderate permeability in the solum and moderately slow in the underlying

glacial till. It has seasonal water table at depths between 3 to 6 feet in the spring. Some areas are flooded for short periods by runoff from adjacent slopes.

USE AND VEGETATION: Most areas cropped to corn, small grain or alfalfa.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and adjoining parts of Minnesota. It is of moderate extent.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Brookings County, South Dakota, 1956.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 24 inches (Ap, A, 2Bw1 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION LOHNES ND+MN

Established Series
CJH
06/1999

LOHNES SERIES

The Lohnes series consists of very deep, well drained, rapidly permeable soils that formed in coarse and medium sands. These soils are on glacial lake and outwash plains and have slopes ranging from 0 to 15 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Sandy, mixed, frigid Entic Hapludolls

TYPICAL PEDON: Lohnes loamy coarse sand--native grass. (Colors are for dry soil unless otherwise stated)

A--0 to 16 inches; very dark gray (10YR 3/1) loamy coarse sand, black (10YR 2/1) moist; weak subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many fine roots; neutral; gradual wavy boundary. (10 to 20 inches thick)

AC--16 to 30 inches; dark grayish brown (10YR 4/2) loamy coarse sand, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; loose, very friable, slightly sticky and nonplastic; common roots; neutral; gradual wavy boundary. (0 to 20 inches thick)

C1--30 to 47 inches; brown (10YR 5/3) coarse sand, dark brown (10YR 4/3) moist; single grain; few fine faint dark yellowish brown (10YR 4/4) redoximorphic concentrations in the lower part; loose, nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual wavy boundary.

C2--47 to 60 inches; grayish brown (2.5Y 5/2) coarse sand, dark grayish brown (2.5Y 4/2) moist; common fine faint dark yellowish brown (10YR 4/4) redoximorphic concentrations in upper part, and common fine distinct brownish yellow (10YR 6/6) redoximorphic concentrations in lower part; single grain; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 2 1/2 miles south and 1/2 mile east of Hamar; 2340 feet north and 75 feet west of the southeast corner, sec. 22, T. 150 N., R. 62 W.

RANGE IN CHARACTERISTICS: The mollic epipedon commonly is more than 14 inches thick but ranges from 10 to 20 inches in thickness. The 10- to 40- inch control section typically is coarse sand, sand, loamy sand, or loamy coarse sand. It averages up to 5 percent by volume coarse fragments, most of which are 2 to 10 mm in diameter. Depth to carbonates ranges from more than 10 inches to less than 60 inches.

The A horizon has hue of 10YR, value of 3 to 5 and 2 or 3 moist, and chroma of 1. Chroma of 2 is allowed below a depth of 7 inches. The A horizon is coarse sand, sand, loamy coarse sand, loamy sand, coarse sandy loam or sandy loam. The A and AC horizons are neutral or slightly alkaline.

Some pedons have a Bw horizon with textures of coarse sand, sand, loamy coarse sand or loamy sand.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It has few or common redoximorphic features below 40 inches in some pedons. It is coarse sand, sand, loamy coarse sand or loamy sand. It is slightly alkaline or moderately alkaline. A thin dark colored layer is below depths of 30 inches in some pedons. Some pedons have loamy glacial till below depths of 40 inches.

COMPETING SERIES: These are the Hubbard, Kost, Maddock and Sandberg soils. Hubbard and Kost soils do not have carbonates within a depth of 60 inches. In addition, Hubbard soils are neutral or acid throughout. Kost and Maddock soils have less than 30 percent medium sand and coarser. Sandberg soils have 2 to 35 percent rock fragments in the series control section.

GEOGRAPHIC SETTING: Lohnes soils commonly are on level concave areas on glacial lake plains and outwash plains. Slope gradients typically are less than 2 percent but range to 15 percent. The soils formed in poorly sorted coarse and medium sands of mixed mineralogy. The mean annual air temperature ranges from 38 to 45 degrees F, and mean annual precipitation ranges from 15 to 22 inches. Three-fourths of the precipitation falls during the growing season.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Maddock soils and the Claire and Hecla soils. Claire soils are on the slightly higher positions in the landscape. They do not have a mollic epipedon. Hecla and Maddock soils are on nearby lake and outwash plains. Hecla soils have redoximorphic features higher in the profile.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is slow or medium. Permeability is rapid.

USE AND VEGETATION: Mainly pasture and range. Limited cultivation to grow small grains. Native vegetation is tall prairie grasses.

DISTRIBUTION AND EXTENT: North-central and eastern North Dakota and western Minnesota. The soil is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 16 inches (A horizon); the AC horizon has the color for mollic epipedon but not the organic matter content.

ADDITIONAL DATA: Laboratory data is available on the following profiles: S59ND-14-2, S60ND-14-2, and S57ND-37-5.

National Cooperative Soil Survey
U.S.A.

LOCATION LUDDEN ND+MN SD

Established Series
Rev. CJH
2/97

LUDDEN SERIES

The Ludden series consists of very deep, poorly or very poorly drained, slowly permeable soils that formed in clayey alluvium. These soils are on floodplains of streams and have slopes of 0 to 1 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Endoaquerts

TYPICAL PEDON: Ludden clay - in a level cultivated field. (Colors are for moist soil unless otherwise stated)

Ap--0 to 5 inches; black (10YR 2/1) clay, dark gray (N 4/0) dry; moderate medium subangular blocky structure parting to moderate very fine angular blocky; extremely hard, firm, sticky and very plastic; slight effervescence; slightly alkaline; abrupt smooth boundary.

A--5 to 14 inches; black (10YR 2/1) clay, dark gray (N 4/0) dry; moderate medium angular blocky structure; extremely hard, firm, sticky and very plastic; slight effervescence; slightly alkaline; gradual smooth boundary. (Combined A horizons thickness 5 to 20 inches)

Bw--14 to 30 inches; black (10YR 2/1) clay, dark gray (N 4/0) dry; moderate medium angular blocky structure; extremely hard, firm, sticky and very plastic; common gypsum crystals in the lower part; common medium masses of carbonate; slight effervescence; moderately alkaline; gradual wavy boundary. (0 to 30 inches thick)

Cg1--30 to 46 inches; dark gray (5Y 4/1) clay, dark gray (N 4/0) dry; massive with varves; extremely hard, firm, sticky and very plastic; many medium masses of carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2--46 to 60 inches; very dark gray (5Y 3/1) clay, gray (5Y 5/1) dry; massive with varves; extremely hard, firm, sticky and very plastic; common snail shells; common coarse masses of carbonate; strong effervescence; moderately alkaline.

TYPE LOCATION: Dickey County, North Dakota; 50 feet north and 50 feet east of the southwest corner, sec. 32, T. 131 N., R. 59 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 24 to 48 inches in thickness. The 10- to 40-inch particle size control section is silty clay, clay or silty clay loam averaging between 35 and 60 percent clay. Some pedons have an O horizon. Saline phases are recognized.

The A horizon has hue of 10YR, 2.5Y, 5Y, or is neutral, value of 2 or 3, 3 to 5 dry, and chroma of 1 or less. It is a clay, silty clay or silty clay loam. It is slightly acid to moderately alkaline. Some pedons have an Ab horizon.

The B horizon has hue of 10YR, 2.5Y, 5Y, or is neutral, value of 2 to 4 and 4 to 6 dry, and chroma of 2 or less. It is clay, silty clay or silty clay loam. It is moderately alkaline. Some pedons have Bkyg, Bzg, Byg, Bss or Bssy horizons.

The Cg horizon has hue of 2.5Y, 5Y, or is neutral, value of 2 to 5 and 3 to 7 dry, and chroma of 2 or less. It is clay or silty clay. It is clay loam below 40 inches in some pedons. It is moderately alkaline.

COMPETING SERIES: These are the Gold Creek and Grano series as previously classified. Gold Creek soils are strongly alkaline or very strongly alkaline and have 15 to 30 percent exchangeable sodium. Grano soils have mollic epipedons less than 24 inches thick.

GEOGRAPHIC SETTING: The soil is on low, level floodplains of streams. Slope ranges from 0 to 1 percent. Ludden soils formed in clay alluvium that was deposited slowly and the organic matter enrichment of the soil kept pace with the rate of deposition. Mean annual precipitation is 15 to 23 inches and mean annual air temperature is 36 to 45 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Lamoure, La Prairie and Ryan soils on adjacent floodplains, levees, and low terraces. La Prairie soils are fine-loamy and are on slightly higher, better drained areas. Lamoure soils have less clay and more silt. Ryan soils have a natric horizon.

DRAINAGE AND PERMEABILITY: Poorly or very poorly drained. Runoff is negligible to low. Permeability is slow. These soils are flooded and water ponds on them for brief periods. An apparent seasonal high water table is at a depth of 0.5 foot above the surface to 1.5 feet below the surface at some time during the period of March through July in the poorly drained phase. It is at a depth of 0.5 foot above the surface to 1.0 foot below the surface at some time during the period of November through July in the very poorly drained phase. It is at a depth of 2 feet above the surface to 1 foot below the surface at some time during the period of November through July in the ponded phase.

USE AND VEGETATION: Mostly cropped to small grains, hay and pasture. Native grasses are big bluestem, green needlegrass, western wheatgrass and other tall grasses.

DISTRIBUTION AND EXTENT: These soils are extensive. They are adjacent to larger drainageways in central and eastern North Dakota, northeastern South Dakota and east-central Minnesota.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Lamoure County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 30 inches (Ap, A, and Bw horizons); Vertisol criteria - cracks greater than 1 cm wide to depth of greater than 50 cm during dry periods; the site will be redescribed in the future to better document other Vertisol criteria.

ADDITIONAL DATA: North Dakota State University Agr. Exp. Sta. sample numbers: S64ND-9-2, S63ND-11-56, S60ND-11-119, S59ND-23-73, and S63ND-23-1.

National Cooperative Soil Survey

U.S.A.

LOCATION MADDOCK ND+MN SD

Established Series
Rev. LEE-CJH
10/98

MADDOCK SERIES

The Maddock series consists of very deep, well drained or somewhat excessively drained, rapidly permeable soils that formed in fine sands deposited by wind or water. These soils are on sandy glaciolacustrine or glaciofluvial, outwash and delta plains and have slopes ranging from 0 to 35 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Sandy, mixed, frigid Entic Hapludolls

TYPICAL PEDON: Maddock loamy fine sand - on a 4 percent west facing slope in native grassland. (Colors for moist soil unless otherwise stated)

A--0 to 10 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine granular structure parting to single grain; loose; nonsticky and nonplastic; many very fine and few fine roots; neutral; clear wavy boundary. (6 to 16 inches thick)

Bw--10 to 14 inches; dark brown (10YR 3/3) fine sand, brown (10YR 4/3) dry; single grain; loose; nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary. (0 to 22 inches thick)

C1--14 to 26 inches; dark yellowish brown (10YR 3/4) fine sand, dark yellowish brown (10YR 4/4) dry; single grain; loose; nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

C2--26 to 43 inches; dark yellowish brownish (10YR 4/4) fine sand, yellowish brown (10YR 5/4) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual wavy boundary.

C3--43 to 60 inches; dark yellowish brownish (10YR 4/4) fine sand, yellowish brown (10YR 5/4) dry; few fine faint dark yellowish brown (10YR 3/4) mottles; single grain; loose; nonsticky and nonplastic; slightly alkaline.

TYPE LOCATION: Ransom County, North Dakota; 1,220 feet west and 150 feet north of southeast corner, Sec. 24, T. 135 N., R. 54 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch particle-size control section is typically fine sand or loamy fine sand, but in some pedons it is loamy sand or sand with less than 30 percent medium and coarse sand. It has less than 5 percent rock fragments. The depth to carbonates ranges from 0 to more than 60 inches. The carbonates commonly are diffused. The mollic epipedon ranges from 7 to 16 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or less; however, chroma of 2 is allowed in the lower part. It is loamy fine sand, fine sandy loam, sandy loam, loam, fine sand or loamy sand. Where A horizon is fine sandy loam, sandy loam or loam, the thickness ranges from 4 to 9

inches. The A horizon is slightly acid to slightly alkaline. Some pedons have an AC horizon.

The Bw horizon has hue of 10YR, value of 2 to 5 and 4 to 6 dry, and chroma of 2 to 4. It is fine sand, loamy fine sand or loamy sand. It is slightly acid to moderately alkaline. Some pedons have a Bk or BC horizon.

The C horizon has hue of 2.5Y or 10YR, value of 3 to 6 and 4 to 7 dry, and chroma of 2 to 4. It is fine sand, loamy fine sand, loamy sand or sand. It has a small amount of fine gravel is in some pedons. It is slightly acid to moderately alkaline. Below depths of 40 inches the texture ranges from sand to clay loam.

COMPETING SERIES: These are the Hubbard, Kost and Lohnes series. Hubbard and Kost soils are substantially wetter in the soil moisture control section during the 120 days following the summer solstice. Hubbard and Lohnes soils contain more than 30 percent medium and coarser sand.

GEOGRAPHIC SETTING: Maddock soils are on level to steep sandy glaciolacustrine or glaciofluvial, outwash and delta plains, some of which have been wind worked. Slope gradients range from 0 to 35 percent. The soil formed in fine sands deposited by wind or water. The mean annual air temperature ranges from about 37 to 48 degrees F, and mean annual precipitation from about 15 to 24 inches. Three-fourths of the rainfall is in the spring and summer. Frost-free period ranges from 105 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Lohnes soils and the Hamar, Hecla, Sverdrup and Venlo soils. Lohnes soils are on the foot slopes and concave positions. Hamar soils are on the lower, somewhat poorly and poorly drained areas. Hecla soils are on more level and slightly concave parts of the landscape and in some areas are in complex with Maddock soils. They have a higher water table. Sverdrup soils are on similar positions as Maddock soils. They have a cambic horizon. Venlo soils are in the lowest basins and swales and are very poorly drained.

DRAINAGE AND PERMEABILITY: Well drained or somewhat excessively drained. Rapidly permeable. Runoff is negligible or very low depending on slope.

USE AND VEGETATION: Cultivated areas are used for growing small grains, corn, hay and pasture. Native vegetation is tall and mid prairie grasses as prairie sandreed, needleandthread, some sedges, and forbs.

DISTRIBUTION AND EXTENT: Eastern North Dakota, northeastern South Dakota and western Minnesota. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Clay County, South Dakota, 1953.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface of the soil to a depth of 10 inches (A horizon); Bw horizon has the color but not the organic matter content to be mollic.

ADDITIONAL DATA: Laboratory sample number S54NDak-39-1 in Soil Survey Investigation Report No. 2, p. 154.

National Cooperative Soil Survey
U.S.A.

LOCATION MARYSLAND MN+ND SD

Established Series
Rev. HRF-AGG
04/2000

MARYSLAND SERIES

The Marysland series consists of very deep, poorly and very poorly drained soils that formed in glacial lacustrine, alluvium or outwash sediments which consists of a 20 to 40 inch loamy mantle over sandy or sandy-skeletal sediments. These soils are on stream terraces, outwash channels, outwash plains, flood plains and lake plains. They have moderate permeability in the upper part and rapid permeability in the underlying material. Slopes range from 0 to 2 percent. Mean annual air temperature is about 43 degrees F. Mean annual precipitation is about 22 inches.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Marysland loam with a plane level slope on a glacial lake plain in a meadow. (Colors are for moist conditions unless otherwise stated.)

A--0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; many roots; slightly effervescent; moderately alkaline; abrupt wavy boundary. (6 to 15 inches thick)

Ak--9 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many roots; disseminated calcium carbonate; strongly effervescent; moderately alkaline; abrupt wavy boundary. (0 to 20 inches thick)

Bkg1--12 to 15 inches; olive gray (5Y 4/2) loam; weak fine subangular blocky structure; very friable; few roots; many fine faint olive gray (5Y 5/2) and dark gray (5Y 4/1) Fe depletions; disseminated calcium carbonate; strongly effervescet; moderately alkaline; clear irregular boundary.

Bkg2--15 to 20 inches; olive gray (5Y 4/2) loam; weak fine and medium subangular blocky structure; very friable; few dark brown (10YR 4/3) coatings in root channels; few fine prominent olive yellow (2.5Y 6/6) Fe concentrations; few small soft lime masses; strongly effervescent; moderately alkaline; clear wavy boundary.

Bkg3--20 to 27 inches; light olive gray (5Y 6/2) loam; weak medium and fine subangular blocky structure; friable; few grayish brown (2.5Y 5/2) root channel fillings; few fine prominent olive yellow (2.5Y 6/6) Fe conmcentrations; few small lime and manganese masses; strongly effervescent; moderately alkaline; clear wavy boundary. (Combined thickness of the Bkg horizons is 6 to 32 inches.)

2Cg1--27 to 40 inches; grayish brown (2.5Y 5/2) sand; single grain; loose; many fine and medium faint light brownish gray (2.5Y 6/2) Fe depletions and common medium prominent yellowish brown (10YR 5/8) Fe concentrations; slightly effervescent; moderately alkaline; gradual wavy boundary.

2Cg2--40 to 80 inches; grayish brown (2.5Y 5/2) sand; single grain; loose; many medium faint light brownish gray (2.5Y 6/2) Fe depletions and few medium prominent red (2.5YR 4/8) Fe concentrations; slightly effervescent; moderately alkaline.

TYPE LOCATION: Swift County, Minnesota, about 5 miles west of Benson; 900 feet east and 200 feet north of the southwest corner, Sec. 4, T. 121 N., R. 40 W., USGS Clontarf South quadrangle, latitude 45 degrees 18 minutes 42.17 seconds N., longitude 95 degrees 42 minutes 06.25 seconds N., NAD27.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 30 inches in thickness. The depth to the calcic horizon ranges from 0 to 16 inches. The loamy outwash material ranges from 20 to 40 inches in thickness. It typically does not have rock fragments, but it contains as much as 10 percent (by volume) mostly in the lower part in some pedons. The 2C horizon contains as much as 40 percent (by volume) of rock fragments. The rock fragments are of mixed lithology. The loamy surface horizons average between 18 and 30 percent clay and 20 to 50 percent of fine sand and coarser. The calcic horizon has calcium carbonate equivalent averaging between 15 and 35 percent. Free carbonates are in all parts of the control section. The soil is slightly alkaline or moderately alkaline.

The A horizon has hue of 10YR to 5Y or is neutral; value of 2 or 3; and chroma of 0 or 1. It is loam, silt loam, sandy clay loam, or clay loam. Some pedons have an ABkg horizon.

The Bkg horizon has hue of 5Y to 10YR or is neutral, value of 3 to 6, 4 to 8 dry; chroma of 0 to 2. It typically is mottled in all parts; however, in some pedons the part at about depths of 20 inches does not have mottles but has chroma of 1 or 0. It is loam, clay loam, or sandy clay loam but the range includes fine sandy loam or sandy loam in the lower part. In some pedons, a transitional layer of gravelly sandy loam less than 5 inches thick is between the Bkg and 2Cg horizons. Some pedons have an Ab horizon or Cg horizon.

The 2Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 and chroma of 1 or 2. In some pedons, the coarse textured strata below 40 inches have chroma of 4 to 6. It is fine sand, sand, or coarse sand with as much as 40 percent gravel or are stratified with sand, coarse sand, loamy sand, loamy coarse sand, or their gravelly or very gravelly analogues. A 3Cg horizon of finer textured material begins at depths as shallow as 40 inches in a few pedons.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: The Marysland soils have plane, slightly concave, or slightly convex slopes. They formed in glacial lacustrine, alluvium or outwash with a 20 to 40 inch upper loamy mantle over sandy and gravelly sediment in drainageways and flats on glacial stream terraces, outwash channels, outwash plains, outwash plains, flood plains and lake plains. Slopes range from 0 to 2 percent. Mean annual air temperature ranges from about 38 to 45 degrees F. Mean annual precipitation ranges from 18 to 24 inches. Frost-free days range from 100 to 150. Elevation above sea level ranges from 800 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Renshaw, Fordville, Spottswood, and Divide soils which are members of a hydrosequence with the Marysland soils. The Renshaw and Fordville soils are well drained and are on higher lying or more sloping terrain. The Spottswood and Divide soils are moderately well and

somewhat poorly drained. The Spottswood soils have plane or slightly concave slopes and lack a calcic horizon at shallow depths. The Divide soils have plane or slightly convex slopes.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. Runoff is slow. Permeability is moderate in the upper loamy mantle and rapid in the 2C horizon. Depth to an apparent seasonal high water table is as high as .5 to 1.5 feet at some time from November through July in most years for the poorly drained phase. The very poorly drained phase has an apparent high water table at depths of +1.0 to 1.0 feet during January to December in most years.

USE AND VEGETATION: Most areas have been drained and are cultivated to corn, soybeans, and small grains. Undrained areas are in pasture or wild hay. The native vegetation is tall grass prairie.

DISTRIBUTION AND EXTENT: Western Minnesota and eastern North Dakota and South Dakota. Series is of moderate extent.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Swift County, Minnesota, 1970.

REMARKS: Diagnostic horizons and features are: mollic epipedon - the zone from the surface to a depth of 12 inches (A and Ak horizons); calcic horizon - the zone from 9 to 27 inches (Ak and Bkg horizons); aquic condition.

ADDITIONAL DATA:: Refer to MN Agr. Exp. Sta. Central File Code No. 29 for results of some laboratory analysis of a representative pedon of the series. Soil Interpretation Record numbers MN0103 and MN0320-depressional.

National Cooperative Soil Survey
U.S.A.

LOCATION MINNEWAUKAN ND+ID SD

Established Series
Rev. CJH-MDS
3/95

MINNEWAUKAN SERIES

The Minnewaukan series consists of very deep, poorly drained, rapidly permeable soils that formed in calcareous sorted sands. These soils are on floodplains, beaches and basins of current and glacial lakes. Slope ranges from 0 to 3 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 16 inches.

TAXONOMIC CLASS: Mixed, frigid Typic Psammaquents

TYPICAL PEDON: Minnewaukan loamy fine sand on a northeast-facing slope of 1 percent in native grass. When described the soil was moist to 44 inches and saturated from 44 to 60 inches. (Colors are for moist soil unless otherwise stated)

A--0 to 3 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky and granular structure; soft, very friable, slightly sticky and nonplastic; many roots; about 1 percent gravel; slight effervescence; slightly alkaline; abrupt smooth boundary. (1 to 8 inches thick)

AC--3 to 5 inches; dark grayish brown and very dark grayish brown (2.5Y 4/2 and 2.5Y 3/2) loamy coarse sand, grayish brown (2.5Y 5/2) dry; single grained; nonsticky and nonplastic; many roots; about 15 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary. (0 to 8 inches thick)

C--5 to 16 inches; dark grayish brown with olive brown (2.5Y 4/2 with 2.5Y 4/4) loamy sand, light brownish gray (2.5Y 6/2) dry; many fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and nonplastic; few roots; about 1 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

Cg1--16 to 28 inches; olive gray and olive (5Y 4/2 and 5Y 4/3) loamy sand, light gray and light olive gray (5Y 6/1 and 5Y 6/2) dry; very weak coarse prismatic structure; slightly sticky and nonplastic; few fine roots; about 10 percent pebbles; about 30 percent of sand and pebbles are shale fragments; few fine masses of carbonate; slight effervescence; slightly alkaline; clear wavy boundary.

Cg2--28 to 36 inches; olive gray and gray (5Y 5/2 and 5Y 5/1) fine sand, light gray (5Y 7/2) dry; single grained; nonsticky and nonplastic; about 1 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary.

Cg3--36 to 50 inches; dark brown (10YR 3/3) fine sand, brown (10YR 4/3 and 10YR 5/3) dry; single grained; nonsticky and nonplastic; few small iron and manganese concretions; slight effervescence; moderately alkaline.

Cg4--50 to 60 inches; olive (5Y 4/3) fine sand, pale olive (5Y 6/3) dry; single grained; nonsticky and nonplastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Benson County, North Dakota; about 3 1/2 miles north and 1 mile west of Warwick; 1055 feet south and 150 feet west of the northeast corner, sec. 17, T. 151 N., R. 63 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section typically is loamy fine sand, loamy sand, fine sand or sand. Some pedons are stratified and some have fine sandy loam to silty clay loam layers below depths of 40 inches. Some have horizons that contain 1 to 20 percent by volume of gravel. A few pedons contain gypsum crystals and other salts.

The A and AC horizons have hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2 moist or dry. Horizons having color darker than value of 3.5 moist and 5.5 dry are less than 6 inches thick. Textures range from fine sandy loam to sand. These horizons are neutral or slightly alkaline. Some pedons have thin Ab horizons.

The C horizon has hue of 10YR, 2.5Y, or 5Y and rarely 5GY, value of 3 to 5 and 4 to 7 dry, and chroma of 1 to 4. It is slightly alkaline or moderately alkaline. Distinct or prominent mottles are in some horizons.

COMPETING SERIES: These are the Bantry, Deford and Gunbarrel series. Bantry soils do not have carbonates in the upper part of the profile. Deford soils are noncalcareous above 25 inches and have thicker dark colored surface horizons. Gunbarrel soils are high in exchangeable sodium.

GEOGRAPHIC SETTING: Minnewaukan soils are on level and nearly level floodplains, beaches and basins of current and glacial lakes. Slope gradients are 0 to 3 percent. The soils formed in calcareous sorted sands. Mean annual air temperature ranges from 37 to 45 degrees F, and mean annual precipitation from 15 to 24 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Lallie soils on the same lake plain and the Arveson, Colvin, Divide, Fossum, Grano, Hamar, Hegne, Marysland and Ojata soils on nearby lake and outwash plains. Lallie soils are fine. All of the other soils have mollic epipedons.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is negligible. Permeability is rapid. A seasonal high water table is at depth of 0.5 foot above the surface to 1.5 foot below the surface at some time during the period March through July. Some areas are covered with water during periods of excessive moisture.

USE AND VEGETATION: The soils are used for range or pasture. Native vegetation is northern reedgrass, prairie cordgrass, little bluestem, tall dropseed and shrubs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota and Idaho. The series is moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County and parts of Benson and Nelson Counties, North Dakota, 1971.

REMARKS: Revised 3/95.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface of the soil to a depth of 5 inches (A and AC horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION MIRANDA SD+ND

Established Series
Rev. EHE-MWS-CJH
10/98

MIRANDA SERIES

The Miranda series consists of very deep, moderately well or somewhat poorly drained soils formed in till on uplands. Permeability is very slow. Slopes range from 0 to 9 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Leptic Natrustolls

TYPICAL PEDON: Miranda loam - on convex, southeast-facing slope of 2 percent under native vegetation. When described the soil was dry to 10 inches and moist below. (Colors are for dry soil unless otherwise stated)

E--0 to 4 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to weak thin platy; hard, friable; neutral; abrupt smooth boundary. (0 to 5 inches thick)

Btn1--4 to 7 inches; grayish brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) moist; strong fine and medium columnar structure; extremely hard, very firm, sticky and plastic; light brownish gray (10YR 6/2) coatings on tops of columns; slightly alkaline; abrupt smooth boundary. (3 to 6 inches thick)

Btn2--7 to 10 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine and medium blocky; very hard, very firm, sticky and plastic; moderately alkaline; clear wavy boundary. (0 to 13 inches thick)

Btnz--10 to 16 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak medium subangular; hard, firm, sticky and plastic; common fine accumulations of salts; strongly alkaline; abrupt wavy boundary. (0 to 12 inches thick)

Bkz--16 to 30 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct strong brown (7.5YR 5/8) moist redox concentrations; weak coarse blocky structure; hard, firm, sticky and plastic; common fine accumulations of salts; common fine accumulations of carbonate; strong effervescence; strongly alkaline; clear smooth boundary. (6 to 30 inches thick)

C1--30 to 38 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; few fine distinct strong brown (7.5YR 5/8) moist redox concentrations and common medium distinct light gray (10YR 7/1) moist redox depletions; massive; hard, firm, sticky and plastic; common fine streaks of salt and gypsum; common medium accumulations of carbonate; strong effervescence; strongly alkaline; clear smooth boundary.

C2--38 to 60 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; few fine distinct strong brown (7.5YR 5/8) moist redox

concentrations and many fine distinct light gray (10YR 7/1) moist redox depletions; massive; hard, firm, sticky and plastic; few fine streaks of gypsum; common medium accumulations of carbonate; strong effervescence; strongly alkaline.

TYPE LOCATION: Edmunds County, South Dakota; about 9 miles east and 3 miles north of Ipswich; 264 feet south and 90 feet west of the northeast corner of sec. 22, T. 124 N., R. 66 W.

RANGE IN CHARACTERISTICS: Depth to carbonates ranges from 5 to 25 inches. Depth to horizons with gypsum and salt accumulations ranges from 5 to 16 inches. The combined thickness of the A and E horizon is 5 inches or less. The soil has an Ustic moisture regime. The soil contains 1 to 10 percent rock fragments throughout.

Some pedons have A horizons 1 to 4 inches thick with hue of 10YR, value of 3 to 5 and 2 or 3 moist, and chroma of 2.

The E horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 or 4 moist, and chroma of 1 or 2. It is loam or silt loam and is slightly acid or neutral. The E horizon is absent in some pedons that have an Ap horizon.

The Btn horizon has hue of 10YR or 2.5Y, value of 3 to 6 and 2 to 4 moist, and chroma of 1 to 4. It is clay loam, silty clay or clay averaging more than 15 percent fine sand or coarser. It has moderate or strong, fine to coarse columnar structure in the upper part. Most pedons have accumulations of salts, especially in the lower part. It ranges from neutral to moderately alkaline.

The Bk horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 7 and 3 to 6 moist, and chroma of 2 to 4. It has common or many accumulations of carbonates. It is moderately or strongly alkaline. In some pedons the Bk horizon does not have accumulations of gypsum or other salts.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 8 and 3 to 7 moist; and chroma of 1 to 4. It is clay loam or loam but is fine sandy loam in some pedons. It is moderately or strongly alkaline. Some pedons have shale bedrock below a depth of 40 inches. Some pedons have thin strata of sandy loam and gravelly sand below a depth of 40 inches.

COMPETING SERIES: These are the Adger, Dogtooth, Exline, Ferney and Mekinock soils. Adger soils have an Ustic moisture regime that borders on Aridic. Dogtooth and Mekinock soils are moderately deep to residual beds. Exline, Ferney and Mekinock soils have a Udic moisture regime. In addition, Exline soils have less than 15 percent fine sand and coarser sand in the particle-size control section and formed in lacustrine sediments.

GEOGRAPHIC SETTING: Miranda soils are level to gently sloping on fine-loamy till plains. Slope gradients typically are less than 2 percent but range from 0 to 9 percent. The Miranda soils formed in calcareous loam or clay loam till. Mean annual air temperature ranges from 34 to 45 degrees F, and mean annual precipitation ranges from 12 to 17 inches. The soils have an Ustic moisture regime. Growing season is about 110 to 130 days; average growing season precipitation from 13 to 16 inches; and growing degree days are about 2500 to 3000. Elevation ranges from 1600 to 2700 feet above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Heil, Niobell, Noonan and Williams soils. Heil soils have an aquic moisture regime and are in

depressions. Niobell and Noonan soils are on higher parts of the landscapes with microrelief. Niobell soils do not have columnar structure in the Btn horizon and have tonguing or interfingering of E materials for more than 1 inch into the Btn horizon. Noonan soils have combined A and E horizons thicker than 5 inches and do not have accumulations of salt within a depth of 16 inches. Williams soils do not have a natric horizon and are on landscapes above the Miranda soils.

DRAINAGE AND PERMEABILITY: Moderately well or somewhat poorly drained. Runoff is negligible to very high depending on slope. Permeability is very slow.

USE AND VEGETATION: Used mainly for native hay and pasture. A few areas are cultivated when in complex with other soils. Native vegetation includes western wheatgrass, blue grama, buffalograss, prairie junegrass, inland saltgrass, prickly pear, sedges, and forbs.

DISTRIBUTION AND EXTENT: North-central South Dakota and central North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Hand County, South Dakota, 1958.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 10 inches (E, Btn1, Btn2 horizons); natric horizon - the zone from about 4 to 16 inches (Btn1, Btn2, Btnz horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION NAHON SD+ND

Established Series
Rev. LDS-BOK
10/98

NAHON SERIES

The Nahon series consists of very deep, moderately well drained and somewhat poorly drained soils formed in clayey glaciolacustrine sediments on lake plains. Permeability is very slow in the subsoil. Slopes range from 0 to 2 percent. Mean annual precipitation is about 19 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Calcic Natrudolls

TYPICAL PEDON: Nahon silty clay loam - on a plain slope of less than 1 percent in a cultivated field. When described the soil was dry to 50 inches and moist below. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 6 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary. (5 to 11 inches thick)

E--6 to 9 inches; gray (10YR 6/1) and (10YR 5/1) silt loam, dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) moist; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary. (1 to 6 inches thick)

Btn1--9 to 14 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; weak medium and fine columnar structure parting to moderate fine blocky; very hard, firm, sticky and plastic; thin continuous shiny films on vertical faces of peds; thin continuous gray (10YR 6/1) coatings on column tops; slightly alkaline; clear wavy boundary.

Btn2--14 to 20 inches; grayish brown (10YR 5/2) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium and fine prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; thin continuous shiny films on vertical faces of peds; few fine nests of salts in the lower part; moderately alkaline; clear wavy boundary. (Combined thickness of Bt horizons is 8 to 17 inches.)

Bz--20 to 25 inches; light brownish gray (2.5Y 6/2) and pale yellow (2.5Y 7/4) silty clay loam, dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common fine nests of gypsum and other salts; few fine accumulations of carbonate; slight effervescence; slightly alkaline. (0 to 20 inches thick)

Bkz--25 to 37 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine nests of gypsum and other salts; violent effervescence (21 percent calcium carbonate equivalent); moderately alkaline; clear wavy boundary. (0 to 14 inches thick)

C1--37 to 56 inches; white (2.5Y 8/2) and grayish brown (2.5Y 5/2) silty clay loam, varved with thin layers of very fine sandy loam and silty clay, pale yellow (2.5Y 7/4) and dark grayish brown (2.5Y 4/2) moist; massive, varves 1 to 3 mm thick; slightly hard, friable, slightly sticky and slightly plastic; violent effervescence (14 percent calcium carbonate equivalent); moderately alkaline; gradual wavy boundary.

C2--56 to 60 inches; white (2.5Y 8/2) and grayish brown (2.5Y 5/2) clay varved with thin layers of very fine sandy loam and silty clay, pale yellow (2.5Y 7/4) and dark grayish brown (2.5Y 4/2) moist; massive, varves 5 to 10 mm thick; hard, firm; strong effervescence; moderately alkaline.

TYPE LOCATION: Brown County, South Dakota; about 6 miles south of Aberdeen; 1160 feet south and 260 feet west of the northeast corner, sec. 9, T. 122 N., R. 63 W.

RANGE IN CHARACTERISTICS: Depth to free carbonate ranges from 14 to 32 inches. The natric horizon has a SAR that ranges from 5 to 15 and an ESP that ranges from 5 to 25. The ESP exceeds 15 within 2 meters of the upper boundary of the Bt horizon.

The A horizon has value of 3 or 4 and 2 or 3 moist. It is silt loam or silty clay loam and ranges from moderately acid to neutral.

The E horizon has value of 5 or 6 and 3 or 4 moist, and chroma of 1 or 2. It is silt loam or silty clay loam and is moderately acid to neutral. The E horizon is absent in some pedons that have an Ap horizon.

The Btn horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 or 3 moist, and chroma of 1 to 3. It is silty clay or silty clay loam that averages between 35 and 55 percent clay. It is neutral to strongly alkaline. Some pedons do not have gypsum or/other salts in the lower part of the Btn horizon or have a Btnz horizon.

The Bz and Bkz horizons have hue of 10YR, 2.5Y, or 5Y; value of 4 to 8 and 3 to 6 moist; and chroma of 1 to 4. They are typically silty clay loam or silty clay but some pedons are silt loam. Reaction ranges from slightly alkaline to strongly alkaline. Gypsum and other salts range from few to common. Some pedons have a BC or By horizon.

The C horizon has hue of 2.5Y or 10YR, value of 5 to 8 and 4 to 7 moist, and chroma of 2 to 4. It is silty clay loam, clay, and silty clay. The lower part is varved very fine sand to clay. It is moderately or strongly alkaline. Varves range from 1 mm to 10 mm in thickness. Some pedons are underlain with sandy materials or loamy glacial till at depths of 40 to 60 inches.

COMPETING SERIES: These are the Cavour and Rich series. Cavour soils contain more than 15 percent fine sand or coarser throughout the series control section. Rich soils do not have an E horizon and are drier in the soil moisture control section for longer periods.

GEOGRAPHIC SETTING: The Nahon soils are on nearly level to level glacial lake plains. Slope gradients are 2 percent or less. The soils formed in calcareous lacustrine deposits of silt, very fine sand, and clay. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation from 16 to 24 inches. Most of the precipitation comes in the spring and summer.

Growing season is about 120 to 130 days; average growing season precipitation is 14 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Aberdeen, Exline, Great Bend and Harmony soils. The Aberdeen, Exline, and Harmony soils are on the broad smooth flats in close association with the Nahon soil. Aberdeen soils are glossic. Exline soils have accumulations of salts within 16 inches and have a thinner sola. Harmony soils do not have a natric horizon. The Beotia and Great Bend soils are on slightly higher positions. They do not have a natric horizon and are fine-silty.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained or moderately well drained. Runoff is medium to high depending on slope. Permeability is very slow.

USE AND VEGETATION: The majority of the Nahon soils are cropped to small grains, alfalfa, and pasture. Native vegetation mainly is western wheatgrass, green needlegrass, blue grama, buffalograss, needleandthread, sedges and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and eastern North Dakota. The series is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Pembina County, North Dakota, 1973.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 6 inches and from 9 to about 20 inches (A, Btn1, Btn2 horizons); natric horizon - the zone from a depth of about 9 to 20 inches (Btn1 and Btn2 horizons).

ADDITIONAL DATA: NSSL Sample Nos. 74K1060-9.

National Cooperative Soil Survey
U.S.A.

LOCATION NUTLEY SD+MN ND

Established Series
Rev. JMS
02/97

NUTLEY SERIES

The Nutley series consists of very deep, well drained soils formed in clayey lacustrine sediments on uplands. Permeability is slow or very slow. Slopes range from 0 to 25 percent. Mean annual precipitation is about 21 inches, and mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Chromic Hapluderts

TYPICAL PEDON: Nutley silty clay - on a slope of 2 percent in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 7 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; slight effervescence; moderately alkaline; abrupt smooth boundary. (4 to 8 inches thick)

Bss--7 to 20 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist, weak coarse prismatic structure parting to moderate very fine and fine blocky; hard, firm, sticky and plastic; tongues 1/4 to 3/4 inches wide of dark gray (10YR 4/1) and black (10YR 2/1) moist; slight effervescence; few intersecting slickensides; moderately alkaline; gradual wavy boundary. (5 to 35 inches thick)

Css--20 to 48 inches; pale yellow (5Y 7/3) clay, olive (5Y 5/3) moist; common fine prominent yellowish red (5YR 4/6) and common fine distinct gray (5Y 5/1) redox depletions; weak fine blocky structure; very hard, firm, very sticky and plastic; fine tongues of dark gray (10YR 4/1) and black (10YR 2/1) moist; strong effervescence; few intersecting slickensides; moderately alkaline; diffuse wavy boundary.

C--48 to 60 inches; pale yellow (5Y 7/3) clay, olive (5Y 5/3) moist; many medium prominent yellowish red (5YR 4/6) redox concentrations and many medium distinct gray (5Y 5/1) redox depletions; weak medium and fine blocky structure; very hard, firm, very sticky and plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Day County, South Dakota; about 2 miles south and 4 miles west of Bristol; 360 feet south and 250 feet east of the northwest corner of sec. 8, T. 121 N., R. 58 W.

RANGE IN CHARACTERISTICS: The soil typically contains free calcium carbonate to the surface, but it it is absent to depths of 8 to 10 inches in some pedons. Thickness of the mollic epipedon ranges from 7 to l6 inches and in some pedons extends into the Bss horizon. When the soil is dry, cracks 1/2 to 2 inches wide and several feet long extend downward through the solum. The control section is silty clay, silty clay loam, or clay averaging between 35 and 60 percent clay and less than 15 percent fine or coarser sand.

The A horizon has value of 3 or 4 and 2 or 3 moist. It is silty clay loam, silty clay, clay, or clay loam. It ranges from neutral to moderately alkaline.

The Bss horizon has 10YR, 2.5Y, or 5Y hue; value of 4 to 6 and 3 to 5 moist; and chroma of 1 to 3. It typically is clay or silty clay, but is silty clay loam in some pedons. It is slightly or moderately alkaline. Dark tongues ranging from 1/4 to 1 inch in thickness with 10YR hue, value of 3 or 4 and 2 or 3 moist, and chroma of 1 or 2, extend through the Bss horizon. Some pedons have tongues extending into the C to depths of more than 24 inches.

Some pedons have a BC or Bk horizon.

The C horizon has 2.5Y or 5Y hue, value of 6 or 7 and 4 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, or silty clay loam. Some pedons do not have inherent mottles throughout the C horizon. Crystals of gypsum are in some pedons. The C horizon below depths of about 36 inches is laminated in some pedons. It is slightly or moderately alkaline.

COMPETING SERIES: These are the Hattie and Wahpeton series. Hattie soils contain more than 15 percent fine sand or coarser and 2 to 8 percent coarse fragments in the control section. Wahpeton soils have mollic epipedons more than 16 inches thick.

GEOGRAPHIC SETTING: The Nutley soils are nearly level to strongly sloping on uplands. Slope gradients range from 0 to 25 percent. The Nutley soils formed in calcareous clayey glaciolacustrine sediments. Mean annual air temperature ranges from 38 to 48 degrees F, and mean annual precipitation ranges from 16 to 24 inches. Growing season is about 110 to 130 days; average growing season precipitation ranges from 13 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Barnes, Buse, Forman, Poinsett, and Sinai soils. Sinai soils have mollic epipedons more than 16 inches thick and are on smooth nearly level to gently sloping areas in close association with the Nutley soils. The Barnes, Buse, Forman, and Poinsett soils are on nearby uplands. The Barnes, Buse, and Forman soils have a fine-loamy control section. In addition, Forman soils have an argillic horizon. Poinsett soils have a fine-silty control section.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is low to very high. Permeability is slow or very slow.

USE AND VEGETATION: Mostly cultivated. Corn, small grain, and alfalfa are the principal crops. Native grasses are green needlegrass, western wheatgrass, little bluestem, big bluestem, sideoats grama, blue grama; sedges and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and eastern and central North Dakota and southwestern Minnesota. Series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Day County, South Dakota, 1952.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 7 inches.

National Cooperative Soil Survey
U.S.A.

LOCATION OJATA ND

Established Series
Rev. SJL-CJH
11/97

OJATA SERIES

The Ojata series consists of deep, poorly drained, moderately slowly or slowly permeable soils that formed in silty lake sediments. These soils are on slightly depressed flats, swales, and channels in glacial lake and outwash plains and have slopes less than 1 percent. Mean annual temperature is 39 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Ojata silty clay loam - on a level slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated. Where described the soil was moist to 50 inches and wet below 50 inches.)

Apz--0 to 8 inches; black (N 2/0) silty clay loam, dark gray (N 4/0) dry; weak very fine subangular blocky structure; hard, friable, sticky, and plastic; common very fine roots; few fine salt crystals; strong effervescence; mildly alkaline; abrupt smooth boundary. (5 to 16 inches thick)

Bkz--8 to 20 inches; gray (5Y 6/1) silt loam, light gray (5Y 7/1) dry; many fine and medium distinct dark gray (5Y 4/1) mottles; weak fine subangular blocky structure; hard, friable, slightly sticky, and slightly plastic; few very fine roots; cracks filled with A material extend to 18 inches; few fine salt crystals; disseminated carbonates throughout; violent effervescence; moderately alkaline; clear wavy boundary. (6 to 26 inches thick)

C1--20 to 32 inches; dark grayish brown (2.5Y 4/2) very finely stratified silt loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct gray (5Y 5/1) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky, and slightly plastic; few very fine roots; slight effervescence; strongly alkaline; gradual wavy boundary. (0 to 30 inches thick)

C2--32 to 47 inches; dark grayish brown (2.5Y 4/2) very finely stratified silt loam, pale yellow (2.5Y 7/4) dry; common fine and medium distinct gray (2.5Y 6/1) and few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; soft, friable, slightly sticky, and slightly plastic; slight effervescence; strongly alkaline; gradual wavy boundary. (0 to 30 inches thick)

C3--47 to 60 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) and light yellowish brown (2.5Y 6/4) dry; common fine and medium distinct gray (5Y 5/1) mottles; weak fine subangular blocky structure; soft, friable, slightly sticky, and slightly plastic; common medium dark reddish brown (5YR 3/4) (iron- manganese) concretions; common large masses of gypsum crystals; slight effervescence; moderately alkaline.

TYPE LOCATION: Grand Forks County, North Dakota; about 2 miles west and 2 miles north of Grand Forks; 1,000 feet east and 200 feet north of the southwest corner, sec. 24, T. 152 N., R. 51 W.

RANGE IN CHARACTERISTICS: The mollic epipedon has a conductivity of more than 16 mmhos/cm. It ranges from 7 to 16 inches in thickness.

The A horizon has hue of 10YR, 2.5Y, 5Y, or neutral; value of 2 or less and 3 or 4 dry; and chroma of 1 or less. It typically is silt loam or silty clay loam, but included is loam and clay loam. Some pedons have an ABk or ABkz horizon.

The Bk horizon has hue of 2.5Y or 5Y, value of 3 to 6 and 4 to 7 dry, and chroma of less than 3. It is silt loam or silty clay loam. Salt accumulations are apparent in this horizon. Some pedons have a Bky horizon.

The C horizon commonly has hue of 2.5Y, 5Y, or 5GY; and is variegated in some pedons. It is laminated silt loam or silty clay loam. Stratified coarser or finer lake sediments or loam or clay loam glacial till are in some pedons below 40 inches. Visible salt accumulations are present in some pedons.

COMPETING SERIES: These are the Bear Lake, Colvin, Regan, and Winger series in the same family and the Bearden, Borup, Hegne, McIntosh, Perella, and Vallers series. All of these soils have electrical conductivity of less than 16 mmhos/cm. In addition, Bearden and McIntosh soils commonly have chroma of 3 or more within 30 inches of the surface. Borup soils are coarse-silty. Hegne soils are clayey. Perella soils do not have calcic horizons within 16 inches of the surface. Vallers soils are fine-loamy. Winger soils have glacial till within depths of 40 inches.

GEOGRAPHIC SETTING: Ojata soils are in level, slightly depressed flats, swales, and channels in glacial lake and outwash plains. Slope gradients are less than 1 percent. The soils formed in calcareous, silty lake sediments. The mean annual temperature ranges from 38 to 45 degrees F, and mean annual precipitation ranges from 17 to 22 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Bearden, Borup, Colvin, and Hegne soils and the Fargo, Glyndon, and Grano soils. Bearden and Glyndon soils are on slightly higher, better drained positions. Borup and Colvin soils are in nearby swales and depressions. Hegne, Fargo, and Grano soils are on nearby lake plains where the lacustrine sediments contain 35 to 60 percent clay.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is very slow. Permeability is moderately slow or slow.

USE AND VEGETATION: Soils are used for pasture and hay. Native vegetation is nuttall alkaligrass, western wheatgrass, slender wheatgrass, and inland saltgrass.

DISTRIBUTION AND EXTENT: Eastern North Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Walsh County, North Dakota, 1972.

REMARKS: Revised 3/89.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface of the soil to a depth of 8 inches (Ap horizon); calcic horizon - zone from 8 to 20 inches (Bkz horizon); characteristics associated with wetness - calcic horizon (Bkz horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION OVERLY ND+MN SD

Established Series
Rev. CJH
2/99

OVERLY SERIES

The Overly series consists of very deep, well drained or moderately well drained soils that formed in calcareous sediments. Permeability is moderately slow in the upper part and moderately slow or slow in the substratum. These soils are on glacial lake plains and terraces on valley side slopes. Slope ranges from 0 to 15 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Overly silty clay loam on a plane north-facing slope of less than 1 percent under cropland. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 5 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; neutral; abrupt smooth boundary.

A--5 to 10 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate coarse and medium angular blocky structure parting to moderate fine subangular blocky; hard, friable, sticky and slightly plastic; many roots; many fine pores; neutral; clear wavy boundary. (Combined A horizons 8 to 18 inches thick)

Bw--10 to 17 inches; dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate fine angular blocky; very hard, firm, sticky and plastic; common roots; common fine pores; faint clay films on faces of peds; segregated carbonates in a few pores and root channels in the lower part; slightly alkaline; clear wavy boundary. (6 to 22 inches thick)

Bk1--17 to 20 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; few fine faint brown (10YR 4/3) moist redox concentrations; moderate fine subangular blocky structure; hard, friable, sticky and slightly plastic; few fine roots; common fine pores; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2--20 to 28 inches; light yellowish brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; few faint yellowish brown (10YR 5/4) redox concentrations; moderate medium and very fine subangular blocky structure; hard, friable, sticky and slightly plastic; few roots; common fine pores; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk3--28 to 38 inches; light yellowish brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; few fine light gray (5Y 7/1) redox depletions and light yellowish brown (10YR 6/4) redox concentrations; moderate very fine subangular blocky structure; hard, friable, sticky and slightly plastic; few roots; few

fine pores; strong effervescence; moderately alkaline, clear wavy boundary. (Combined Bk horizons 6 to 30 inches thick)

C--38 to 60 inches; multicolored light yellowish brown (2.5Y 6/4), pale olive (5Y 6/3), gray (5Y 6/1), and yellowish brown (10YR 5/6) laminated silt loam and silty clay loam; gray (5Y 6/1) redox depletions and yellowish brown (10YR 5/6) prominent redox concentrations in the lower part; very hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Walsh County, North Dakota; about 6 miles west and 3 miles south of Minto; 300 feet east and 150 feet south of the northwest corner, sec. 18, T. 155 N., R. 53 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 16 to 40 inches in thickness and includes all or part of the Bw horizon. The 10- to 40-inch control section typically is silty clay loam and some is silt loam or clay loam. It averages between 27 and 35 percent clay. Some pedons are saline.

The A horizon has hue of 10YR, value of 3 or 4 and 2 or 3 moist, and chroma of 1. It typically is silty clay loam, but some is silt loam, clay loam, loam, or silty clay. It is neutral or slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 4. It is silty clay loam or silt loam. It is neutral or slightly alkaline. It has weak or moderate grades of prismatic, subangular or angular blocky structure.

The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is silty clay loam or silt loam. It is slightly alkaline or moderately alkaline. It has a calcium carbonate equivalent of 15 to over 30 percent. Carbonates are disseminated or in few to many, and small to large masses. Some pedons have BC or BCk horizons.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 6. It is slightly alkaline or moderately alkaline. Redox features range from few to many and faint to prominent, but they may be absent in some well drained pedons. The C horizon is laminated and commonly has textures including silty clay loam, clay loam, silt loam, or silty clay. Below depths of 40 inches in some pedons are strata of sand or clay.

COMPETING SERIES: These are the Beotia, Brookings, Tara and Waubay series. Beotia soils have 18 to 27 percent clay in the control section. Brookings and Tara soils have loam or clay loam glacial till within depths of 20 to 40 inches. Waubay soils have 20 to 27 percent clay in the control section.

GEOGRAPHIC SETTING: Overly soils are on level to gently sloping glacial lake plains and terraces on valley side slopes. Slope commonly is less than 2 percent but range from 0 to 15 percent. The soils formed in calcareous lacustrine sediments. Mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 15 to 24 inches. Most of the moisture falls in the spring and summer. Frost-free period ranges from 105 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Beotia soils and Bearden, Colvin, Fargo, Gardena, Glyndon, Great Bend, Hegne, Perella and Walsh soils. Bearden, Beotia, Colvin, Great Bend and Perella soils are in a drainage sequence with Overly soils. Beotia and Great Bend soils are well drained soils

on higher elevations. Bearden soils are on smoother, slightly lower elevations. Colvin and Perella soils are in low concave swales and shallow basins. Both soils are poorly drained. In addition, Colvin soils have calcic horizons within depths of 16 inches. Gardena, Glyndon and Walsh soils are on nearby deltas and lake plains. Glyndon soils have calcic horizons within depths of 16 inches and have coarse-silty textures. Fargo and Hegne soils are on nearby lake plains where sediments contain more clay. Both soils have fine textures.

DRAINAGE AND PERMEABILITY: Well or moderately well drained. Runoff ranges from negligible to medium depending on slope. Permeability is moderately slow in the upper part and moderately slow or slow in the substratum below 40 to 60 inches. A seasonal high water table is at a depth of 3 to 5 feet at some time during the period of April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Soils mainly are cropped to small grains, sugar beets, and hay. Native vegetation was western wheatgrass, green needlegrass, big bluestem, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, northeastern South Dakota, and northwestern Minnesota. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 17 inches (Ap, A, and Bw horizons); the Bk1 horizon has the color but not the organic matter content to be a mollic epipedon.

ADDITIONAL DATA: Laboratory data; S53NDak-9-1, S53NDak-9-2 and N.D. Agricultural Experiment Station Soils Dept. S66ND-50-1.

National Cooperative Soil Survey
U.S.A.

LOCATION PARNELL MN+ND SD

Established Series
Rev. HGF-ELB-AGG
2/97

PARNELL SERIES

The Parnell series consists of very deep, very poorly drained and poorly drained soils that formed in water-sorted sediments from glacial drift in depressions, swales and drainageways on glacial moraines. These soils have slow permeability. Slopes range from 0 to 3 percent. Mean annual precipitation is about 20 inches; and mean annual air temperature is about 41 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Vertic Argiaquolls

TYPICAL PEDON: Parnell silty clay loam with a nearly level slightly concave slope in a depression in a glacial moraine. (Colors are for moist soil unless otherwise stated.)

A1--0 to 15 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; moderate very fine and fine subangular blocky structure; friable; common roots; few fine distinct dark brown (7.5YR 3/2) and few fine prominent reddish brown (5YR 4/4) Fe concentrations; neutral; clear smooth boundary.

A2--15 to 22 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate fine and medium platy structure parting to weak very fine subangular blocky; friable; few roots; few patchy gray (10YR 6/1) coatings on faces of peds when dry; slightly acid; clear smooth boundary. (Combined thickness of the A horizons is 8 to 32 inches.)

Btg1--22 to 32 inches; black (10YR 2/1) silty clay loam, Very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few roots; many thin coatings of clean sand and silt particles on faces of peds; few faint black (10YR 2/1) clay films on faces of peds; slightly acid; gradual smooth boundary.

Btg2--32 to 55 inches; black (10YR 2/1) grading to very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to strong angular blocky; firm; many faint black (10YR 2/1) clay films on faces of peds; slightly acid in upper part grading to neutral in lower part; diffuse wavy boundary. (Combined thickness of Btg horizons is 12 to 40 inches.)

BCg--55 to 80 inches; grayish brown (2.5Y 5/2) grading to olive gray (5Y 5/2) in the lower part, silty clay loam; weak very fine angular blocky structure; firm in upper part and friable in lower part; few strata of loam and silty clay; few distinct black (10YR 2/1) and very dark gray (10YR 3/1) clay films in upper part; common fine prominent reddish brown (5YR 4/4) Fe concentrations and common fine faint dark grayish brown (2.5Y 4/2) Fe depletions; neutral in upper part becoming slightly alkaline; slight effervescence in lower part.

TYPE LOCATION: Pope County, Minnesota; about 8 miles west and 3 miles north of Starbuck; 1,320 feet north and 35 feet west of the southeast corner of sec. 10, T. 125 N., R. 40 W., USGS Lowry quadrangle, latitude 45 degrees 38 minutes 52.56 seconds N., longitude 95 degrees 33 minutes 05.03 seconds W., NAD27.

RANGE IN CHARACTERISTICS: Depth to free calcium carbonate ranges from 35 to over 80 inches. Pedons typically do not have rock fragments, but some pedons contain as much as 8 percent, by volume, in the lower part of the B horizon and in the C horizon. Stony surface phases have been recognized. Some pedons have an 0a horizon as much as 6 inches thick. The mollic epipedon ranges from 24 to 80 inches in thickness and typically includes all or part of the B horizon.

The A horizon has hue of 10YR to 5Y or is neutral, value of 2 or 3, and chroma of 0 or 1. It typically is silty clay loam but the range includes silt loam, loam and silty clay. It is slightly acid to slightly alkaline.

Some pedons have an E horizon as much as 4 inches thick.

The Btg horizon has hue of 10YR to 5Y, value of 2 to 4 and chroma of 1 or 2. It commonly is silty clay or silty clay loam but the range includes clay loam or clay. It typically averages between 40 and 45 percent clay and ranges from 35 to 60 percent and as much as 30 percent sand. B/A clay ratios are 1.2 to 1.8. The upper part of the B horizon commonly has few to many, thin or medium coatings of clean sand and silt particles on the faces of peds, but such coatings are not present in some pedons. Clay films range from few to many and faint to distinct with the greatest number being in the middle part of the Btg horizon. The clay films have value of 2 or 3. The Btg horizon is slightly acid to slightly alkaline.

Some pedons have a Bk horizon.

The BCg horizon has hue of 10YR to 5Y, value of 3 to 6 chroma of 1 or 2 or less commonly chroma of 3 or 4. It is loam, clay loam, silty clay loam, silty clay or clay. Some ped faces have patchy clay films or organic coatings. It ranges from neutral to moderately alkaline. It has secondary carbonates in some pedons.

The Cg horizon has hue of 10YR to 5Y, value of 3 to 7, chroma of 1 or 2 or less commonly chroma of 3 or 4.. It is loam, clay loam, silty clay loam, silty clay or clay. It ranges from neutral to moderately alkaline. It has secondary carbonates in some pedons.

Some pedons have a 2Cg horizon that formed in glacial till.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: The Parnell soils are in depressions, swales and drainageways on ground and end moraines. Slope gradients are 0 to 3 percent. The Parnell soils formed mostly in water-sorted sediments from glacial till. Calcareous loam or clay loam glacial till commonly underlies these sediments. Mean annual air temperature is 38 to 45 degrees F. The mean annual precipitation is 16 to 24 inches thick. Frost free days range from 120 to 160 days. Elevation above sea level ranges from 1000 to 1600 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: The Aastad, Aazdahl, Barnes, Flom, Forman, Formdale, Hamerly, Poinsett, Svea, Vallers, and Waukon soils are the main ones. These soils formed in loamy glacial till and are on higher lying or more sloping terrain or both. The Barnes, Forman, Formdale, Poinsett, and Waukon soils are well drained; the Aastad, Aazdahl and Svea soils are moderately well drained; the Hamerly soils are moderately well and somewhat poorly drained; and the Flom and Vallers soils are poorly drained.

DRAINAGE AND PERMEABILITY: Very poorly drained and poorly drained. Surface runoff is very low on the poorly drained phase and ponded on the very poorly drained phase. Permeability is slow. In most years a seasonal high water table is at a depth of 0.5 to 1.5 feet during the period November to June for the poorly drained phase and +1 to .5 during the period January to December for the very poorly drained phase.

USE AND VEGETATION: Most undrained areas are in native vegetation with some used for pasture or hayland. Drained areas are typically used to grow corn, soybeans, and small grain. Native vegetation is mostly marsh grasses, reeds, and sedges.

DISTRIBUTION AND EXTENT: Western Minnesota, northeastern South Dakota, and eastern North Dakota. Moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Reconnaissance survey of the Red River Valley of Minnesota, 1933.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 55 inches (A and Btg horizons); argillic horizon - the zone from 22 to 55 inches (Btg horizons); aquic condition based on redox features in the mollic epipedon and low chroma colors below the mollic epipedon.

The classification was changed based on the latest revisions to Soil Taxonomy. The previous classification was Typic Argiaquolls.

ADDITIONAL DATA: Refer to MAES Central File Code No. 954 for results of some laboratory analysis of the typifying pedon. Soil Interpretation Record numbers MN0035-depressional phase and MN0594.

National Cooperative Soil Survey
U.S.A.

LOCATION PERELLA ND+MN

Established Series
Rev. CJH
12/97

PERELLA SERIES

The Perella series consists of very deep, poorly drained and somewhat poorly drained soils that formed in lacustrine sediments. Permeability is moderate or moderately slow. These soils are on low flats, concave swales and shallow depressions in glacial lake plains. Slope ranges from 0 to 1 percent. Mean annual air temperature is 40 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, frigid Typic Endoaquolls

TYPICAL PEDON: Perella silty clay loam - on a level concave slope of less than 1 percent under grass. (Colors are for moist soil unless otherwise stated. Where described the soil was moist throughout.)

A1--0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate very fine angular blocky structure; very hard, very friable, sticky and slightly plastic; many roots, many pores, neutral; clear irregular boundary.

A2--9 to 14 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; few fine prominent light olive brown (2.5Y 5/6) redox concentrations; moderate very fine angular blocky structure; very hard, very friable, sticky and slightly plastic; many roots; many pores; neutral; clear wavy boundary. (Combined A horizons 7 to 24 inches thick)

Bg1--14 to 18 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; many fine prominent dark yellowish brown (10YR 4/4) and distinct olive (5Y 4/3) redox concentrations; strong fine and very fine angular blocky structure; hard, friable, sticky and plastic; common roots; many fine pores, neutral; gradual wavy boundary.

Bg2--18 to 24 inches; dark gray (5Y 4/1) silty clay loam, gray (5Y 5/1) dry; many fine prominent dark reddish brown (5YR 3/3) and many fine distinct olive (5Y 5/4) redox concentrations; moderate medium and thin platy structure; hard, friable, sticky and plastic; few roots, many fine pores; slightly alkaline; clear wavy boundary. (Combined Bg horizons 6 to 18 inches thick)

Cg1--24 to 30 inches; olive gray (5Y 5/2) silt loam, light gray (5Y 7/2) dry; many fine prominent strong brown (7.5YR 5/6) and dark reddish brown (5YR 3/4) and many large prominent dark reddish brown (5YR 2/2) redox concentrations; moderate medium and thin platy structure; hard, friable, slightly sticky and slightly plastic; few roots; common fine pores, slightly alkaline, gradual wavy boundary.

Cg2--30 to 52 inches; gray (5Y 6/1) silt loam, light gray (5Y 7/1) dry; many fine prominent strong brown (7.5YR 5/6) redox concentrations; massive; hard, friable, slightly sticky and slightly plastic; few medium pores; many small iron-manganese accumulations; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg3--52 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; many medium prominent gray (5Y 6/1) redox depletions and many fine prominent strong brown (7.5YR 5/6) redox concentrations; massive; hard, friable, sticky and plastic; few soft small iron accumulations; slight effervescence; moderately alkaline.

TYPE LOCATION: Pembina County, North Dakota; about 1/2 mile south and 2 miles west of Joliet; 1,390 feet north and 300 feet west of southeast corner, sec. 31, T. 162 N., R. 51 W.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from about 10 to 24 inches. Depth to carbonates ranges from 16 to 36 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 and 3 or 4 dry, and chroma of 1 or less. It is silt loam, silty clay, clay, silty clay loam, clay loam or loam. It is neutral or slightly alkaline.

The Bg horizon has hue of 10YR, 2.5Y, 5Y, or is neutral, value of 2 to 4 and 3 to 6 dry, and chroma of 3 or less. It has few to many distinct or prominent low or high chroma redox features. It is silt loam or silty clay loam. It has thin layers of silty clay or clay in some pedons. It typically contains about 24 to 30 percent clay but ranges from 18 to 35 percent. It is neutral or slightly alkaline. It has moderate or strong grades or medium or fine angular or subangular blocky structure. Some is weak or moderate prismatic structure parting easily to blocky or platy structure. Some pedons have a Bkg horizon below a depth of 16 inches.

The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6 and 5 to 7 dry, and chroma of 1 to 4. It has many redox features with chroma of 1 to 6. It is silt, silt loam or silty clay loam, and is massive or varved. Coarser or finer textured sediments are below depths of 40 inches in some pedons. The Cg horizon is slightly alkaline or moderately alkaline.

COMPETING SERIES: This is the Hidewood series as previously classified. Hidewood soils have fine-loamy glacial till within depths of 40 inches.

GEOGRAPHIC SETTING: Perella soils are on flats, concave swales and shallow depressions in glacial lake plains. Slope gradients are 0 to 1 percent. The soils formed in calcareous silt loam and silty clay loam lacustrine sediments. The climate is cool, subhumid. The mean annual temperature ranges from about 36 to 48 degrees F., and the mean annual precipitation from 15 to 27 inches. Frost-free period ranges from 90 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Borup, Colvin, Gardena, Glyndon and Overly soils. Bearden, Colvin and Overly soils are on slightly higher elevations in the lake plain. Bearden and Colvin soils have calcic horizons within depths of 16 inches. Overly soils do not have distinct mottling within depths of 30 inches and are moderately well drained. Borup, Gardena and Glyndon soils are on nearby lake plains and are coarse-silty.

DRAINAGE AND PERMEABILITY: Poorly or somewhat poorly drained. Runoff is negligible to ponded. Moderate or moderately slow permeability. Water runs onto these soils and ponds for a time during wet seasons. The poorly drained Perella soils commonly are too wet to cultivate unless drained. A seasonal high water table is at a depth of 0.5 foot above the surface to 1.5 feet below the

surface sometime during the period March through July on the poorly drained phase. It is at a depth of 1.0 foot to 2.5 feet sometime during the period April through June on the somewhat poorly drained phase.

USE AND VEGETATION: Soils are cropped to spring seeded small grains. Undrained areas are used for pasture or hay. Native vegetation of the poorly drained part is northern reedgrass, prairie cordgrass, slim sedge, and wooly sedge,

DISTRIBUTION AND EXTENT: Eastern North Dakota and northwestern Minnesota. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 18 inches (A1, A2, and Bg1 horizons); cambic horizon - the zone from 18 to 24 inches (Bg2 horizon); characteristics associated with wetness - chroma of 1 and distinct and prominent redox concentrations in the lower part of the mollic epipedon (Bg1 horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION PLAYMOOR SD+ND

Established Series
Rev. LDS-JMS
2/97

PLAYMOOR SERIES

The Playmoor series consists of very deep, poorly drained soils formed in alluvium on flood plains. Permeability is moderately slow. Slopes are less than 2 percent. Mean annual precipitation is about 21 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, calcareous, frigid Cumulic Endoaquolls

TYPICAL PEDON: Playmoor silty clay loam - on flood plain of Whetstone River under native grass. When described the soil was wet to 60 inches. (Colors are for moist soil unless otherwise stated.)

Az--0 to 6 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine accumulations of salt; strong effervescence; slightly alkaline; clear wavy boundary. (6 to 22 inches thick)

Bz--6 to 16 inches; very dark gray (5Y 3/1) silty clay loam, gray (N 5/0) dry; weak medium and coarse subangular blocky structure parting to weak fine and medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine accumulations of salt; common fine nests of gypsum; strong effervescence; slightly alkaline; abrupt wavy boundary. (0 to 24 inches thick)

Bkz--16 to 23 inches; black (5Y 2/1) silty clay loam, dark gray (N 4/0) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine accumulations of salt; few medium accumulations of carbonate; strong effervescence; slightly alkaline; clear wavy boundary.

Bk--23 to 38 inches; very dark gray (5Y 3/1) silty clay loam, gray (N 5/1) dry; few fine faint very dark grayish brown (10YR 3/2) redox concentrations; weak coarse subangular blocky structure; hard, friable, sticky and slightly plastic; few fine and medium accumulations of carbonate; strong effervescence; slightly alkaline; clear wavy boundary. (Combined Bk horizons are 0 to 32 inches thick.)

Cg--38 to 60 inches; gray (5Y 5/1) silty clay loam, light gray (5Y 6/1) dry; many fine distinct very dark grayish brown (10YR 3/2) and few medium distinct yellowish brown (10YR 5/6) redox concentrations; massive; hard, firm, sticky and plastic; few fine and medium accumulations of carbonate; strong effervescence; slightly alkaline.

TYPE LOCATION: Roberts County, South Dakota; about one-third mile north of Wilmot; 2212 feet east and 1760 feet north of the southwest corner of sec. 31, T. 123 N., R. 49 W.

RANGE IN CHARACTERISTICS: The 10 to 40 inch particle size control section typically is silty clay loam, but silt loam is within the range averaging between 20 and 35 percent noncarbonate clay. Some pedons have thin layers within the control section containing more than 35 percent clay. The mollic epipedon ranges from 24 to more than 60 inches in thickness. The electrical conductivity ranges from 4 to 16 mmho/cm in the upper 20 inches of the profile. Exchangeable sodium percentage ranges from about 8 to 16 percent. Reaction is slightly alkaline to strongly alkaline throughout. Buried A horizons are common. The A horizon and control section contain carbonate.

The A horizon has hue of 10YR, 2.5Y, 5Y, or neutral; value of 2 or 3 and 3 to 5 dry; and chroma of 1 or less. It is silty clay loam or silt loam. Fine accumulations of salt range from few to many in the A horizon.

The Bz horizon has hue of 10YR, 2.5Y, 5Y, or neutral; value of 2 to 4 and 3 to 7 dry; and chroma of 1 or less. It is silty clay loam or silt loam. Accumulations of salts, carbonate, and gypsum are few to many. Some pedons have a BC horizon with colors of the Bz horizon. Some pedons do not have Bz horizons.

The Bk horizon has hue of 2.5Y, 5Y, or neutral; value of 2 to 6 and 4 to 7 dry; and chroma of 0 or 1. It is silty clay loam or silt loam. Some pedons have a Bg horizon with colors of the Bk horizon.

The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 and 5 to 7 dry, and chroma of 0 to 2. Glacial till or thin strata of sand, silt or clay are below a depth of 40 inches in some pedons. Some pedons have a Cyg horizon.

COMPETING SERIES: These are the Downata, Halleck, Inkom, Lamoure, and Rauville series. Downata, Halleck, and Inkom soils do not have electrical conductivities greater than 4 in the upper 20 inches of the control section. The Lamoure and Rauville soils contain less visible salt throughout the profile and contain less than 8 percent exchangeable sodium.

GEOGRAPHIC SETTING: The Playmoor soils are on nearly level flood plains and broad flats. Slope gradients are less than 2 percent. They formed in silty and clayey alluvial sediments and have high water tables. Mean annual air temperature ranges from 36 to 48 degrees F., and mean annual precipitation from 17 to 24 inches. Growing season is about 120 to 130 days; average growing season precipitation ranges from 14 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Lamoure soils and the Dovray, Forman, LaDelle, Ludden, Peever, and Poinsett soils. The Lamoure and Ludden soils are in similar landscapes. Dovray soils are deeper to carbonate, have a fine textured series control section, and are on similar landscapes. The Forman, Peever, and Poinsett soils do not have redox features with chroma of 2 or less within depths of 40 inches and are on adjacent uplands. In addition, the Forman and Peever soils have argillic horizons. LaDelle soils are moderately well drained and do not have concentrations of salt in the upper part of the profile, and are on slightly higher positions on the landscape. Ludden soils have a fine textured series control section.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is negligible or low. Permeability is moderate or moderately slow. The water table is near the surface in the spring and at depths of 20 to 40 inches in the fall. The soils flood for short periods when streams overflow.

USE AND VEGETATION: Mostly used as pasture or hayland. Some areas are used to grow corn, small grains, and feed crops. Native vegetation is nuttall alkaligrass, switchgrass, cordgrass, foxtail barley, western wheatgrass, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota and adjacent parts of North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Marshall County, South Dakota, 1970.

REMARKS: The Playmoor soils have 15 to 20 percent calcium carbonate equivalent at depths greater than 16 inches.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 38 inches (Az, Bz, Bkz, Bk horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION RAUVILLE SD+MN ND

Established Series
Rev. PRJ-DLB-JMS
12/97

RAUVILLE SERIES

The Rauville series consists of very deep, very poorly drained soils formed in alluvium on flats and flood plains. Permeability is moderately slow in the upper part and moderately rapid in the underlying sand and gravel. Slopes are less than 2 percent. Mean annual precipitation is about 22 inches and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, calcareous, frigid Cumulic Endoaquolls

TYPICAL PEDON: Rauville silty clay loam - on a plane slope of less than 1 percent in native range. When described the soil was wet. (Colors are for moist soil unless otherwise stated.)

A1--0 to 7 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1 and dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; few fine and medium snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

A2--7 to 27 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine and medium snail shell fragments; strong effervescence; moderately alkaline; gradual smooth boundary. (Combined thickness of the A horizon is 24 to 42 inches)

Cg--27 to 45 inches; dark gray (2.5Y 4/1) silty clay loam, light gray (10YR 6/1) dry; massive; hard, friable, sticky and plastic; few fine roots; common fine and medium snail shell fragments; strong effervescence; moderately alkaline; abrupt smooth boundary. (0 to 35 inches thick)

2Cg--45 to 60 inches; light olive brown (2.5Y 5/3) stratified gravelly sand and clay loam, light yellowish brown (2.5Y 6/3) dry; common medium prominent yellowish brown (10YR 5/8) and common medium distinct greenish gray (5G 6/1) mottles; massive; very hard, firm; strong effervescence; moderately alkaline.

TYPE LOCATION: Grant County, South Dakota; about 5 miles south and 13 miles west of Marvin; 635 feet west and 90 feet south of the northeast corner of sec. 17, T. 120 N., R. 52 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 24 to more than 60 inches. The series control section typically is silty clay loam or silt loam averaging between 25 and 35 percent clay. The calcium carbonate equivalent ranges from 20 to 40 percent. From 10 to 20 percent of the calcium carbonate is clay-size carbonates. Some pedons have mottles throughout. An 0 horizon up to 6 inches thick is on some pedons.

The A horizon has a hue of 10YR, 2.5Y, 5Y or is neutral; value of 2 or 3 and 3 to 5 dry; and chroma of 2 or less. It is silty clay loam or silt loam with high organic matter content. It is slightly alkaline or moderately alkaline. Some pedons have Ak and Bkg horizons.

The Cg horizon has a hue of 10YR, 2.5Y, 5Y or is neutral; value of 2 to 6 and 5 to 8 dry; and chroma of 1 or less. Some pedons have chroma of 2 with mottles. It is silty clay loam or silt loam, but is silty clay, clay loam, or loam below a depth of 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 and 5 to 8 dry, and chroma of 1 to 4. It is stratified gravelly sand with thin layers of gravelly sandy loam, sandy loam, silt loam, loam, fine sandy loam, and clay loam. It ranges from neutral to moderately alkaline. Some pedons do not have 2C horizons.

COMPETING SERIES: These are the Downata, Halleck, Inkom, Lamoure, and Playmoor series. Downata and Halleck soils have violent effervescence at depths of 20 to 40 inches and are drier in the soil moisture control section during the 120 days following the summer solstice. In addition Downata soils have a high water table of 0 to 18 inches from January to June. Inkom soils have 18 to 27 percent clay in the particle size control section. Lamoure soils typically have mottles within depths of 40 inches and are poorly drained. Playmoor soils have many salt accumulations in the upper part of the control section.

GEOGRAPHIC SETTING: Rauville soils are on flat to nearly level low bottom lands along streams and drainageways. Slopes are less than 2 percent. They formed in calcareous, silty recent alluvium. The mean annual air temperature ranges from 38 to 48 degrees F, and mean annual precipitation ranges from 14 to 24 inches. Growing season is about 120 to 130 days; average growing season precipitation ranges from 14 to 18 inches; and growing degree days are about 2500 to 2900.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Lamoure and Playmoor soils and the similar Divide, Fordville, LaDelle, Marysland, Oldham, Parnell, Renshaw, and Spottswood soils. Lamoure, Playmoor, and Marysland soils are on slightly higher positions on bottom lands. The Divide, Fordville, Renshaw, and Spottswood soils are underlain by sand and gravel at depths less than 40 inches and are on higher adjacent landscapes. Ladelle soils have a drier soil moisture control section and are on higher position on the landscape. Marysland soils have calcic horizons within 16 inches. Oldham soils have a fine textured series control section. Parnell soils have a fine textured control section and have argillic horizons. The Oldham and Parnell are poorly drained soils in depressions.

DRAINAGE AND PERMEABILITY: Very poorly drained; surface runoff is very low; permeability is moderately slow or moderate and is moderately rapid in underlying sand and gravel. These soils have a water table that typically is at or near the surface and is within 2 feet of the surface even in periods of drought. A ponded phase is recognized in which up to 2 feet of water is on the surface.

USE AND VEGETATION: Mostly used to grow grass for pasture. Native vegetation is prairie cordgrass, reedgrass, rivergrass, sedges, and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. It is moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Rock County, Minnesota, 1945.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 27 inches (A1, A2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION RENSHAW SD+MN ND

Established Series
Rev. WJB-CJH
10/98

RENSHAW SERIES

The Renshaw series consists of very deep, somewhat excessively drained soils formed in loamy sediments and the underlying sand and gravel on outwash plains and terraces.
Permeability is moderate in the upper part and very rapid in the underlying material. Slopes range from 0 to 25 percent. Mean annual precipitation is about 22 inches and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Renshaw loam - on a plane slope of less than 1 percent in a cultivated field. When described the soil was dry throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; neutral; clear smooth boundary. (4 to 12 inches thick)

Bw--7 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few pebbles; neutral; abrupt wavy boundary. (6 to 12 inches thick)

2Bk--15 to 20 inches; vari-colored gravelly loamy sand; single grain; loose; carbonates coat the undersides of pebbles; slight effervescence; slightly alkaline; diffuse wavy boundary. (0 to 25 inches thick)

2C2--20 to 60 inches; vari-colored gravelly loamy sand; single grain; loose; strong effervescence; slightly alkaline.

TYPE LOCATION: Codington County, South Dakota; about 6 miles south and 4 miles east of Florence; 80 feet north and 255 feet east of the southwest corner of sec. 5, T. 117 N., R. 53 W.

RANGE IN CHARACTERISTICS: The depth to sand and gravel (15 to 55 percent gravel by volume) ranges from 14 to 20 inches. Thickness of the mollic epipedon ranges from 7 to 16 inches and includes all of the B horizon in most pedons.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1 or 2. It typically is loam, but is gravelly loam, sandy loam, stony loam, or very stony loam in some pedons. It ranges from moderately acid to slightly alkaline. Some pedons have an ABk horizon.

The Bw horizon has hue of 10YR or 7.5YR value of 3 to 5 and 3 or 4 moist, and chroma of 1 to 4. It typically is loam, but it is sandy loam, sandy clay loam, or gravelly loam containing less than 30 percent by volume of gravel. It typically is moderately acid to slightly alkaline, but is moderately alkaline in

the lower part of some pedons. In some pedons there is a loamy sand or sandy loam transitional horizon less than 5 inches thick between the Bw and 2C horizons. Some pedons have Bk horizons.

The 2Bk and 2C horizons have hue of 10YR or 2.5Y, value of 4 to 7, 3 to 6 moist, and chroma of 2 to 4 and are gravelly loamy sand, very gravelly loamy sand, gravelly sand, very gravelly sand, gravelly coarse sand, very gravelly coarse sand, or coarse sand. Some pedons are loamy sand below depths of 40 inches. Calcium carbonates are in the upper part as coats on the undersides of pebbles, but some pedons do not have carbonates. Reaction ranges from moderately acid to moderately alkaline.

COMPETING SERIES: This is the Brantford series. The Brantford soils contain more than 35 percent shale fragments in the lower one-third of the series control section.

GEOGRAPHIC SETTING: Renshaw soils are nearly level to moderately steep on outwash plains, glacial stream terraces, flood plains, and terrace escarpments. Slope gradients typically are less than 6 percent but range from 0 to 25 percent. Renshaw soils formed in a thin layer of loamy alluvium underlain by thick beds of sand and gravel. Mean annual temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 15 to 28 inches, most of which falls in spring and summer. Growing season is about 100 to 165 days; average growing season precipitation ranges from 15 to 28 inches; growing degree days are about 2400 to 3000. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Divide, Fordville, Sioux, and Spottswood. The Divide soils have a calcic horizon and are in the lower positions in the landscape adjacent to swales and depressions. Fordville and Spottswood soils have a mollic epipedon more than 16 inches thick. Fordville and Spottswood soils are on similar landscapes. Sioux soils have sand and gravel at depths less than 14 inches and are on steeper convex slopes.

DRAINAGE AND PERMEABILITY: Somewhat excessively drained. Runoff is negligible to low depending on slope. Permeability is moderate in the upper part and very rapid in the underlying material.

USE AND VEGETATION: When cultivated, the principal crops are small grains and alfalfa. Native grass species include needleandthread, little bluestem, blue grama, sideoats grama, green needlegrass, sedges, forbs, and shrubs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Brookings County, South Dakota, 1956.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 15 inches (Ap and Bw horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION RENSHAW SD+MN ND

Established Series
Rev. WJB-CJH
10/98

RENSHAW SERIES

The Renshaw series consists of very deep, somewhat excessively drained soils formed in loamy sediments and the underlying sand and gravel on outwash plains and terraces.
Permeability is moderate in the upper part and very rapid in the underlying material. Slopes range from 0 to 25 percent. Mean annual precipitation is about 22 inches and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Renshaw loam - on a plane slope of less than 1 percent in a cultivated field. When described the soil was dry throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; neutral; clear smooth boundary. (4 to 12 inches thick)

Bw--7 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few pebbles; neutral; abrupt wavy boundary. (6 to 12 inches thick)

2Bk--15 to 20 inches; vari-colored gravelly loamy sand; single grain; loose; carbonates coat the undersides of pebbles; slight effervescence; slightly alkaline; diffuse wavy boundary. (0 to 25 inches thick)

2C2--20 to 60 inches; vari-colored gravelly loamy sand; single grain; loose; strong effervescence; slightly alkaline.

TYPE LOCATION: Codington County, South Dakota; about 6 miles south and 4 miles east of Florence; 80 feet north and 255 feet east of the southwest corner of sec. 5, T. 117 N., R. 53 W.

RANGE IN CHARACTERISTICS: The depth to sand and gravel (15 to 55 percent gravel by volume) ranges from 14 to 20 inches. Thickness of the mollic epipedon ranges from 7 to 16 inches and includes all of the B horizon in most pedons.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1 or 2. It typically is loam, but is gravelly loam, sandy loam, stony loam, or very stony loam in some pedons. It ranges from moderately acid to slightly alkaline. Some pedons have an ABk horizon.

The Bw horizon has hue of 10YR or 7.5YR value of 3 to 5 and 3 or 4 moist, and chroma of 1 to 4. It typically is loam, but it is sandy loam, sandy clay loam, or gravelly loam containing less than 30 percent by volume of gravel. It typically is moderately acid to slightly alkaline, but is moderately alkaline in

the lower part of some pedons. In some pedons there is a loamy sand or sandy loam transitional horizon less than 5 inches thick between the Bw and 2C horizons. Some pedons have Bk horizons.

The 2Bk and 2C horizons have hue of 10YR or 2.5Y, value of 4 to 7, 3 to 6 moist, and chroma of 2 to 4 and are gravelly loamy sand, very gravelly loamy sand, gravelly sand, very gravelly sand, gravelly coarse sand, very gravelly coarse sand, or coarse sand. Some pedons are loamy sand below depths of 40 inches. Calcium carbonates are in the upper part as coats on the undersides of pebbles, but some pedons do not have carbonates. Reaction ranges from moderately acid to moderately alkaline.

COMPETING SERIES: This is the Brantford series. The Brantford soils contain more than 35 percent shale fragments in the lower one-third of the series control section.

GEOGRAPHIC SETTING: Renshaw soils are nearly level to moderately steep on outwash plains, glacial stream terraces, flood plains, and terrace escarpments. Slope gradients typically are less than 6 percent but range from 0 to 25 percent. Renshaw soils formed in a thin layer of loamy alluvium underlain by thick beds of sand and gravel. Mean annual temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 15 to 28 inches, most of which falls in spring and summer. Growing season is about 100 to 165 days; average growing season precipitation ranges from 15 to 28 inches; growing degree days are about 2400 to 3000. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Divide, Fordville, Sioux, and Spottswood. The Divide soils have a calcic horizon and are in the lower positions in the landscape adjacent to swales and depressions. Fordville and Spottswood soils have a mollic epipedon more than 16 inches thick. Fordville and Spottswood soils are on similar landscapes. Sioux soils have sand and gravel at depths less than 14 inches and are on steeper convex slopes.

DRAINAGE AND PERMEABILITY: Somewhat excessively drained. Runoff is negligible to low depending on slope. Permeability is moderate in the upper part and very rapid in the underlying material.

USE AND VEGETATION: When cultivated, the principal crops are small grains and alfalfa. Native grass species include needleandthread, little bluestem, blue grama, sideoats grama, green needlegrass, sedges, forbs, and shrubs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Brookings County, South Dakota, 1956.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of about 15 inches (Ap and Bw horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION RYAN ND+SD

Established Series
Rev. CJH
02/97

RYAN SERIES

The Ryan series consists of very deep, poorly drained, very slowly permeable soils that formed in alkaline clayey sediments. These soils are on stream terraces and glacial lake plains and have slopes of 0 to 1 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Natraquerts

TYPICAL PEDON: Ryan silty clay on a plane level slope of less than 1 percent under grass. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

E--0 to 2 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak thin platy and angular blocky structure; very hard, firm, sticky and plastic; many fine roots; moderately alkaline; abrupt smooth boundary. (0 to 3 inches thick)

Btn1--2 to 4 inches; black (10YR 2/1) silty clay, dark gray (5Y 4/1) dry; strong medium and coarse columnar structure parting to strong fine angular blocky; top of columns coated with gray (5Y 5/1) silt coatings; very hard, firm, very sticky and very plastic; common fine roots; many faint clay films on faces of peds; strongly alkaline; clear smooth boundary.

Btn2--4 to 8 inches; black (10YR 2/1) silty clay, dark gray (5Y 4/1) dry; moderate medium and coarse prismatic structure parting to strong fine angular blocky; very hard, firm, very sticky and very plastic; many fine roots; many faint clay films on faces of peds; slight effervescence; strongly alkaline; clear wavy boundary. (Combined Btn horizons 5 to 25 inches thick)

Bg1--8 to 22 inches; black (10YR 2/1) silty clay, dark gray (N 4/0) dry; very weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, firm, very sticky and very plastic; common fine roots; few carbonate masses; common fine salt crystals; strong effervescence; strongly alkaline; gradual wavy boundary.

Bg2--22 to 36 inches; black (10YR 2/1) silty clay, dark gray (N 4/0) dry; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; common fine salt crystals; few carbonate masses; strong effervescence; strongly alkaline; gradual wavy boundary. (Combined Bg horizons 0 to 35 inches thick)

Cg--36 to 60 inches; very dark gray (5Y 3/1) silty clay, gray (N 5/0) dry; massive; very hard, firm, very sticky and very plastic; common fine gypsum crystals; few fine carbonate masses; strong effervescence; strongly alkaline.

TYPE LOCATION: Dickey County, North Dakota; about 4 miles north and 2 1/4 miles west of Oakes; 1,810 feet south and 1,735 feet west of the northeast corner, sec. 36, T. 132 N., R. 60 W.

RANGE IN CHARACTERISTICS: The depth to carbonates typically is about 4 to 10 inches, but some pedons have carbonates to the surface. The mollic epipedon typically is more than 30 inches thick, but ranges from 20 to 50 inches in thickness. Where uncultivated, the combined A and E horizon thickness is less than 5 inches. The soil ranges from slightly acid in the upper part to strongly alkaline in the lower part.

Some pedons have an A horizon up to 21 inches thick. Where present, it has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or less. It is loam, silty clay, clay or silty clay loam. Some pedons have an Ap horizon up to 9 inches thick.

The E horizon has hue of 10YR, value of 2 or 3 and 4 or 5 dry, and chroma of 1. It is loam, silt loam, silty clay loam or silty clay.

The Btn horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 and 3 or 4 dry, and chroma of 1 or 2. It typically is clay or silty clay averaging 50 to 60 percent clay, but ranges from 35 to 60 percent clay. Some pedons have a Btnz, Bk or Bkz horizon.

The Bg and Cg horizons have hue of 10YR, 2.5Y, 5Y, or are neutral, value of 2 to 4 and 4 to 6 dry, and chroma of 3 or less. Where chroma is 2 or 3, the hue is either 5Y or the soil has mottles with chroma of 1 or less. It typically is silty clay or clay averaging between 45 and 60 percent clay, but some is silty clay loam. Salt crystals and carbonate accumulations are in the C horizon in most pedons. Coarser-textured sediments are in some pedons at a depth of 40 to 60 inches.

COMPETING SERIES: These are the Harriet and Ranslo series as previously classified and the Heil series. Harriet soils average 35 to 50 percent clay in the Btn horizon and formed in stratified alluvium. Ranslo soils have combined A and E horizon thickness of more than 5 inches, and are somewhat poorly drained. Heil soils are deeper than 12 inches to salts or carbonates and they are absent in the A, E and upper Btn horizons.

GEOGRAPHIC SETTING: Ryan soils are on level stream terraces and glacial lake plains with slope gradients of 0 to 1 percent. The soils formed in alkaline clayey sediments. The climate is cool, subhumid, with long cold winters and short warm summers. The mean annual air temperature ranges from 36 to 45 degrees F, and the annual precipitation from 15 to 23 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aberdeen, Enloe, Exline, Fairdale, Fargo, Hegne, Lamoure, La Prairie, Ludden and Wahpeton soils. Aberdeen and Exline soils are on nearby areas where sediments contain more silt. They are moderately well drained and somewhat poorly drained, respectively. None of the other associated soils have natric horizons. In addition, Fairdale and La Prairie soils contain less than 35 percent clay and Lamoure soils are fine-silty. Enloe, Fargo, Hegne and Ludden soils are on the same lake plain. Fairdale, La Prairie and Wahpeton soils are on better drained sites on floodplains. Lamoure soils are on similar positions on floodplains.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is medium or high. Permeability is very slow. These soils flood when streams overflow. A seasonal high water table is at a depth of 0.5 foot above the surface to 1.5 foot below the surface at some time during the period of March through July.

USE AND VEGETATION: Soils are cropped to spring seeded small grains and used for hay and pasture. Native vegetation is western wheatgrass, sedges, blue grama, inland saltgrass, Nuttall alkaligrass and salt tolerant forbs.

DISTRIBUTION AND EXTENT: Eastern North Dakota and north-central South Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Revised 3/95.

The site will be redescribed in the future to document Vertisol criteria.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 36 inches (A, Btn1, Btn2, Bg1, and Bg2 horizons); natric horizon - the zone from 2 to 8 inches (Btn1 and Btn2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION SINAI SD+MN ND

Established Series
Rev. MS-WJB
02/97

SINAI SERIES

The Sinai series consists of very deep, moderately well drained and well drained soils formed in glaciolacustrine sediments on uplands. Permeability is slow or very slow. Slopes range from 0 to 9 percent. Mean annual precipitation is about 23 inches, and mean annual air temperature is about 44 degrees F.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Hapluderts

TYPICAL PEDON: Sinai silty clay - on a nearly level slope in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 7 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, sticky and plastic; few fine roots; slightly acid; abrupt smooth boundary.

A--7 to 12 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate medium subangular blocky structure parting to moderate medium granular; very hard, firm, sticky and plastic; few fine roots; slightly acid; cracks 1/2 inch to 1 inch wide; clear smooth boundary (Combined thickness of the A horizon is 8 to 17 inches.)

Bss--12 to 23 inches; dark gray (10YR 4/1) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, very sticky and very plastic; few fine roots; surfaces of peds are shiny; tongues of very dark gray (10YR 3/1) moist, 1/8 inch to over 2 inches thick are common; few intersecting slickensides;; neutral; clear wavy boundary. (7 to 16 inches thick)

Bkss1--23 to 33 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; tongues of very dark gray (10YR 3/1) moist, 1/8 inch to over 2 inches thick; few intersecting slickensides; strong effervescence; moderately alkaline; clear wavy boundary.

Bkss2--33 to 42 inches; light gray (2.5Y 7/2), silty clay, grayish brown (2.5Y 5/2) moist; few medium prominent yellowish brown (10YR 5/6) redox concentrations moist; moderate medium prismatic structure; very hard, firm, sticky and plastic; few intersecting slickensides; common fine and medium accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary. (combined thickness of the Bk horizon is 8 to 30 inches)

C--42 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; few

coarse prominent yellowish brown (10YR 5/6) redox concentrations; massive; very hard, firm, sticky and plastic; few fine nests of gypsum; slight effervescence; moderately alkaline.

TYPE LOCATION: Day County, South Dakota; 740 feet west and 310 feet south of the northeast corner, Sec. 4, T. 124 N., R. 55 W.

RANGE IN CHARACTERISTICS: Depth to free calcium carbonate ranges from about 17 to 35 inches. Thickness of the mollic epipedon ranges from 16 to 25 inches. Tonguing of A horizon material occurs below the Ap or A horizon above depths of 35 inches. The tongues of soil material extend into the C horizons in some pedons. The particle size control section contains 45 to 60 percent clay. When the soil is dry, cracks 1/8 inch to 2 inches wide and several feet long extend downward through the solum.

The A horizon has value of 3 or 4 and 2 or 3 moist, and chroma of 1 or 2. It typically is silty clay, but is silty clay loam or clay in some pedons. It is slightly acid or neutral.

The Bss horizon has hue of 10YR or 2.5Y, value of 3 to 6 and 2 to 4 moist, and chroma of 1 to 3. It is silty clay or clay. Some pedons have mottles inherent to the parent material. Intersecting slickensides are few to common. It is neutral or slightly alkaline.

The Bkss and C horizons have hue of 10YR, 2.5Y, or 5Y; value of 4 to 7 and 3 to 6 moist and chroma of 1 to 6. It is silty clay or clay. Intersecting slickensides are few to common. The C horizon in most pedons is stratified with layers of silty clay, silty clay loam, clay loam, and silt loam. It is slightly alkaline or moderately alkaline. Most pedons have mottles inherent to the parent material in the Bk and C horizons.

COMPETING SERIES: These are the Hattie and Wahpeton series. Hattie soils contain 2 to 8 percent rock fragments in the series control section. Wahpeton soils typically have buried horizons and an irregular decrease in organic carbon.

GEOGRAPHIC SETTING: Sinai soils are nearly level to moderately sloping on uplands having plane and convex surfaces. Slope gradients typically are less than 6 percent, but range from 0 to 9 percent. They are mostly circular in shape, are typically surrounded by shallow depressions or moats, and are in high parts of the landscape. The soils formed in clayey glaciolacustrine sediments of ice-walled lakes. Mean annual air temperature ranges from 39 to 48 degrees F, and mean annual precipitation ranges from 16 to 27 inches. Growing season is about 125 to 130 days; average growing season precipitation from 13 to 22 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Barnes, Buse, Forman, Kranzburg, Nutley, Peever, Poinsett, and Tonka soils. Nutley soils are on similar landscapes and have a mollic epipedon less than 16 inches thick. Sinai soils are on slightly higher positions in the landscape than the Barnes, Forman, Kranzburg, Poinsett, and Peever soils. Buse soils are on plane to convex slopes below the Sinai soils. The Barnes, Buse, and Forman soils contain less than 35 percent clay in the control section. The Kranzburg, Poinsett, and Peever soils have a mollic epipedon less than 16 inches thick. In addition, the Kranzburg and Poinsett soils have less than 35 percent clay in the control section. The Peever soils have an argillic horizon. Tonka soils have an albic horizon and are in depressions.

DRAINAGE AND PERMEABILITY: Moderately well drained and well drained. Surface runoff is low to very high. Permeability is slow or very slow. An apparent seasonal high water table is at a depth of 3.5 to 6 feet at some time from March to June for the moderately well drained phase.

USE AND VEGETATION: Most areas are used to grow corn, small grains, and alfalfa. Native grasses include little bluestem, western wheatgrass, big bluestem, green needlegrass, and sideoats grama.

DISTRIBUTION AND EXTENT: Northeastern and east-central South Dakota and adjacent parts of North Dakota and Minnesota. It is of moderate extent.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Day County, South Dakota, 1952.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 23 inches. (Ap, A, and Bss horizons)

National Cooperative Soil Survey
U.S.A.

LOCATION SOUTHAM ND+SD

Established Series
Rev. RJB-KJL
02/97

SOUTHAM SERIES

The Southam series consists of very deep, very poorly drained, slowly permeable soils that formed in local alluvium from glacial drift. These soils are in basins and depressions on till plains, moraines and lake plains. Slope is 0 to 1 percent. Mean annual air temperature is 41 degrees F, and mean annual precipitation is 17 inches.

TAXONOMIC CLASS: Fine, smectitic, calcareous, frigid Cumulic Vertic Endoaquolls

TYPICAL PEDON: Southam silty clay loam - on a level slope in a deep depression in aquatic vegetation. When described the depth of surface water was 50 inches. (Colors are for moist soil unless otherwise stated)

Ag1--0 to 16 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; massive; firm, sticky and plastic; common fine snail shell fragments; strong effervescence; slightly alkaline; gradual wavy boundary.

Ag2--16 to 26 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; few fine prominent olive brown (2.5Y 4/4) redox concentrations; massive; firm, sticky and plastic; common fine snail shell fragments; strong effervescence; slightly alkaline; gradual wavy boundary.

Ag3--26 to 32 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; massive; very firm, very sticky and very plastic; few fine prominent olive brown (2.5Y 4/4) redox concentrations; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Ag4--32 to 40 inches; black (5Y 2/1 and 5Y 2/2) silty clay, dark gray (5Y 4/1) and olive gray (5Y 4/2) dry; massive; very firm, very sticky and very plastic; few fine prominent olive brown (2.5Y 4/4) redox concentrations; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; slight effervescence; moderately alkaline; gradual wavy boundary. (Combined thickness of the A horizon 24 to 60 inches)

Cg1--40 to 48 inches; very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) dry; massive; very firm, very sticky and very plastic; few fine prominent yellowish red (5YR 4/6) and few fine distinct olive brown (2.5Y 4/4) redox concentrations; few fine rounded manganese concretions; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2--48 to 54 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; massive; very firm, very sticky and very plastic; many fine and medium distinct olive brown (2.5Y 4/4) and few medium prominent yellowish red (5YR 4/6) redox concentrations; few medium prominent threadlike light gray (N 7/0) redox depletions; common fine snail shell fragments; common fine rounded

manganese concretions; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg3--54 to 60 inches; dark grayish brown (2.5Y 4/2) and light gray (N 7/0) silty clay, light gray (2.5Y 7/2) and white (2.5Y 8/2) dry; common medium prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) redox concentrations; few fine rounded manganese concretions; massive; very firm, very sticky and very plastic; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline.

TYPE LOCATION: Ramsey County, North Dakota; about 2 miles north of Doyon; 2,450 feet north and 1,050 feet west of the southeast corner, sec. 6, T. 153 N., R. 61 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch particle size control section averages between 35 to 50 percent clay. Depth to carbonates ranges from 0 to 10 inches. The electrical conductivity ranges from less than 2 to 8 mmhos/cc. It typically does not have coarse fragments but some pedons contain as much as 10 percent in some horizons. Some pedons have an 0 horizon as much as 6 inches thick.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3 and 3 to 5 dry, and chroma of 2 or less. It typically is silty clay loam or silty clay, but the range includes clay loam and clay. In some pedons the surface layer is silt loam. It is neutral to moderately alkaline. Some pedons have a 2A or AC horizon or both.

The C horizon has hue of 2.5Y, 5Y, 5GY or is neutral, value of 3 to 7 and 4 to 8 dry, and chroma of 2 or less. Some pedons do not have prominent mottles. It typically is silty clay, but the range includes silty clay loam, clay loam and clay. It is slightly alkaline or moderately alkaline. Some pedons have a 2C horizon.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: Southam soils are in closed basins and deep depressions on till plains, moraines and lake plains. Slope gradient is 0 to 1 percent. The soils formed in local clayey alluvium from glacial drift. Mean annual air temperature ranges from 34 to 45 degrees F, and mean annual precipitation from 12 to 23 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aastad, Barnes, Forman, Hamerly, Hamlet, Parnell, Svea and Vallers soils. These soils are all above Southam soils on the landscape. All these soils, except Parnell, formed in loam or clay loam glacial till. Barnes and Forman soils are well drained; Aastad, Hamlet and Svea soils are moderately well drained; Hamerly soils are moderately well and somewhat poorly drained; and Vallers soils are poorly drained. Parnell soils have an argillic horizon.

DRAINAGE AND PERMEABILITY: Very poorly drained. Runoff is ponded. Permeability is slow. A seasonal high water table is at a depth of 5.0 feet above the surface to 1.0 foot below the surface throughout the year. The soils are usually ponded continuously throughout the growing season. Only in some dry years is the soil surface exposed.

USE AND VEGETATION: Most areas are in native vegetation. Native vegetation is mostly bulrushes, cattails, reeds and aquatic submergents.

DISTRIBUTION AND EXTENT: Northern, eastern and central North Dakota, and possibly western Minnesota, and northeastern South Dakota. The Southam soils are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Ramsey County, North Dakota, 1984.

REMARKS: Revised 5/94.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - zone from the surface of the soil to a depth of 40 inches (Ag horizons); vertic subgroup criteria - LE of more than 6 cm in the upper 1 meter.

The soil is from the deep marsh vegetative zone of a Class IV wetland as defined by Stewart and Kantrud, 1971 in Resource Publication 92.

ADDITIONAL DATA: Bigler, R. J. Correlation of Wetland Soils and Plants, M.S. Thesis - N.D.S.U.

National Cooperative Soil Survey
U.S.A.

LOCATION SVEA ND+MN MT SD

Established Series
Rev. CJH
06/1999

SVEA SERIES

The Svea series consists of very deep, well or moderately well drained soils that formed in calcareous till and local alluvium from the till. Permeability is moderate in the solum and moderate or moderately slow in the C horizon. These soils are on concave positions on till plains and have slopes ranging from 0 to 25 percent. Mean annual air temperature is 42 degrees F, and mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Svea loam - on a concave slope of less than 2 percent under cropland. When described, the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 7 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; neutral; abrupt smooth boundary.

A--7 to 10 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine pores; neutral; clear wavy boundary. (Combined A horizons 7 to 20 inches thick)

Bw--10 to 21 inches; dark grayish brown (2.5Y 4/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; faint patches of clay films on vertical faces of peds; common fine roots; common fine pores; neutral; clear wavy boundary. (4 to 24 inches thick)

Bk--21 to 36 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; few medium masses of carbonates; strong effervescence; moderately alkaline; gradual wavy boundary. (7 to 26 inches thick)

C--36 to 60 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; few fine distinct yellowish red (5YR 4/6) redoximorphic concentrations and few fine faint gray (5Y 5/1) redoximorphic depletions increasing to common coarse distinct redoximorphic depletions at a depth of about 42 inches; massive, breaks with slight pressure into weak subangular blocky and platy fragments characteristic of till; hard, friable, slightly sticky and slightly plastic; few masses of carbonates; slight effervescence; moderately alkaline.

TYPE LOCATION: LaMoure County, North Dakota; about 6 miles east and 15 miles north of LaMoure; 500 feet north and 10 feet east of the southwest corner, sec. 19, T. 136 N., R. 59 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section averages between 18 and 28 percent clay and 14 to 45 percent fine sand or coarser. It typically contains 1 to 10 percent by volume of rock fragments throughout. The mollic epipedon ranges from 16 to more than 30 inches in thickness and may include part or all of the Bw horizon. Stony phases are recognized.

The A horizon has hue of 10YR, 2.5Y or neutral, value of 3 to 5 and 2 or 3 moist, and chroma of 1 or less. It is loam, silt loam or clay loam. It is slightly acid to slightly alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 2 to 4 moist, and chroma of 1 to 4. It typically is loam, but some is silt loam or clay loam. It is slightly acid to slightly alkaline. It has weak or moderate grades of prismatic or blocky structure. The lower part of the Bw horizon contains a few mottles in some pedons.

The Bk horizon has hue of 2.5Y, less commonly 10YR or 5Y, value of 5 to 8 and 4 to 6 moist, and chroma of 1 to 4. It is loam or clay loam. It is slightly alkaline or moderately alkaline. It contains 15 to 25 percent calcium carbonate. The carbonates are disseminated through the Bk horizon and segregated into few to common threads and masses. Some pedons have BC or BCk horizons.

The C horizon has hue of 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is loam or clay loam. It is slightly alkaline or moderately alkaline. It is friable or firm till. Some pedons contain a thin stone or pebble band or thin lenses of sandy, silty, or loamy material at the boundary of the solum and the C horizon.

COMPETING SERIES: These are the Aastad, Delette, Lankin, Lismore and Walsh series. Aastad soils have Bw horizons containing 28 to 35 percent clay. Delette soils are more acid, do not have carbonates in the solum and have a thicker mollic epipedon. Lankin and Lismore soils do not have rock fragments in the upper part. They formed in lacustrine sediments over till. Walsh soils do not have Bk horizons and have coarse fragments that are primarily shale.

GEOGRAPHIC SETTING: Svea soils are on level to moderately steep and slightly concave positions on till plains. Slope gradients commonly are less than 3 percent but range from 0 to 25 percent. The soils formed in calcareous till and local alluvium from the till. The climate is cool subhumid. Mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation from 15 to 24 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Barnes, Buse, Hamerly, Hamlet, Langhei, Parnell, Quam and Tonka soils. Barnes soils are on convex and plane, well drained nearby areas and Hamlet soils are on nearby similar positions as Svea. They have mollic epipedons less than 16 inches thick. Buse and Langhei soils are on convex crests of steeper hills. They do not have cambic horizons. Hamerly soils are on slightly convex and smooth lower slopes on nearby areas surrounding depressions. They have calcic horizons within depths of 16 inches. Parnell, Quam and Tonka soils are in poor and very poorly drained depressions. They have an aquic moisture regime. In addition, Parnell and Tonka soils are fine and Quam soils are fine-silty.

DRAINAGE AND PERMEABILITY: Well or moderately well drained. Svea soils receive some runoff from higher parts of the landscape. Runoff is negligible to high depending on slope. Permeability is moderate in the solum and moderate or moderately slow in the C horizon. A seasonal high water table is at depths of 3 to 5 feet at some time during the period of April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Soils are cropped to small grains, flax, some row crops, hay, and pasture. Native vegetation was big bluestem, green needlegrass, western wheatgrass, bearded wheatgrass, and a variety of forbs.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, northeastern South Dakota, and western Minnesota. The soils are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Sargent County, North Dakota, 1960.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 21 inches (Ap, A, and Bw horizons).

ADDITIONAL DATA: S53NDak-2-2, S53NDak-2-3, SU70NDak-2-3, and SU65NDak-37-4.

National Cooperative Soil Survey
U.S.A.

LOCATION SWENODA SD+MN ND

Established Series
KFM-CJH
03/2000

SWENODA SERIES

The Swenoda series consists of very deep, well drained and moderately well drained soils formed in loamy sediments underlain by silty and loamy sediments on uplands. Permeability is moderately rapid in the upper part and moderate or moderately slow in the underlying material. Slopes range from 0 to 9 percent. Mean annual precipitation is about 21 inches, and mean annual temperature is about 42 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Swenoda fine sandy loam - in cultivation. (Colors are for moist soil unless otherwise stated)

Ap--0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak coarse granular structure; slightly hard and very friable; slightly sticky and slightly plastic; many very fine and fine roots; neutral; clear smooth boundary.

A--9 to 13 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; many very fine and fine roots; neutral; clear wavy boundary. (Combined A horizons 8 to 18 inches thick)

Bw1--13 to 19 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine and fine roots; slightly alkaline; clear wavy boundary.

Bw2--19 to 29 inches; dark yellowish brown (10YR 4/4) fine sandy loam, light yellowish brown (10YR 6/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; few very fine and fine roots; slightly alkaline; gradual wavy boundary.

Bw3--29 to 33 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine and fine roots; about 2 percent gravel; slightly alkaline; clear wavy boundary. (Combined Bw horizons 4 to 26 inches thick)

2Bk--33 to 39 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; common fine prominent yellowish brown (10YR 5/4) redoximorphic concentrations; weak coarse subangular blocky structure; soft and friable; slightly sticky and slightly plastic; about 4 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary. (0 to 35 inches thick)

2C--39 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct light brownish gray (2.5Y 6/2) redoximorphic depletions and light olive brown (2.5Y 5/6) redoximorphic concentrations; massive; slightly hard and friable; slightly sticky and slightly plastic; about 4 percent gravel; slight effervescence; moderately alkaline.

TYPE LOCATION: Griggs County, North Dakota; 135 feet west and 1,750 feet south of the northeast corner of sec. 34, T. 147 N., R. 58 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon is greater than 16 inches. The depth to silty or loamy sediments typically is about 30 inches and ranges between 20 and 40 inches. The depth to carbonates typically is about 30 inches and ranges between 16 and 40 inches. A thin stone line is at the upper boundary of the 2Bk or 2C horizon in some pedons.

The A horizon has hue of 10YR, value of 2 or 3 and 2 to 4 dry, and chroma of 1. Chroma of 2 is allowed if it is below 7 inches or if the horizon is dry. It typically is fine sandy loam or sandy loam, but is loam or loamy fine sand in some pedons. It is slightly acid or neutral.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 and 3 to 6 dry, and chroma of 1 to 4. Few to common, faint to distinct redoximorphic features are in lower parts of some pedons. The Bw horizon is fine sandy loam or sandy loam. Some pedons have thin horizons of loamy sand or loamy fine sand in the B or C horizon, but the average texture of the material between depths of 10 inches and the upper boundary of the 2C horizon is fine sandy loam or sandy loam. The Bw horizon is neutral or slightly alkaline. Some pedons have 2Bw, Bk or C horizons.

The 2Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6 and 6 to 8 dry, and chroma of 2 to 6. It is silt loam or silty clay loam, or loam or clay loam till. It is slightly alkaline or moderately alkaline.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 and 6 to 8 dry, and chroma of 2 to 6. It is silt loam or silty clay loam, or loam or clay loam till. It is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Clontarf, Embden, Emrick, Flathead and Inkster None of these soils have a discontinuity of finer textured materials within 40 inches. In addition, Inkster soils have sand-sized fraction dominated by shale fragments.

GEOGRAPHIC SETTING: The Swenoda soils are nearly level to moderately sloping on uplands. The slopes are plain or convex. Slope gradients typically are less than 4 percent but range from 0 to 9 percent. The soil formed in loamy sediments overlying laminated lacustrine silt to clay or loam or clay loam till. Mean annual air temperature ranges from 36 to 48 degrees F, and mean annual precipitation ranges from 16 to 24 inches. Growing season is 120 to 130 days; average growing season precipitation ranges from 15 to 18 inches; and growing degree days are about 2500 to 3000.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Clontarf and Embden soils and the Beotia, Hamar, Hecla, Malachy, Towner, Ulen and Wyndmere soils. Beotia soils are fine-silty and are on slightly higher positions. Clontarf, Malachy and Towner soils are on similar landscapes. Malachy soils are calcareous within depths of 10 inches and do not have a discontinuity of finer textured materials within 40 inches. Towner soils have sandy particle-size in the upper control section and have contrasting textures. Embden, Ulen and

Wyndmere soils are on slightly lower concave positions. The Ulen and Wyndmere soils have a calcic horizon within depths of 16 inches and have a wetter soil moisture control section. Hecla and Hamar soils are on broad flats and swales. Hamar and Hecla soils have a sandy particle-size control section and have wetter soil moisture control sections.

DRAINAGE AND PERMEABILITY: Moderately well drained or well drained. Surface runoff is low to medium. Permeability is moderately rapid in the upper part and moderate or moderately slow in the finer textured underlying material. The moderately well drained phase has a seasonal high water table at depths of 3 to 5 feet at some time during the period of April through June.

USE AND VEGETATION: When cultivated the principal crops are corn, alfalfa, small grains and tame pasture. Native grasses include big bluestem, prairie sandreed, little bluestem, needlegrass, western wheatgrass, sideoats grama, needleandthread, bluegrama, sedges and forbs.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Marshall County, South Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 19 inches (Ap, A and Bw1 horizons); cambic horizon - the zone from 19 to 33 inches (Bw1 and Bw2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION TIFFANY ND+SD

Established Series
Rev. CJH
03/97

TIFFANY SERIES

The Tiffany series consists of very deep, somewhat poorly and poorly drained, moderately or moderately rapidly permeable soils that formed in glacial outwash. These soils are in depressions, basins and concave positions in glaciolacustrine deltas and outwash plains. Slope ranges from 0 to 1 percent. Mean annual temperature is 39 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Typic Endoaquolls

TYPICAL PEDON: Tiffany fine sandy loam - cultivated. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist to 48 inches and saturated below 48 inches.)

Ap--0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; many very fine roots; many fine pores; slightly acid; abrupt smooth boundary.

A--10 to 15 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; many fine distinct dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common medium pores; neutral; clear wavy boundary. (Combined A horizons 10 to 24 inches thick)

AC--15 to 23 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; many medium prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; common fine pores; few fine black iron-manganese concretions; neutral; clear wavy boundary. (0 to 18 inches thick)

C1--23 to 36 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/3) dry; many medium prominent strong brown (7.5YR 5/6) and few fine distinct dark gray (10YR 4/1) mottles; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; common fine pores; few fine black iron-manganese concretions; slight effervescence in lower part; slightly alkaline; clear wavy boundary.

C2--36 to 60 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) stratified fine sandy loam, loamy fine sand, and loamy very fine sand, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; many fine and medium prominent strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), very dark brown (10YR 2/2), and olive gray (5Y 5/2) mottles; massive; slightly hard, very friable; nonsticky and nonplastic; few fine iron-manganese concretions; slight effervescence; slightly alkaline.

TYPE LOCATION: Grand Forks County, North Dakota; about 2 miles west and 2 miles south of Arvilla; 550 feet south and 330 feet east of the northwest corner, sec. 23, T. 151 N., R. 54 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 10 to 24 inches. The 10- to 40-inch particle size control section averages fine sandy loam to silt loam with less than 18% clay. Depth to carbonates commonly ranges from 20 to 50 inches, but is more than 60 inches in some pedons.

The A horizon has hue of 10YR or is neutral, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or less. Hue of 2.5Y and chroma of 2 is allowed in the lower part. The A horizon is fine sandy loam, sandy loam, loam, very fine sandy loam or silt loam. It is slightly acid to slightly alkaline. It typically is mottled in the lower part.

The AC horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. It is mottled and mottles increase in number and distinctness with depth. It is neutral or slightly alkaline. Some pedons have a Bw or Bk horizon.

The C horizon has a wide variety of colors due to mottling and is often stratified. It is neutral or slightly alkaline. Loamy, silty and clayey substratum phases are recognized (see REMARKS). Permeability is moderate or moderately slow in these phases.

COMPETING SERIES: These are the Adolph, Forada, Nokasippi, Parent, Prebish and Runeberg series as previously classified. Adolph soils have 2B and 2C horizons of glacial till at a depth of less than 35 inches. Forado soils have sand and gravel 2C horizons at a depth of less than 40 inches. Nokasippi soils have a sandy mantle over the till and are not as gray in their B and C horizons. Parent, Prebish and Runeburg soils have formed in glacial till and contain coarse fragments.

GEOGRAPHIC SETTING: Tiffany soils are in depressions, basins and concave positions in glaciolacustrine deltas and outwash plains. Slope ranges from 0 to 1 percent. The soils formed in glacial outwash composed mostly of fine and very fine sands. The climate is cool subhumid. Mean annual temperature ranges from 36 to 45 degrees F, and mean annual precipitation from 15 to 23 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Embden, Gardena, Glyndon, Hecla and Wyndmere soils. Embden, Gardena, and Hecla soils are on higher topographic positions and do not have the mottling in the A horizons. Glyndon and Wyndmere soils are on nearby swales and low flats and have calcic horizons within depths of 16 inches.

DRAINAGE AND PERMEABILITY: Somewhat poorly and poorly drained. Very slow runoff. Moderate or moderately rapid permeability. A seasonal high water table is at a depth of 0.5 foot above the surface to 1.5 feet below the surface at some time during the period of March through July for the poorly drained phase. It is at a depth of 1.0 foot to 2.5 feet at some time during the period of April through June for the somewhat poorly drained phase.

USE AND VEGETATION: Mostly used for growing hay and pasture. Some drained areas are used for growing small grains. Natural vegetation is typically tall grasses as big bluestem, prairie cordgrass and sedges. Sedges and rushes dominant on the wetter sites.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota, and possibly northwestern Minnesota and northeastern South Dakota. The soil is moderately extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Cass County, North Dakota, 1961.

REMARKS: Revised 2/94.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 15 inches (Ap and A horizons); characteristic associated with wetness - chroma of 1 and distinct mottles in the lower part of the mollic epipedon (A horizon).

Series will be established, as time permits and as needed, for the loamy, silty and clayey substratum phases. These new series will be Typic Epiaquolls.

National Cooperative Soil Survey
U.S.A.

LOCATION TOTTEN ND

Established Series
Rev. MDS-CJH
3/98

TOTTEN SERIES

The Totten series consists of very deep, poorly drained soils that formed in loamy material overlying stratified sand and sand and gravel glacial alluvium. Permeability is moderately slow or slow in the solum and rapid in the substratum. These soils are on slightly depressed areas on outwash plains and channels and have slopes less than 2 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is l7 inches.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Typic Natraquolls

TYPICAL PEDON: Totten loam on a southwest-facing plane slope of less than l percent in a cultivated field. When described the soil was moist to l7 inches, dry from l7 to 26 inches, and moist from 26 to 60 inches. (Colors are for moist soil unless otherwise stated)

Ap--0 to 5 inches; black (l0YR 2/l) loam, very dark gray (l0YR 3/l) dry; moderate fine angular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky, slightly plastic; many fine roots and pores; a few fine pebbles; strong effervescence; moderately alkaline; abrupt smooth boundary. (4 to l2 inches thick)

Btn1--5 to l0 inches; very dark gray (l0YR 3/l) sandy clay loam, dark gray (l0YR 4/l) dry; interior of prisms are light brownish gray (2.5Y 6/2) and white (N 8/0) dry; moderate very coarse prismatic structure parting to strong fine and very fine angular blocky; hard, friable, sticky and plastic; common roots; clean sand grains coat faces of prisms; violent effervescence ped interiors; strong effervescence ped exteriors; moderately alkaline; clear irregular boundary.

Btn2--l0 to l7 inches; light olive brown (2.5Y 5/4) sandy clay loam, light gray (2.5Y 7/2) dry; many fine and medium distinct gray (5Y 6/l) redoximorphic depletions and yellowish brown (l0YR 5/6) redoximorphic concentrations; very dark gray (l0YR 3/l) coatings on faces of prisms; moderate very coarse prismatic structure parting to moderate fine and very fine angular blocky; hard, friable, slightly sticky, slightly plastic; few roots; common fine pores; diffuse carbonates in interior of peds; violent effervescence; moderately alkaline; gradual wavy boundary. (Combined Btn horizons 4 to l9 inches thick)

Bk--l7 to 26 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/l) dry; patches of dark grayish brown (2.5Y 4/2) on faces of prisms; many fine and medium prominent yellowish brown (l0YR 5/6) and few fine prominent black (10YR 2/1) redoximorphic concentrations and medium distinct gray (5Y 6/l) redoximorphic depletions; moderate very coarse prismatic structure parting to moderate coarse and medium platy and moderate and strong fine and very fine angular blocky; hard, friable, slightly sticky, slightly plastic; few roots; slight effervescence, strong effervescence in interiors of peds; moderately alkaline; clear irregular boundary. (0 to 9 inches thick)

2Cl--26 to 34 inches; light olive brown (2.5Y 5/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; common distinct light gray (5Y 7/2) dry redoximorphic depletions and few fine prominent black (10YR 2/1) redoximorphic concentrations; single grain; slightly hard, loose, nonsticky; slight effervescence; moderately alkaline; clear wavy boundary.

2C2--34 to 40 inches; dark yellowish brown (l0YR 4/4) gravelly coarse sand, light yellowish brown (l0YR 6/4) dry; single grain; loose; 25 percent by volume of fragments coarser than 2 mm; slight effervescence; moderately alkaline; clear wavy boundary.

2C3--40 to 60 inches; olive brown (2.5Y 4/4) and brown (l0YR 5/3) stratified coarse sand and very gravelly coarse sand, light olive brown (2.5Y 5/4) and light yellowish brown (l0YR 6/4) dry; single grained; loose; l0 to over 60 percent by volume of fragments coarser than 2 mm in some strata; strong effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 4 miles north and 4 l/2 miles east of New Rockford; 2,550 feet east and l80 feet south northwest corner, sec. 7, T. l49 N., R. 65 W.

RANGE IN CHARACTERISTICS: The depth to coarse sand typically is 22 to 30 inches but ranges from l4 to 40 inches. Typically the A and Bt horizons contain a few pebbles.

The A horizon has hue of l0YR, 2.5Y or 5Y, value of 2 or 3 and 3 or 4 dry, and chroma of l. It typically is loam, but some is silt loam or sandy loam. It contains some salts and ranges from slight to strong effervescence.

The Btn horizon has hue of l0YR, 2.5Y or 5Y, value of 3 to 6 and 4 to 8 dry, and chroma of l to 4 when mixed. Distinct or prominent mottles with hue of 5Y, 2.5Y, or l0YR and chroma of l to 6 are in the interior of the prisms in most pedons. The Btn horizon typically is sandy clay loam but some is loam or clay loam.

The Bk horizon has hue of 5Y or 2.5Y, value of 3 to 6 and 4 to 7 dry, and chroma of l to 3. It is loam, clay loam, or sandy loam. The lower boundary of the Bt or Bk horizon commonly is very irregular or tongues into the 2C horizon.

The 2C horizon has hue of 2.5Y, 5Y or l0YR, value of 4 to 6, and 5 to 8 dry, and chroma of l to 4. The 2C horizon typically is coarse sand containing l0 to 40 percent by volume of fine gravel, but some are stratified and contain layers of coarse and medium sand and gravel. Some pedons contain sand and gravel composed of shale channers. Glacial till is within depths of 40 to 60 inches in some pedons.

COMPETING SERIES: There are no other series in this family. Related series are the Airport, Durrstein, Fiander, Harriet, Heil, Manfred, Ryan, and Stirum series. Airport, Durrstein, and Fiander soils have mesic temperatures. Harriet and Manfred soils do not have sand and gravel 2C horizons within depths of 40 inches and contain less sand in the sola. Heil and Ryan soils are fine. Stirum soils are coarse-loamy.

GEOGRAPHIC SETTING: Totten soils are on nearly level, slightly depressed areas on outwash plains, and channels. Slope gradients are less than 2 percent. The soils formed in loamy material overlying stratified sand and sand and gravel glacial alluvium. The climate is cool, subhumid. Mean annual air temperature

ranges from 38 to 45 degrees F, and mean annual precipitation from l6 to 20 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Stirum soils and the Arveson, Arvilla, Binford, Borup, Brantford, Divide, Kensal, Marysland, Osakis, Walum, and Warsing soils. Stirum soils are on similar positions. Arveson, Borup, Divide, and Marysland soils do not have Bt horizons and have calcic horizons within depths of l6 inches. Arvilla, Binford, Brantford, Kensal, Osakis, Walum and Warsing soils are on nearby outwash plains on higher topographic positions. They are moderately well to somewhat excessively drained and none have Bt horizons.

DRAINAGE AND PERMEABILITY: Poorly drained. A few areas are very poorly drained. Surface runoff is slow. Permeability is moderately slow or slow in the solum and rapid in the substratum. The water table is at depths of less than 24 inches in the spring and during periods of above average precipitation.

USE AND VEGETATION: Soils are used for hay and pasture; some are cropped to hay and small grains. Native vegetation is western wheatgrass, inland salt-grass, wetland sedges, rushes, forbs and annuals.

DISTRIBUTION AND EXTENT: East-central North Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County and parts of Benson and Nelson Counties, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 10 inches (Ap and Btn1 horizons); natric horizon - the zone from 5 to 17 inches (Btn1 and Btn2 horizons) characteristicts associated with wetness - chroma of 1 in the lower part of the mollic epipedon, and immediately below the mollic epipedon hue of 2.5Y, value of 5 and chroma of 1 on ped surfaces and distinct redoximorphic features.

National Cooperative Soil Survey
U.S.A.

LOCATION TOWNER ND+MN SD

Established Series
CJH
1/99

TOWNER SERIES

The Towner series consists of very deep, well or moderately well drained soils that formed in wind and water deposited sands over glacial till or lacustrine sediments. Permeability is rapid or moderately rapid in the upper part and moderate or moderately slow in the 2Bk and 2C horizons. These soils are on sand-mantled till or glaciolacustrine plains and have slopes ranging from 0 to 15 percent. Mean annual air temperature is 39 degrees F and mean annual precipitation is 16 inches.

TAXONOMIC CLASS: Sandy over loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Towner loamy fine sand on a concave south-facing slope of 2 percent under grassland. When described the soil was moist to 20 inches and dry below 20 inches. (Colors are for moist soil unless otherwise stated)

A1--0 to 6 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; many fine roots; neutral; clear wavy boundary.

A2--6 to 20 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very coarse prismatic structure parting to weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; slightly alkaline; clear wavy boundary. (Combined A horizons 8 to 35 inches thick)

Bw--20 to 29 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; slightly alkaline; abrupt wavy boundary. (0 to 26 inches thick)

2Bk--29 to 36 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary. (6 to 25 inches thick)

2C--36 to 60 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Pierce County, North Dakota; about 1 mile west and 1 mile north of Orrin; 552 feet west and 530 feet south of the northeast corner, sec. 5, T. 153 N., R. 74 W.

RANGE IN CHARACTERISTICS: Depth to the loamy material commonly is 24 to 36 inches but ranges from 20 to 40 inches. The mollic epipedon ranges from 16 to 30 inches thick.

The A horizon has 10YR hue, value of 2 or 3 and 3 or 4 dry, and chroma of 1. It is loamy sand, loamy fine sand, sandy loam or fine sandy loam. The lower A horizon below depths of about 19 inches has 10YR or 2.5Y hue, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2. It is loamy sand, loamy fine sand or fine sand. The A horizon is neutral or slightly alkaline.

The Bw horizon has 10YR or 2.5Y hue, value of 3 to 5 and 4 to 6 dry, and chroma of 1 to 4. It is loamy sand, loamy fine sand or fine sand. It is neutral or slightly alkaline. Some pedons have a 2Bw horizon. A stony or gravelly layer is at the contact between the sandy mantle and the 2Bk horizon in some pedons.

The 2Bk horizon has hue of 2.5Y, value of 4 to 6 and 6 to 8 dry, and chroma of 2 to 4. It is loam, clay loam, silty clay loam or silt loam. Some pedons have a BCk horizon.

The 2C horizon has 10YR, 2.5Y, or 5Y hue, value of 4 to 6, and 6 to 8 dry, and chroma of 2 to 4. It typically is loam or clay loam glacial till containing up to 19 percent coarse fragments, but some is silt loam or silty clay loam lacustrine sediments. In addition, some pedons contain pockets or layers of sandy or clayey materials in some pedons. The 2C horizon is slightly alkaline or moderately alkaline. Some pedons have a C horizon above the 2C horizon.

COMPETING SERIES: These are the Dickey series. Dickey soils have a mollic epipedon less than 16 inches thick.

GEOGRAPHIC SETTING: Towner soils are on level to rolling sand-mantled till or glaciolacustrine plains. Slopes are smooth or concave and range from 0 to 15 percent. The soils formed in wind and water deposited sands over glacial till or lacustrine sediments. The climate is cool, subhumid, with a mean annual air temperature ranging from 36 to 48 degrees F, and a mean annual precipitation ranging from 15 to 24 inches. Most of the precipitation falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Dickey soils and the Egeland, Embden, Grimstad, Hecla, Maddock, Serden, Swenoda and Ulen soils. Dickey and Maddock soils commonly are on nearby more sloping, higher lying areas. Maddock soils are sandy. Egeland and Serden are on nearby glaciolacustrine and outwash plains. Egeland soils are coarse-loamy and Serden soils are sandy and do not have a mollic epipedon. Embden, Grimstad, Hecla, Swenoda, and Ulen soils are on nearby deltas and lake plains. Embden soils are coarse-loamy and pachic. Grimstad and Ulen soils have a calcic horizon within depths of 16 inches. Hecla soils have mottles with chromas of 2 or less within 40 inches of the surface. Swenoda soils are coarse-loamy and pachic.

DRAINAGE AND PERMEABILITY: Well and moderately well drained. Runoff is negligible to low depending on slope and surface texture. Rapid or moderately rapid permeability in the upper part and moderate or moderately slow in the 2Bk and 2C horizons. A perched seasonal high water table is above the 2Bk or 2C horizon at a depth of 3 to 5 feet at some time during the period of April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Used mainly for growing small grains, corn, hay and pasture. Native vegetation is prairie sandreed, needleandthread, Kentucky bluegrass, and other grasses and grass-likes.

DISTRIBUTION AND EXTENT: Eastern and central North Dakota, northwestern Minnesota and northeastern South Dakota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 29 inches (A1, A2 and Bw horizons); calcic horizon - the zone from 29 to 36 inches (2Bk horizon).

ADDITIONAL DATA: Laboratory samples S50ND-5-5, S50ND-25-5, S51ND-5-19 and ND-54-P-8.

National Cooperative Soil Survey
U.S.A.

LOCATION TOWNER ND+MN SD

Established Series
CJH
1/99

TOWNER SERIES

The Towner series consists of very deep, well or moderately well drained soils that formed in wind and water deposited sands over glacial till or lacustrine sediments. Permeability is rapid or moderately rapid in the upper part and moderate or moderately slow in the 2Bk and 2C horizons. These soils are on sand-mantled till or glaciolacustrine plains and have slopes ranging from 0 to 15 percent. Mean annual air temperature is 39 degrees F and mean annual precipitation is 16 inches.

TAXONOMIC CLASS: Sandy over loamy, mixed, superactive, frigid Calcic Hapludolls

TYPICAL PEDON: Towner loamy fine sand on a concave south-facing slope of 2 percent under grassland. When described the soil was moist to 20 inches and dry below 20 inches. (Colors are for moist soil unless otherwise stated)

A1--0 to 6 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; many fine roots; neutral; clear wavy boundary.

A2--6 to 20 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very coarse prismatic structure parting to weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; slightly alkaline; clear wavy boundary. (Combined A horizons 8 to 35 inches thick)

Bw--20 to 29 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; slightly alkaline; abrupt wavy boundary. (0 to 26 inches thick)

2Bk--29 to 36 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary. (6 to 25 inches thick)

2C--36 to 60 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

TYPE LOCATION: Pierce County, North Dakota; about 1 mile west and 1 mile north of Orrin; 552 feet west and 530 feet south of the northeast corner, sec. 5, T. 153 N., R. 74 W.

RANGE IN CHARACTERISTICS: Depth to the loamy material commonly is 24 to 36 inches but ranges from 20 to 40 inches. The mollic epipedon ranges from 16 to 30 inches thick.

The A horizon has 10YR hue, value of 2 or 3 and 3 or 4 dry, and chroma of 1. It is loamy sand, loamy fine sand, sandy loam or fine sandy loam. The lower A horizon below depths of about 19 inches has 10YR or 2.5Y hue, value of 2 to 4 and 3 to 6 dry, and chroma of 1 or 2. It is loamy sand, loamy fine sand or fine sand. The A horizon is neutral or slightly alkaline.

The Bw horizon has 10YR or 2.5Y hue, value of 3 to 5 and 4 to 6 dry, and chroma of 1 to 4. It is loamy sand, loamy fine sand or fine sand. It is neutral or slightly alkaline. Some pedons have a 2Bw horizon. A stony or gravelly layer is at the contact between the sandy mantle and the 2Bk horizon in some pedons.

The 2Bk horizon has hue of 2.5Y, value of 4 to 6 and 6 to 8 dry, and chroma of 2 to 4. It is loam, clay loam, silty clay loam or silt loam. Some pedons have a BCk horizon.

The 2C horizon has 10YR, 2.5Y, or 5Y hue, value of 4 to 6, and 6 to 8 dry, and chroma of 2 to 4. It typically is loam or clay loam glacial till containing up to 19 percent coarse fragments, but some is silt loam or silty clay loam lacustrine sediments. In addition, some pedons contain pockets or layers of sandy or clayey materials in some pedons. The 2C horizon is slightly alkaline or moderately alkaline. Some pedons have a C horizon above the 2C horizon.

COMPETING SERIES: These are the Dickey series. Dickey soils have a mollic epipedon less than 16 inches thick.

GEOGRAPHIC SETTING: Towner soils are on level to rolling sand-mantled till or glaciolacustrine plains. Slopes are smooth or concave and range from 0 to 15 percent. The soils formed in wind and water deposited sands over glacial till or lacustrine sediments. The climate is cool, subhumid, with a mean annual air temperature ranging from 36 to 48 degrees F, and a mean annual precipitation ranging from 15 to 24 inches. Most of the precipitation falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Dickey soils and the Egeland, Embden, Grimstad, Hecla, Maddock, Serden, Swenoda and Ulen soils. Dickey and Maddock soils commonly are on nearby more sloping, higher lying areas. Maddock soils are sandy. Egeland and Serden are on nearby glaciolacustrine and outwash plains. Egeland soils are coarse-loamy and Serden soils are sandy and do not have a mollic epipedon. Embden, Grimstad, Hecla, Swenoda, and Ulen soils are on nearby deltas and lake plains. Embden soils are coarse-loamy and pachic. Grimstad and Ulen soils have a calcic horizon within depths of 16 inches. Hecla soils have mottles with chromas of 2 or less within 40 inches of the surface. Swenoda soils are coarse-loamy and pachic.

DRAINAGE AND PERMEABILITY: Well and moderately well drained. Runoff is negligible to low depending on slope and surface texture. Rapid or moderately rapid permeability in the upper part and moderate or moderately slow in the 2Bk and 2C horizons. A perched seasonal high water table is above the 2Bk or 2C horizon at a depth of 3 to 5 feet at some time during the period of April through June in the moderately well drained phase. It is at a depth of 4 to more than 6 feet for the same period in the well drained phase.

USE AND VEGETATION: Used mainly for growing small grains, corn, hay and pasture. Native vegetation is prairie sandreed, needleandthread, Kentucky bluegrass, and other grasses and grass-likes.

DISTRIBUTION AND EXTENT: Eastern and central North Dakota, northwestern Minnesota and northeastern South Dakota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 29 inches (A1, A2 and Bw horizons); calcic horizon - the zone from 29 to 36 inches (2Bk horizon).

ADDITIONAL DATA: Laboratory samples S50ND-5-5, S50ND-25-5, S51ND-5-19 and ND-54-P-8.

National Cooperative Soil Survey
U.S.A.

LOCATION ULEN MN+ND SD

Established Series
MNJ-RBH-CJH
05/2000

ULEN SERIES

The Ulen series consists of very deep, somewhat poorly drained soils that formed in sandy glaciolacustrine deposits on glacial lake plains. Permeability is rapid. Slopes range from 0 to 3 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 41 degrees F.

TAXONOMIC CLASS: Sandy, mixed, frigid Aeric Calciaquolls

TYPICAL PEDON: Ulen fine sandy loam on a 1 percent east facing slope. When described the soil was moist throughout. (Colors are for moist soil unless otherwise stated)

A--0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and very friable; nonsticky and nonplastic; common very fine and few fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

Ak--9 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; strong effervescence; moderately alkaline; clear wavy boundary. (Combined A horizons 10 to 20 inches thick)

Bk1--13 to 20 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) redoximorphic concentrations; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2--20 to 42 inches; grayish brown (10YR 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; strong effervescence; moderately alkaline; gradual wavy boundary. (Combined Bk horizons 4 to 30 inches thick)

C--42 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; few medium distinct dark yellowish brown (10YR 4/4) redoximorphic concentrations; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

TYPE LOCATION: Foster County, North Dakota; about 9 miles south and 3 miles east of Glenfield, 2,600 feet north and 600 feet west of the southeast corner of sec. 36, T. 147 N., R. 62 W.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from 7 to 20 inches. Where the texture is loamy fine sand it is more than 10 inches thick.

The soil is calcareous throughout. The soil does not have rock fragments above a depth of 40 inches. However, strata up to 6 inches thick with up to 5 percent rock fragments are allowed in the C horizon above a depth of 40 inches. The average texture of the particle-size control section is commonly fine sand or loamy fine sand or sand or loamy sand with appreciable amounts of fine sand or finer particles or both. It has 5 to 30 percent medium and coarser sand. The depth to loamy fine sand or coarser textures is less than 25 inches. The soil is moderately alkaline or slightly alkaline throughout. The A horizon and/or upper Bk horizon have accumulations of carbonates and a calcium carbonate equivalent of 5 to 20 percent.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is loamy fine sand or fine sandy loam, but, sandy loam or very fine sandy loam are within the range. An ABk horizon is present in some pedons.

The Bk horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 3 or hue of 2.5Y, value of 4 to 6, and chroma of 2 to 4. Hue of 5Y occurs in the lower part of the Bk horizon in some pedons. It is loamy sand, loamy fine sand, fine sand, sandy loam or fine sandy loam. A BCk horizon is present in some pedons.

The C horizon has a matrix with hue of 10YR, 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 6 and commonly has redoximorphic features. The colors with chroma of 2 are mostly in the lower part. The C horizon is mostly fine sand or loamy fine sand; but sand, coarse sand, or very fine sand subhorizons are in some pedons. Also, it has loamy or silty layers below depths of 40 inches in some pedons.

COMPETING SERIES: These are the Karlsruhe and Wyrene series. The Karlsruhe and Wyrene soils contain more than 30 percent medium sand and coarser in the particle-size control section.

GEOGRAPHIC SETTING: The Ulen soils are primarily on plane to slightly convex positions on glacial lake plains. Slope gradient typically is 0 to 3 percent. They formed in thick glaciolacustrine deposits that are dominated by fine sand. Mean annual air temperature ranges from 36 to 45 degrees F. Mean annual precipitation from 15 to 24 inches. Frost-free period ranges from 90 to 155 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arveson, Flaming, Fossum, Hamar, Hecla and Rosewood soils. These soils are in a drainage sequence with Ulen. Flaming and Hecla soils are moderately well drained and are on slightly higher lying positions. Arveson, Fossum, Hamar and Rosewood soils are poorly drained or very poorly drained, and they commonly are on nearby flats or depressions.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is negligible or very low. Permeability is rapid. An apparent seasonal high water table is at a depth of 1.5 to 3.5 feet at some time during the period of April through June in most years.

USE AND VEGETATION: Soils are mostly cropped to small grains. In some places, potatoes, corn, and hay are important crops. A small amount of the Ulen soil is used for permanent pasture or is idle. Native vegetation was mostly tall grass prairie. An encroachment of trees, most commonly quaking aspen, has occurred on some areas.

DISTRIBUTION AND EXTENT: These soils are primarily in the eastern edge of the glacial Lake Agassiz basin of northwestern and west-central Minnesota and in eastern North Dakota and northeastern South Dakota. They are extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Reconnaissance of the Red River Valley Area, Minnesota, in 1933.

REMARKS: Diagnostic horizons and features recognized are: mollic epipedon - the zone from the surface to a depth of 13 inches (Ap and Ak horizons); calcic horizon - the zone from 9 to 42 inches (Ak, Bk1 and Bk2 horizons); aquic moisture regime; aeric subgroup due to 10YR hue and high chroma of 2 below mollic epipedon (Bk1 horizon).

Where correlated as moderately well drained phase or with slopes of more than 3 percent, a new series should be established (Aquic Calciudolls).

ADDITIONAL DATA: Laboratory analysis: S67MN107-003 and S67MN107-006 (in S67-Minn-54.5 - Lincoln Laboratory) and S92ND073-003.

National Cooperative Soil Survey
U.S.A.

LOCATION VALLERS MN+ND SD

Established Series
RTD-RBH-CJH
05/2000

VALLERS SERIES

The Vallers series consists of very deep, poorly drained soils that formed in calcareous fine-loamy till on till plains, moraines and lake plains. These soils have moderately slow permeability. Slopes range from 0 to 3 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Typic Calciaquolls

TYPICAL PEDON: Vallers loam, on a plane slope on a glacial moraine in cropland. (Colors are for moist soil unless otherwise noted)

Ap--0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate very fine and fine granular structure; hard, friable, sticky and plastic; strong effervescence; slightly alkaline; abrupt smooth boundary. (Combined A horizons 6 to 24 inches thick)

Bkg--9 to 22 inches; gray (5Y 5/1) and olive gray (5Y 5/2) clay loam, light gray (5Y 6/1) and light gray (5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/4) redoximorphic concentrations; weak medium subangular blocky structure; hard, firm, sticky and plastic; about 5 percent pebbles and other rock fragments; violent effervescence; slightly alkaline; clear wavy boundary.

Bkyg--22 to 44 inches; olive gray (5Y 5/2) and gray (5Y 5/1) clay loam, light olive gray (5Y 6/2) and light gray (5Y 7/1) dry; many large prominent yellowish brown (10YR 5/4) redoximorphic concentrations; weak fine subangular blocky structure; hard, firm, sticky and plastic; about 5 percent pebbles and other rock fragments; many nests of gypsum; strong effervescence; slightly alkaline; gradual wavy boundary. (Combined Bkg horizons 6 to 35 inches thick)

BCyg--44 to 60 inches; gray (5Y5/1) clay loam, light gray (5Y 6/1) dry; many medium prominent yellowish brown (10YR 5/4) redoximorphic concentrations; massive, very hard, firm, sticky and plastic; about 5 percent pebbles and other rock fragments; common nests of gypsum; slight effervescence; slightly alkaline.

TYPE LOCATION: Benson County, North Dakota; about six miles east and six miles north of Leeds; 800 feet west and 150 feet north of the southeast corner of sec. 6, T. 156 N., 67 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 25 inches in thickness. In some pedons the lower part of the mollic epipedon qualifies as part of the calcic horizon. The calcic horizon has a calcium carbonate equivalent of about 20 to 35 percent. The 10 to 40 inch particle-size control section typically has between 22 and 32 percent clay but ranges from 18 to 35 percent and 15 to 35 percent sand coarser than very fine sand. It typically contains 2 to 8 percent rock fragments of mixed lithology, but in some pedons the upper part lacks rock fragments. Typically, the soil is calcareous

throughout, but a few pedons have neutral or slightly alkaline surface A horizons. Firm subsoil, saline and depressional phases are recognized.

The A horizon has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3, and chroma of 1 or less. Redoximorphic features or chroma of 2 are in the lower part of the A horizon of some pedons. Typically it is clay loam or loam and less commonly silty clay loam, sandy clay loam or silt loam. An ABk or Ak horizon is in some pedons.

The Bk horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2, or is neutral with values of 4 to 6. It commonly has few to many, faint to prominent, and fine to medium redoximorphic features, but they are lacking in some pedons. However, where the horizon has a chroma is 2 above a depth of 20 inches, there are distinct or prominent redoximorphic features present. It is a clay loam, silty clay loam, loam or sandy clay loam. It does not have gypsum accumulations in some pedons. Some pedons have BCk horizons.

The BC and C horizons have 2.5Y or 5Y hue, value of 4 to 7, and chroma of 1 to 3. Typically, they have redoximorphic features. They are loam or clay loam. They do not have gypsum accumulations in some pedons. Some pedons have coarse sandy loam to gravelly sand below a depth of 50 inches and are recognized as a sandy substratum phase.

COMPETING SERIES: These are the Easby, Hapur, Lowe and Nortonville series. Easby soils have a SAR greater than 13. Hapur soils have a calcic horizons at the surface. Lowe soils do not have rock fragments in the particle-size control section. Nortonville soils have a gypsic horizon.

GEOGRAPHIC SETTING: The Vallers soils are on level and nearly level slight rises, shallow depressions and drainageways of till plains, moraines and lake plains. They are on slightly concave to slightly convex slopes with gradient of 0 to 3 percent. These soils formed in fine-loamy, calcareous till of Late Wisconsinan Age. In some areas, these soils have a silty lacustrine mantle as much as 24 inches thick. The mean annual air temperature is about 32 to 45 degrees F, and the mean annual precipitation is about 12 to 26 inches. Frost-free period ranges from 90 to 150 days. Elevation ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Langhei, Barnes, Forman, Formdale, Svea, Hamerly, Parnell and Quam soils in a hydrosequence with the Vallers soils on till plains and moraines; and the Roliss, Kratka, Strathcona and Hamre soils on lake plains. The somewhat excessively drained Langhei soils; the well drained Barnes, Forman,and Formdale soils; the moderately well drained Svea soils; and the somewhat poorly drained Hamerly soils are on higher lying or more sloping terrain. The very poorly drained Parnell and Quam soils are in depressions. The Roliss soils do not have a calcic horizon. The Kratka and Strathcona soils have 20 to 40 inches of sandy materials in the upper part. The Hamre soils are on lower lying areas and have a histic epipedon.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff is negligible to low. Permeability is moderately slow. An apparent seasonal high water table is at a depth of 0.5 to 1.5 feet at some time during the period of March through July.

USE AND VEGETATION: Most of this soil is cultivated. Corn, soybeans, small grains and legumes are the principal crops. Native vegetation is tall grass prairie.

DISTRIBUTION AND EXTENT: Western Minnesota, northeastern South Dakota, and eastern North Dakota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Big Stone County, Minnesota, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 9 inches (Ap horizon); calcic horizon - the zone from 9 to 44 inches (Bkg and Bkyg horizons); aquic moisture regime per 5Y hue, chroma of 2 and redoximorphic concentrations below the mollic epipedon.

National Cooperative Soil Survey
U.S.A.

LOCATION VANG ND+SD

Established Series
Rev. CJH
10/98

VANG SERIES

The Vang series consists of very deep, moderately well and well drained soils that formed in loam sediments overlying sand and gravel sediments that have appreciable amounts of shale. Permeability is moderate in the solum and rapid or very rapid in the substratum. These soils are on glacial outwash plains, eskers, terraces, deltas and beaches and have slopes ranging from 0 to 9 percent. Mean annual air temperature is 38 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Vang loam - on a southwest-facing convex slope of 3 percent in a cultivated field. When described the soil was moist to 20 inches and dry below. (Colors are for moist soil unless otherwise stated)

Ap--0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; slightly hard, very friable, sticky and plastic; common very fine roots; slightly acid; abrupt smooth boundary.

A--7 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; slightly acid; clear wavy boundary. (Combined A horizons 6 to 18 inches thick)

Bw1--11 to 19 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark grayish brown (2.5Y 4/2) dry; weak medium prismatic structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; about 5 percent gravel; slightly acid; gradual wavy boundary.

Bw2--19 to 27 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; about 10 percent gravel; slightly acid; clear wavy boundary. (Combined Bw horizons 8 to 25 inches thick)

2C--27 to 60 inches; very dark grayish brown (2.5Y 3/2) very gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; about 90 percent shale in the 0.1 to 76 mm fraction; slightly alkaline.

TYPE LOCATION: Cavalier County, North Dakota; about 4 miles north and 2 miles east of Olga; 1,000 feet west and 390 feet south of the northeast corner, sec. 15, T. 162 N., R. 57 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 16 to 33 inches. Depth to stratified sandy and gravelly material ranges from 20 to 40 inches. The solum averages between 18 and 30 percent clay.

The A horizon has hue of 10YR, value of 2 or 3 and 3 or 4 dry, and chroma of 1. It is loam or clay loam. It is moderately acid or neutral.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 and 4 to 6 dry, and chroma of 1 to 3. It is loam or clay loam. It is moderately acid to moderately alkaline. It contains 0 to 10 percent by volume of rock fragments in the upper part and as much as 20 percent in the lower part. Some pedons have Bk, BC or thin C horizons.

The 2C horizon has hue of 2.5Y or 5Y, value of 2 to 6 (5 to 7 dry), and chroma of 1 to 4. It is sand, coarse sand, loamy sand or loamy coarse sand averaging 30 to 80 percent gravel, although some pedons have layers with 15 to 30 percent gravel. It is stratified and has more than 20 percent shale in the 0.1 to 76 mm fraction. It is moderately acid to moderately alkaline. Some pedons have 2C horizons with yellowish brown relict mottles.

COMPETING SERIES: These are the Fordville and Spottswood series. These soils have sand and gravel 2C horizons that have less than 20 percent shale in the 0.1 to 76 mm fraction.

GEOGRAPHIC SETTING: Vang soils are on level to moderately sloping glacial outwash plains, terraces, deltas, eskers and beaches. Slope gradients range from 0 to 9 percent. The soils formed in loam sediments overlying sandy and gravelly sediments that have appreciable amounts of shale. The mean annual air temperature ranges from 37 to 45 degrees F, and the mean annual precipitation from 15 to 22 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Fordville soils and the Binford, Brantford, Coe, Divide, Eckman, Embden, Gardena, Kensal, Renshaw, Tolna, Walsh and Warsing soils. Fordville and Renshaw soils are on nearby areas where siliceous sand and gravel comprise the main part of the outwash. Renshaw soils have sand and gravel within depths of 10 to 20 inches and have 2C horizons that have less than 20 percent shale in the 0.1 to 76 mm fraction. Binford soils are on nearby areas. They are sandy. Brantford and Coe soils are in toposequence with Vang soils. Brantford soils are on the convex, nearly level to gently sloping areas and Coe soils are on more sloping, steep ridges. Brantford soils have sand and gravel within depths of 10 to 20 inches and Coe soils are sandy-skeletal. Divide soils are in low areas adjacent to the Vang soils. They have calcic horizons within depths of 16 inches. Eckman, Embden and Gardena soils are on nearby delta and lake plains. None of these soils have sand and gravel 2C horizons within depths of 40 inches. Kensal and Warsing soils are on low lying areas where surface runoff is slower. Kensal soils have distinct redoximorphic features within depths of 20 inches. Warsing soils have sand and gravel within depths of 10 to 20 inches. Tolna soils are in shallow basins and swales. They have platy structure in the Bw horizon, are moderately acid, and are somewhat poorly drained. Walsh soils are on nearby delta and outwash areas where loam sediments extend to depths greater than 40 inches. They do not have sand and gravel within depths of 40 inches.

DRAINAGE AND PERMEABILITY: Moderately well and well drained. Runoff is negligible to medium depending on the slope and surface texture. Permeability is moderate in the solum and rapid or very rapid in the substratum. Moderately well drained pedons have a seasonal high water table at depths of 4 to 6 feet.

USE AND VEGETATION: Soils are cropped to spring seeded small grains, beans and potatoes. Native vegetation is western wheatgrass, needleandthread, green needlegrass, prairie junegrass, bearded wheatgrass and forbs.

DISTRIBUTION AND EXTENT: Eastern and central North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Walsh County, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: Mollic epipedon - the zone from the surface of the soil to the depth of 27 inches (Ap, A, Bw1, and Bw2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION VELVA ND+UT

Established Series
Rev. CJH
10/98

VELVA SERIES

The Velva series consists of very deep, well drained, moderately or moderately rapidly permeable soils that formed in stratified recent alluvium. These soils are on flood plains and low terraces and have slopes of 0 to 6 percent. Mean annual temperature is 41 degrees F, and mean annual precipitation is 16 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Fluventic Haplustolls

TYPICAL PEDON: Velva fine sandy loam - cultivated. (Colors are for dry soil unless otherwise stated)

Ap--0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; many fine pores; neutral; abrupt smooth boundary. (5 to 12 inches thick)

AC--6 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many fine pores; mildly alkaline; abrupt smooth boundary. (0 to 20 inches thick)

Ab--12 to 13 inches; very dark grayish brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many fine pores; slight effervescence; mildly alkaline; clear smooth boundary. (0 to 8 inches thick)

C1--13 to 15 inches; grayish brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common roots; common fine pores; strong effervescence; mildly alkaline; clear smooth boundary.

C2--15 to 36 inches; grayish brown (2.5Y 5/2) fine sandy loam with thin strata of loam and loamy fine sand less than 1 inch thick, dark grayish brown (2.5Y 4/2) moist; weak very coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common roots; common fine pores; strong effervescence; mildly alkaline; clear smooth boundary.

C3--36 to 52 inches; grayish brown (2.5Y 5/2) loamy fine sand, very dark grayish brown (2.5Y 3/2) moist; single grain; few roots; strong effervescence; moderately alkaline; clear smooth boundary.

C4--52 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; slightly hard, very

friable, slightly sticky and slightly plastic; few roots; few pores; strong effervescence; moderately alkaline.

TYPE LOCATION: Mercer County, North Dakota; about 1/2 mile west of Hazen; 1090 feet west and 90 feet north of the southeast corner, sec. 13, T. 144 N., R. 87 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section averages between 7 and 18 percent clay and 25 and 60 percent fine sand or coarser. Some pedons contain carbonates throughout. Saline phases are recognized. The soil commonly has one or more buried A horizons. Some pedons have an O horizon.

The A horizon has 10YR or 2.5Y hue, value of 3 to 5 and 2 or 3 moist, and chroma of 1 to 3. It commonly is loam or fine sandy loam but some is sandy loam, very fine sandy loam or clay loam. Some pedons have Bw horizons.

The C horizon has 10YR or 2.5Y hue, value of 4 to 7 and 3 to 5 moist and chroma of 2 to 4. It averages fine sandy loam, very fine sandy loam or loam; some pedons have thin layers of coarser or finer material. It commonly contains carbonates and some pedons have Bk horizons.

COMPETING SERIES: There are no other series in the family. Other competing series are the Glendive, Hamilton, Havrelon, Korchea, Straw, and Trembles series. Glendive, Havrelon and Trembles soils do not have mollic epipedons. Hamilton soils are coarse-silty. Korchea and Straw soils are fine-loamy.

GEOGRAPHIC SETTING: Velva soils are on flood plains and low terraces. Slope gradients typically are less than 2 percent, but range to 6 percent along channels and edges of terraces. The soils formed in stratified recent alluvium. Mean annual temperatures range from 38 degrees to 45 degrees F, and mean annual precipitation from 12 to 20 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Havrelon, Korchea, Straw, and Trembles soils and the Farland, Parshall, Savage, Shambo, Stady, and Tally soils. Havrelon, Korchea, Straw, and Trembles soils are on similar landscapes. Farland, Parshall, Savage, Shambo, Stady, and Tally soils are on nearby higher terraces. All have a regular decrease in organic matter with depth.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is slow. Permeability is moderate or moderately rapid. These soils flood early in the spring following snowmelt and after high intensity rainfall.

USE AND VEGETATION: The soils are cropped and used for hay and pasture. Native vegetation is slender wheatgrass, big bluestem, green needlegrass, western wheatgrass, Canada wildrye, Maximilian sunflower, goldenrod and other forbs and a few shrubs.

DISTRIBUTION AND EXTENT: Eastern to western North Dakota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Bowman County, North Dakota, 1969.

REMARKS: Revised 3/90.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth 13 inches (Ap, AC, and Ab horizons); the C1 horizon has the color but not the organic matter content to be mollic; irregular decrease in organic carbon with depth - presence of Ab horizon and stratifications in C2 horizons.

National Cooperative Soil Survey
U.S.A.

LOCATION VENLO ND+MN SD

Established Series
Rev. LEE-CJH
2/99

VENLO SERIES

The Venlo series consists of very deep, very poorly drained, rapidly permeable soils that formed in glaciofluvial or glaciolacustrine deposits. These soils are in low, basins and swales on delta, outwash and lake plains and have slopes of 0 to 1 percent. The mean annual air temperature is 42 degrees F, and the mean annual precipitation is 20 inches.

TAXONOMIC CLASS: Sandy, mixed, frigid Typic Endoaquolls

TYPICAL PEDON: Venlo fine sandy loam - on a slightly concave slope of less than 1 percent in native grassland. When described the soil was wet throughout. (Colors are for moist soil unless otherwise stated)

A--0 to 13 inches; black (N 2/0) fine sandy loam, very dark gray (N 3/0) dry; weak medium subangular blocky structure parting to weak very fine granular; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; neutral; clear smooth boundary. (10 to 20 inches thick)

Cg1--13 to 30 inches; olive gray (5Y 5/2) fine sand, light gray (5Y 7/2) dry; common distinct greenish gray (5GY 5/1) redox depletions; single grain; loose, nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual wavy boundary.

Cg2--30 to 60 inches; gray (5Y 5/1) fine sand, light gray and white (5Y 7/1 and 8/1) dry; single grain; loose, nonsticky and nonplastic; slight effervescence; slightly alkaline.

TYPE LOCATION: Ransom County, North Dakota; about 3 1/2 miles north and 6 miles west of McLeod; 1000 feet north and 130 feet east of the southwest corner, sec. 1, T. 134 N., R. 54 W.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon typically is 10 to 20 inches, but ranges to 24 inches. Some pedons have 0 horizons as much as 6 inches thick. Some pedons have Ab horizons.

The A horizon has hue of 10YR, 2.5Y, 5Y, or is neutral, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or less. It is loamy sand, loamy fine sand, sandy loam or fine sandy loam. It is slightly acid or neutral.

The Cg horizon has hue of 2.5Y, 5Y, 5GY, or is neutral, value of 4 to 6 and 5 to 8 dry, and chroma of 2 or less. Some pedons have chroma of 3. Those with chroma of 2 or 3 have common or many low chroma redox depletions. The Cg horizon is neutral to moderately alkaline. Some pedons have Cg horizons with low chroma and distinct or prominent redox concentrations with chroma of 3 or higher. The Cg horizon is loamy sand, loamy fine sand, fine sand, or sand.

COMPETING SERIES: These are the Hamar, Hangaard, Isan and Isanti series and the Medano series as previously classified. Hamar soils are poorly or somewhat

poorly drained. Hangaard soils are dominantly coarse sand and have 10 to 35 percent rock fragments. Isan and Isanti soils are acid throughout. Medano soils are calcareous in the upper part of the control section and noncalcareous in the lower part.

GEOGRAPHIC SETTING: Venlo soils are in low basins and swales on delta, outwash and lake plains. Slopes are plane or slightly concave with gradients of 0 to 1 percent. The soils formed in glaciofluvial or glaciolacustrine deposits. Mean annual temperature ranges from 36 to 48 degrees F, and mean annual precipitation from 15 to 24 inches. Frost-free period ranges from 105 to 140 days. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Hamar soils and Arveson, Fossum, Hecla, Maddock, Serden and Stirum soils. Fossum, Arveson and Hamar soils occupy similar or slightly higher positions on the landscape. Arveson soils are coarse-loamy. Fossum soils are calcareous throughout. Hecla, Maddock and Serden soils are on nearby higher lying level to hilly areas. They are moderately well to excessively drained and do not have an aquic moisture regime. Stirum soils are calcareous throughout and have a natric horizon.

DRAINAGE AND PERMEABILITY: Very poorly drained. Runoff is negligible or ponded. A seasonal high water table is at depths of one foot above the surface to one foot below the surface at some time during the period of November through July. Rapid permeability.

USE AND VEGETATION: Used for pasture and wildlife. Native vegetation is slough sedge, rivergrass, slim sedge, prairie cordgrass, rushes and other wetland sedges.

DISTRIBUTION AND EXTENT: Southeastern and east-central North Dakota, western Minnesota and northeastern South Dakota. The soil is of small extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 13 inches (A horizon); characteristics associated with wetness - chroma of 1 or less in the lower part of the mollic epipedon (A horizons), and immediately below the mollic epipedon (Cg1 horizon) color value of 4 or more, hue of 5Y, distinct or prominent redox features, and chroma of 3 or less.

National Cooperative Soil Survey
U.S.A.

LOCATION WAHPETON ND+MN

Established Series
Rev. RLH-CJH
02/97

WAHPETON SERIES

The Wahpeton series consists of very deep, moderately well drained, moderately or moderately slowly permeable soils that formed in clayey alluvium. These soils are on levees and low terraces of large streams and have slopes of 0 to 15 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine, smectitic, frigid Typic Hapluderts

TYPICAL PEDON: Wahpeton silty clay - on a slope of less than 1 percent under cropland. Where described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

Ap--0 to 8 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; strong very fine angular blocky structure; very hard, friable; sticky and plastic; many fine roots; many fine pores; slight effervescence; slightly alkaline; abrupt smooth boundary.

A--8 to 23 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; strong medium subangular blocky structure parting to strong very fine angular blocky; very hard, firm; sticky and plastic; common fine roots; common fine pores; faces of peds have slick, shiny surface when moist; gray (10YR 5/1) band crosses horizon at depths of 12 to 14 inches; slight effervescence; slightly alkaline; clear smooth boundary. (Combined A horizons 16 to 40 inches thick)

C--23 to 27 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; strong very fine angular blocky structure; hard, firm; sticky and plastic; few roots, common fine pores; slight effervescence; slightly alkaline; clear smooth boundary. (2 to 10 inches thick)

Assb--27 to 38 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; strong medium subangular blocky structure parting to strong very fine angular blocky; hard, firm; sticky and plastic; few roots; common fine pores; slickensides on vertical faces of peds; few fine masses of carbonates; slight effervescence; slightly alkaline; gradual wavy boundary. (0 to 15 inches thick)

Css--38 to 47 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to strong very fine angular blocky; very hard, firm; sticky and plastic; few fine roots; common fine pores; distinct slickensides on faces of peds; common medium masses of carbonates; strong effervescence; slightly alkaline; gradual wavy boundary. (0 to 10 inches thick)

A'ssb--47 to 60 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium prismatic structure parting to strong fine and very fine angular blocky; very hard, firm; sticky and plastic; few fine pores; slickensides are vertical but slant to 15 degrees from vertical below depths of 54 inches; few masses of carbonates; slight effervescence; slightly alkaline.

TYPE LOCATION: Walsh County, North Dakota; about 11 1/2 miles east of 1/2 mile north of Grafton; 1,640 feet south and 380 feet west of the northeast corner, Sec. 13, T. 157 N., R. 51 W. (90 feet south of road, 800 feet east of fence on east side of woods)

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section typically averages between 50 to 60 percent clay, but ranges from 35 to 60 percent. The mollic epipedon ranges from 16 to 40 inches in thickness. The soil commonly has one or more Ab horizons separated by C horizons below depths of 24 inches. Many pedons when dry have cracks which extend from the surface to depths of 60 inches or more. Slickensides are in the lower half of most pedons. Some pedons do not have carbonates to depths of 36 inches and do not have segregated carbonates below these depths.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 5 and 2 or 3 moist, and chroma of 1. Some pedons have chroma of 2 moist in the lower part of the A horizon when the soil is crushed. It is clay or silty clay. It is slightly acid to slightly alkaline. The lower boundary of the A horizon ranges from gradual or clear smooth to irregular and tongued. Some pedons have a Bw or Bk horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 or 2. It is clay, silty clay or silty clay loam. It is neutral to moderately alkaline.

The Ab horizons have hue of 10YR, 2.5Y, 5Y or are neutral, value of 3 to 5 and 2 or 3 moist, and chroma of 2 or less. They are clay, silty clay or silty clay loam. They are neutral or slightly alkaline.

COMPETING SERIES: These are the Hattie, Nutley and Sinai series as previously classified. Hattie soils do not have buried A horizons and contain 2 to 8 percent by volume rock fragments. Nutley soils have mollic epipedons less than 16 inches thick. Sinai soils have a regular decrease in organic matter and do not have buried horizons.

GEOGRAPHIC SETTING: Wahpeton soils are on level to strongly sloping levees and low terraces of large streams. Slope gradients commonly are less than 2 percent but some on levee and terrace edges range to 15 percent. The soil formed in clayey alluvium. The climate is cool, subhumid. The mean annual air temperatures range from 36 to 45 degrees F, and mean annual precipitation from 16 to 23 inches. Most of the moisture falls in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bearden, Cashel, Dovray, Fairdale, Fargo, Hegne, La Prairie and Overly soils. Bearden and Overly soils are on higher elevations on the nearby lake plains. They are fine-silty. Cashel, Fairdale and La Prairie soils are on flood plains and low terraces that are lower on the landscape than the Wahpeton soils. Cashel soils do not have mollic epipedons. Fairdale and La Prairie soils are fine-loamy. The poorly drained Dovray, Fargo and Hegne soils are on nearby glacial lake plains. Dovray and Fargo soils have Bw horizons. Hegne soils have a calcic horizon within a depth of 16 inches.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is slow or medium. Permeability is moderate or moderately slow. These soils flood occasionally in the early spring.

USE AND VEGETATION: Most areas are used to grow small grains and some row crops, such as soybeans and sugar beets. Native vegetation was western wheatgrass, big bluestem, green needlegrass, blue grama, little bluestem, a variety of forbs, shrubs, and such trees as American elm, oak, boxelder and cottonwood.

DISTRIBUTION AND EXTENT: Eastern North Dakota and northwestern Minnesota along the Red River and other large streams. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, June 1970.

REMARKS: Revised 5/94.

The site will be redescribed to better describe the Vertisol characteristics.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 23 inches (Ap and A horizon), the C horizon has the color but not the organic matter content to be mollic; Vertisol criteria - silty clay texture throughout, cracks (range in characteristics), and slickensides below 27 inches (Assb, Css, and A'ssb horizons).

ADDITIONAL DATA: S67NDak-50-1(1-8) and S67NDak-50-2(1-4).

National Cooperative Soil Survey
U.S.A.

LOCATION WALSH ND

Established Series
Rev. CJH
10/98

WALSH SERIES

The Walsh series consists of very deep, well or moderately well drained, moderately or moderately slowly permeable soils that formed in glacial alluvium or till containing a high amount of shale. These soils are on glacial terraces, deltas, fans and foot slopes and have slopes of 0 to 15 percent. Mean annual temperature is 39 degrees F, and mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Pachic Hapludolls

TYPICAL PEDON: Walsh silt loam - on a north-facing plane slope of 1 percent under cropland. (Colors are for dry soil unless otherwise stated. Where described the soil was moist throughout.)

Ap--0 to 10 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; moderate very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; neutral; clear wavy boundary. (8 to 20 inches thick)

Bw1--10 to 17 inches; gray (10YR 5/1) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine prismatic structure parting to moderate very fine subangular blocky; hard, friable, sticky and plastic; common fine roots; many fine pores; very dark brown (10YR 2/2) moist thin coatings on faces of peds; neutral; gradual wavy boundary.

Bw2--17 to 22 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate very fine subangular blocky; hard, friable, sticky and plastic; few fine roots; many fine pores; few faint of clay films on faces of peds; neutral; gradual wavy boundary. (Combined Bw horizons 10 to 30 inches thick)

C1--22 to 48 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist, few faint brown (10YR 4/3) moist mottles at 40 to 48 inches; moderate fine and very fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many fine pores; few hard shale fragments; few fine soft masses of carbonates at 40 to 48 inches; mildly alkaline.

C2--48 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; about 5 percent by volume shale fragments; few fine soft masses of carbonates; mildly alkaline.

TYPE LOCATION: Walsh County, North Dakota; about 5 1/2 miles west of Park River; 2500 feet west and 350 feet north of the southeast corner, sec. 21, T. 157 N., R. 56 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section typically averages between 25 and 35 percent clay and 15 to 45 percent fine and coarse sand. It

contains 0 to 10 percent by volume of hard shale fragments in the solum. The mollic epipedon is 16 to 30 inches thick.

The A horizon has 10YR or 2.5Y hue, value of 3 or 4 and 2 or 3 moist, and chroma of 1. It typically is silt loam or clay loam and some is loam or silty clay loam.

The Bw horizon has 10YR or 2.5Y hue, value of 3 to 6 and 2 to 4 moist, and chroma of 1 to 3. It is loam, silt loam, clay loam, or silty clay loam.

The C horizon has 2.5Y or 5Y hue, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 3. It is loam, silt loam, clay loam, or silty clay loam, or gravelly loam. Some pedons contain diffuse and segregated carbonates at depths of 36 to 60 inches. Some contain sand and gravel composed mostly of shale within depths of 40 to 60 inches.

COMPETING SERIES: These are the Aastad, Darnen, Delette, Lankin, Lismore, and Svea series in the same family and the Beotia, Embden, Emrick, La Prairie, Overly, and Waubay series. Aastad and Svea soils have formed in till and have Bk horizons. Darnen soils average between 18 and 30 percent clay in the 10- to 40-inch control section and do not have shale fragments. Delette soils are slightly to strongly acid. Lankin and Lismore soils have Bk horizons. Beotia, Overly, and Waubay soils are fine-silty. Embden and Emrick soils are coarse-loamy. La Prairie soils have an irregular decrease in organic matter with depths.

GEOGRAPHIC SETTING: Walsh soils are on glacial terraces, deltas, fans, and foot slopes. Slope gradients commonly are less than 3 percent, but some range to 15 percent on a few fans and foot slopes. The soils formed in glacial alluvium which was derived from shale or glacial till containing a high amount of shale. The climate is cool, subhumid. Mean annual temperature ranges from 38 to 45 degrees F., and mean annual precipitation from 16 to 20 inches. Most of the precipitation comes in the spring and summer.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing LaPrairie, Overly, and Svea soils and the Barnes, Brantford, Buse, Coe, Divide, Edgeley, Gardena, Kloten, and Vang soils. LaPrairie soils are on similar landscapes as Walsh soils. Overly soils are in nearby glaciolacustrine deposits. Svea soils are on nearby till plains. Barnes, Buse, and Edgeley soils are on nearby till plains and have thinner mollic epipedons. Brantford soils are on nearby outwash plains and Vang soils are on similar landscapes as Walsh soils. These soils are fine-loamy over sandy or sandy-skeletal. Coe and Kloten soils are on hills and side slopes above the fans and foot slopes. Coe soils are sandy-skeletal and Kloten soils are shallow. Divide soils are in swales and depressions and have calcic horizons within 16 inches of the surface. Gardena soils are in nearby glaciolacustrine deposits and are coarse-silty.

DRAINAGE AND PERMEABILITY: Well and moderately well drained. Runoff is slow or medium. Permeability is moderate or moderately slow.

USE AND VEGETATION: Soils are cropped to small grains and row crops such as potatoes and beans, and are used for pasture. Native vegetation is tall and mid prairie grasses.

DISTRIBUTION AND EXTENT: Northeastern and north-central North Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Walsh County, North Dakota, 1938.

REMARKS: Revised 3/90.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 17 inches (Ap and Bw1 horizons); cambic horizon - the zone from 17 to 22 inches (Bw2 horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION WAMDUSKA ND+MN

Established Series
Rev. CJH-RJB-KJL
02/97

WAMDUSKA SERIES

The Wamduska series consists of deep, excessively drained, rapidly permeable soils that formed in sorted sand and gravel. These soils are on beaches of current and former lakes. They are very shallow to sand and gravel. Slopes range from 0 to 45 percent. Mean annual precipitation is 17 inches, and mean annual temperature is 41 degrees F.

TAXONOMIC CLASS: Sandy, mixed, frigid Typic Udorthents

TYPICAL PEDON: Wamduska loamy coarse sand on a beach on a southeast- facing convex slope of 5 percent. (Colors are for moist soil unless otherwise stated. Where described the soil was moist to 7 inches and dry below 7 inches.)

Oe--2 inches to 0; black (10YR 2/1) and very dark grayish brown (10YR 3/2) partially decomposed leaves, roots, and twigs; many very fine and few medium and coarse roots; abrupt smooth boundary. (0 to 3 inches thick)

A--0 to 3 inches; very dark gray (10YR 3/1) loamy coarse sand, dark grayish brown (10YR 4/2) dry; single grain; loose, very friable, nonsticky, and nonplastic; many very fine and few fine and medium roots; slight effervescence; mildly alkaline; abrupt smooth boundary. (1 to 7 inches thick)

C1--3 to 7 inches; dark grayish brown (2.5Y 4/2) gravelly loamy coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky, and nonplastic; many very fine and few fine and medium roots; about 35 percent by volume gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

C2--7 to 18 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky, and nonplastic; common very fine and few medium roots; about 40 percent by volume gravel; slight effervescence; mildly alkaline; clear smooth boundary.

C3--18 to 25 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky, and nonplastic; common very fine and few fine roots; about 55 percent by volume gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

C4--25 to 32 inches; very dark grayish brown (2.5Y 3/2) gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky, and nonplastic; common very fine and few fine, medium and coarse roots; about 20 percent by volume gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

C5--32 to 57 inches; dark brown (7.5YR 4/4), dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) gravelly coarse sand, brown (7.5YR 5/4), grayish brown (10YR 5/2) and brown (10YR 5/3) dry; single grain; loose, nonsticky, and nonplastic; few very fine, fine and medium roots; about 15 percent by volume gravel; slight effervescence; moderately alkaline; abrupt wavy boundary.

Ab--57 to 60 inches; black (10YR 2/1) gravelly loamy coarse sand, dark gray (10YR 4/1) dry; massive; loose, very friable, nonsticky, and nonplastic; few very fine roots; about 30 percent by volume gravel; slight effervescence; moderately alkaline. (0 to 12 inches thick)

TYPE LOCATION: Nelson County, North Dakota; about 11 miles south of Lakota on the shore of Stump Lake; 1730 feet south and 875 feet east of the northwest corner, sec. 28, T. 151 N., R. 60 W.

RANGE IN CHARACTERISTICS: The 10- to 40-inch control section averages 15 to 35 percent by volume coarser than 2 mm. At least one subhorizon has more than 35 percent by volume coarser than 2 mm. Typically, carbonates are at the surface, but in some pedons the depth ranges from 4 to 48 inches. Some pedons have a very stony surface. The amount of shale in the soil profile typically ranges from 2 to 80 percent by volume, but some pedons do not contain any shale.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is loamy coarse sand, loamy sand, sandy loam, gravelly loamy coarse sand, coarse sandy loam, or loam. Where the A horizon is sandy loam, coarse sandy loam, or loam, it is 5 inches or less in thickness. The A horizon is neutral or mildly alkaline.

The C horizon has hue of 7.5YR, 10YR, or 2.5Y, and rarely 5Y; value of 3 to 6 (4 to 7 dry); and chroma of 1 to 4. The C horizon is gravelly coarse sand, gravelly very coarse sand, gravelly sand, or gravelly loamy coarse sand, but has at least one layer of very gravelly coarse sand, very gravelly sand, very gravelly very coarse sand, very gravelly loamy coarse sand, or very gravelly loamy sand. In some pedons it has layers of sand, coarse sand, very coarse sand, or loamy sand. Some pedons have thin strata of finer material. Some pedons have loam or clay loam 2C horizons of till or lacustrine sediments at depths of 40 to 60 inches. The C horizon ranges from neutral to moderately alkaline.

COMPETING SERIES: There are no other series in the same family. Claire, Coe, Emmert, and Sioux are similar soils. The Claire soils have less than 15 percent by volume coarser than 2 mm in the 10- to 40-inch control section. The Coe, Emmert, and Sioux soils are sandy-skeletal. In addition, Coe and Sioux soils have mollic epipedons.

GEOGRAPHICAL SETTING: Wamduska soils are on level to very steep beaches of current and former lakes. Slopes are plane or convex and gradients range from 0 to 45 percent. The soils formed in water sorted sand and gravel. Mean annual temperature ranges from 38 to 45 degrees, and mean annual precipitation ranges from 15 to 20 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Lallie, Mauvais, and Minnewaukan soils on lake shores and lake plains. Lallie soils formed in lower lying fine textured lacustrine sediments. Mauvais soils formed in till and are poorly and somewhat poorly drained. Minnewaukan soils are poorly drained and have fewer coarse fragments.

DRAINAGE AND PERMEABILITY: Excessively drained. Permeability is rapid. Surface runoff is very slow.

USE AND VEGETATION: Most areas are used for rangeland or wildlife. Some gently sloping and nonstony areas are cultivated or used for hay. The dominant

vegetation is needleandthread, western wheatgrass, and blue grama and some cottonwood and American elm.

DISTRIBUTION AND EXTENT: Central and northern North Dakota. The series is moderately extensive. (About 15,000 acres in Nelson, Benson, Ramsey, and Eddy Counties.)

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Ramsey County, North Dakota, 1984.

REMARKS: The soils mapped Claire in Benson County Area Soil Survey and the soils mapped Minnewaukan loamy fine sand, 6 to 9 percent slopes in Eddy County and parts of Benson and Nelson Counties contain many pedons of the Wamduska series.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - zone from the surface of the soil to a depth of 3 inches (A horizon).

ADDITIONAL DATA: Refer to NDSU File Code No. S82ND063-119 (1-8) for laboratory analysis of type location pedon of the series.

National Cooperative Soil Survey
U.S.A.

LOCATION WYNDMERE ND+MN SD

Established Series
CJH
06/1999

WYNDMERE SERIES

The Wyndmere series consists of very deep, somewhat poorly drained, moderately rapidly permeable soils formed in calcareous moderately coarse and coarse glaciofluvial and glaciolacustrine deposits. These soils are on delta, outwash and glaciolacustrine plains, and on beach ridges. Slope ranges from 0 to 3 percent. Mean annual air temperature is 42 degrees F, and the mean annual precipitation is 19 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Aeric Calciaquolls

TYPICAL PEDON: Wyndmere fine sandy loam - on a plane, nearly level slope of less than 1 percent in a cultivated field. (Colors are for moist soil unless otherwise stated. Where described, the soil was moist throughout.)

Ap--0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; slightly hard, very friable; many roots; strong effervescence; moderately alkaline; abrupt boundary. (Combined A horizons 6 to 11 inches thick)

ABk--8 to 15 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, very friable; common roots; strong effervescence; moderately alkaline; gradual wavy boundary. (0 to 8 inches thick)

Bk--15 to 26 inches; gray (10YR 5/1) fine sandy loam, light gray (10YR 6/1) dry; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, very friable; few roots; violent effervescence; moderately alkaline; gradual wavy boundary. (6 to 36 inches thick)

C1--26 to 44 inches; light olive brown (2.5Y 5/4) fine sandy loam, pale yellow (2.5Y 7/4) dry; few fine prominent dark reddish brown (5YR 3/2) redoximorphic concentrations; weak coarse subangular blocky structure parting to weak coarse granular; slightly hard, very friable; strong effervescence; moderately alkaline; gradual boundary.

C2--44 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam, pale yellow (2.5Y 7/4) dry; many prominent very dark brown (10YR 2/2) and yellowish brown (10YR 5/6) redoximorphic concentrations; massive; slightly hard, friable; strong effervescence; moderately alkaline.

TYPE LOCATION: Richland County, North Dakota; about 2 1/2 miles west and 3 miles south of Galchutt; 455 feet east and 190 feet north of the southwest corner, Sec. 9, T. 133 N., R. 49 W.

RANGE IN CHARACTERISTICS: The mollic epipedon ranges from 7 to 16 inches in thickness. The 10- to 40-inch particle-size control section typically is fine sandy loam or sandy loam, but loamy fine sand, fine sand, loam, very fine sand or loamy very fine sand are below depths of 25 inches in some pedons. Some pedons have an EC up to 12 mmhos/cm.

The A horizon has 10YR hue, value of 2 or 3 and 3 to 5 dry, and chroma of 1 or 2. It typically is fine sandy loam, but some is sandy loam, very fine sandy loam, silt loam or loam. It is neutral to moderately alkaline. Some pedons have an Ak horizon.

The Bk horizon has 2.5Y or 10YR hue, value of 3 to 6 and 4 to 8 dry, and chroma of 1 to 4. It is fine sandy loam or sandy loam and has a calcium carbonate equivalent of 15 to 30 percent. It is slightly alkaline or moderately alkaline. In some pedons it has a few fine faint redoximorphic features.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 and 5 to 8 dry, and chroma of 2 to 4. Chroma of 6 is allowed below depths of 35 inches. The C horizon has textures ranging from silt loam to fine sand. Where present, the coarser textures are below depths of 25 inches. The C horizon is slightly alkaline or moderately alkaline. Redoximorphic features range from few to many and from faint to prominent. Materials below a depth of 40 inches in some pedons range from fine to coarse textured.

COMPETING SERIES: These are the Cookcan, Cowbone and Fram series. Cookcan soils occur at elevations above 4,900 feet, have a water table at less than 1.5 feet and are on floodplains. Cowbone soils occur at elevations above 3,600 feet, do not have carbonates below the calcic horizon, have a water table at less than 1.5 feet and are on floodplains. Fram soils contain 1 to 10 percent rock fragments throughout and formed in loam till.

GEOGRAPHIC SETTING: Wyndmere soils are on level or nearly level, glaciolacustrine and outwash plains, and on beach ridges. Slope gradients are 0 to 3 percent. They formed in calcareous moderately coarse and coarse glaciofluvial and glaciolacustrine deposits. Mean annual air temperature ranges from 36 to 45 degrees F, and mean annual precipitation from 14 to 23 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arveson, Egeland, Embden, Hecla, Maddock, Tiffany and Ulen series. Arveson and Tiffany soils are in nearby low swales and flats. Arveson soils have prominent mottling within a depth of 20 inches and are poorly drained. Tiffany soils do not have a calcic horizon within depths of 16 inches. Egeland soils are well drained and are on higher lying convex areas. Embden soils have mollic epipedons more than 16 inches thick and are on slightly higher, better drained positions. Hecla and Maddock soils are on nearby higher lying areas. Ulen soils are in similar positions as the Wyndmere soils. Hecla, Maddock and Ulen soils are sandy.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Permeability is moderately rapid. Runoff is negligible or very low depending on slope. An apparent seasonal high water table is at a depth of 1.5 to 3.5 feet at some time during the period of April through June.

USE AND VEGETATION: Most areas are used to grow spring-seeded small grains, flax, potatoes and some corn. Native vegetation is blue grama, little bluestem, needleandthread and prairie sandreed.

DISTRIBUTION AND EXTENT: Eastern and central North Dakota, north- central South Dakota, and northwestern Minnesota. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Richland County, North Dakota, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 15 inches (Ap and ABk horizons); calcic horizon - the zone from 8 to 26 inches (ABk and Bk horizons); characteristics associated with wetness - calcic horizon within 16 inches; aquic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION WYRENE ND+MN

Established Series
Rev. CJH-MDS
2/99

WYRENE SERIES

The Wyrene series consists of very deep, somewhat poorly drained soils that formed in moderately coarse overlying coarse textured sediments. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils are on slightly depressed areas on outwash plains and interbeach areas. Slope ranges from 0 to 3 percent. Mean annual air temperature is 39 degrees F, and mean annual precipitation is 18 inches.

TAXONOMIC CLASS: Sandy, mixed, frigid Aeric Calciaquolls

TYPICAL PEDON: Wyrene sandy loam - on a plane slope of less than 1 percent under cropland. (Colors are for moist soil unless otherwise stated. When described the soil was moist throughout.)

A--0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; strong effervescence; moderately alkaline; gradual wavy boundary. (7 to 16 inches thick)

Bk1--8 to 13 inches; dark gray (10YR 4/1) sandy loam, gray (10YR 6/1) dry; moderate coarse prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common roots; carbonates disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2--13 to 21 inches; dark gray (10YR 4/1) sandy loam, gray (10YR 6/1) dry; moderate coarse and medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine roots; carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary. (Combined Bk horizons 8 to 34 inches thick)

2C1--21 to 29 inches; light olive brown (2.5Y 5/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; slight effervescence; moderately alkaline; clear wavy boundary.

2C2--29 to 42 inches; light olive brown (2.5Y 5/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark yellowish brown (10YR 4/4) redox concentrations; single grain; loose; about 3 percent pebbles; slight effervescence; moderately alkaline; clear wavy boundary.

2C3--42 to 60 inches; very dark grayish brown (2.5Y 3/2) coarse sand, light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) dry; single grain; loose; about 5 percent pebbles; slight effervescence; moderately alkaline.

TYPE LOCATION: Eddy County, North Dakota; about 15 miles east and 3 1/2 miles south of New Rockford; 2420 feet south and 1450 feet west of the northeast corner, sec. 22, T. 148 N., R. 64 W.

RANGE IN CHARACTERISTICS: Depth to loamy sand or coarser textures ranges from 20 to 32 inches. Typically, the A and Bk horizons average between 6 and 18 percent clay and 18 to 35 percent silt. They contain up to 10 percent rock fragments. The particle-size control section contains more than 30 percent medium and coarser sand. The mollic epipedon is 7 to 16 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 and 3 to 5 dry, and chroma of 1. It is sandy loam or coarse sandy loam. It is neutral to moderately alkaline. Some pedons have an AK horizon.

The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 and 5 to 7 dry, and chroma of 1 or 2. It is sandy loam, coarse sandy loam or loam. It is slightly alkaline or moderately alkaline. It contains 15 to more than 30 percent calcium carbonate equivalent. Some pedons have a 2Bk horizon. It has textures similar to the 2C horizon, however, it may also have a texture of loamy sand.

The 2C horizon has hue of 10YR, 2.5Y or 5Y, value of 3 to 6 and 5 to 8 dry, and chroma of 1 to 6. It is sand or coarse, or their gravelly analogues, containing up to 35 percent rock fragments. It is slightly alkaline or moderately alkaline. It has few to many, and faint to prominent redox features in some pedons. Glacial till or lacustrine sediments with textures of loam, clay loam or silt loam are below depths of 40 inches in some pedons.

COMPETING SERIES: These are the Karlsruhe and Ulen series. Karlsruhe soils have loamy sand or coarser textures at depths of less than 20 inches. Ulen soils have a particle-size control section that averages fine sand or loamy fine sand with less than 30 percent medium and coarser sand.

GEOGRAPHIC SETTING: Wyrene soils are on level and nearly level slightly depressed areas on outwash plains and interbeach areas. Slope ranges from 0 to 3 percent. The soils formed in moderately coarse overlying coarse textured sediments. The climate is cool, subhumid. Mean annual air temperature ranges from 37 to 45 degrees F, and mean annual precipitation from 15 to 22 inches. Most of the precipitation comes in the spring and summer. Frost-free period ranges from 110 to 140 days. Elevation above sea level ranges from 900 to 2300 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arveson, Arvilla, Claire, Divide, Hamar, Hangaard, Lohnes, Marysland, Osakis, Sandberg, Syrene, Totten, Warsing and Wyndmere soils. Arveson, Marysland, Syrene and Totten soils are on nearby slightly lower lying areas. Arveson soils are coarse-loamy. Marysland soils are fine-loamy over sandy or sandy skeletal. Totten soils have natric horizons. Arvilla, Claire, Lohnes, Osakis, Sandberg and Warsing soils are on higher lying areas and are moderately well drained to excessively drained. Divide, Hamar and Wyndmere soils are on nearby outwash plains. Divide soils are fine-loamy over sandy or sandy-skeletal. Hamar and Hangaard soils do not have calcic horizons. Wyndmere soils are coarse-loamy.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. Runoff is negligible or very low depending on slope. Permeability is moderately rapid in the upper part and rapid in the lower part. A seasonal high water table is at a depth of 1.5 to 3.5 feet below the surface at some time during the period of April through June.

USE AND VEGETATION: Soils are cropped to spring seeded small grains. Some are used for hay and pasture. Native vegetation was mid and tall prairie grasses such as little and big bluestem.

DISTRIBUTION AND EXTENT: Central and eastern North Dakota and northwestern Minnesota. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Eddy County, North Dakota, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 8 inches (A horizon); calcic horizon - the zone from 8 to 21 inches (Bk1 and Bk2 horizons).

ADDITIONAL DATA: Laboratory data sample S76ND49-11.

National Cooperative Soil Survey
U.S.A.

LOCATION ZELL SD+MN ND

Established Series
Rev. FTM-CJH
2/99

ZELL SERIES

The Zell series consists of very deep, well drained moderately permeable soils formed in glaciolacustrine sediments. These upland soils have slopes ranging from 0 to 25 percent. Mean annual air temperature is about 44 degrees F., and mean annual precipitation is about 18 inches.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, frigid Typic Calciudolls

TYPICAL PEDON: Zell silt loam - on a 15 percent convex east-facing slope in native grass. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated)

A--0 to 6 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine and medium granular structure; soft, very friable; slight effervescence; slightly alkaline; clear smooth boundary. (4 to 10 inches thick)

Bk1--6 to 11 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak medium and coarse subangular blocky structure parting to weak fine granular; soft, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

Bk2--11 to 18 inches; light brownish gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/4) moist; many fine distinct yellowish brown (10YR 5/6) moist relict redoximorphic concentrations and many fine prominent gray (5Y 5/1) moist relict redoximorphic depletions; weak coarse subangular blocky; slightly hard, friable; few fine threads and masses of calcium carbonate; violent effervescence; moderately alkaline; clear wavy boundary. (Combined thickness of Bk horizons is 0 to 25 inches)

Bky--18 to 26 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; many medium prominent yellowish brown (10YR 5/6) moist relict redoximorphic concentrations and gray (5Y 5/1) moist relict redoximorphic depletions; weak medium and fine subangular blocky structure parting to weak thin platy; slightly hard, friable; few fine threads and masses of calcium carbonate; few fine nests of gypsum; strong effervescence; slightly alkaline; gradual smooth boundary. (0 to 12 inches thick)

C--26 to 60 inches; pale yellow (2.5Y 7/3) silt loam, light yellowish brown (2.5Y 6/3) moist; many coarse prominent brownish yellow (10YR 6/6) moist relict redoximorphic concentrations and gray (5Y 5/1) moist relict redoximorphic depletions; laminated; slightly hard, friable; strong effervescence; moderately alkaline.

TYPE LOCATION: Brown County, South Dakota; about 2 miles west and 1.5 miles north of Stratford; 2,500 feet north and 1,320 feet east of the southwest corner, sec. 31, T. 122 N., R. 62 W.

RANGE IN CHARACTERISTICS: The thickness of the mollic epipedon ranges from 7 to 16 inches. Typically, free calcium carbonates are at the surface, but are leached from the upper few inches in some pedons in native grass. Redoximorphic features are inherent from the parent material and vary widely in amount and intensity between pedons.

The A horizon has value of 3 to 5 and 2 or 3 moist, and chroma of less than 1.5. It has a chroma of 2 in some cultivated pedons. It typically is silt loam but is very fine sandy loam, fine sandy loam, or loam in some pedons. It ranges from neutral to moderately alkaline. Some pedons have an AB horizon. Some pedons have a thin Bw horizon. The combined thickness of A and Bw horizons is less than 10 inches thick.

The Bk and Bky horizons have hue of 10YR or 2.5Y, value of 5 to 8 and 3 to 6 moist, and chroma of 2 to 4. It is silt loam or very fine sandy loam. It is slightly or moderately alkaline. Few or common, fine or medium masses and threads of calcium carbonate are in the Bk horizon which has a calcium carbonate equivalent of 10 to 20 percent. Few to many, fine or medium nests of gypsum are in most pedons.

The C horizons have hue of 10YR or 2.5Y, value of 6 to 8 and 4 to 6 moist, and chroma of 2 to 4. They are is silt loam, loam, or very fine sandy loam with thin lenses of finer or coarser textures in the lower part. Some pedons are not distinctly laminated below depths of 16 to 20 inches. The C horizon is slightly to strongly alkaline.

COMPETING SERIES: This is the Huffton series. Huffton soils have an electrical conductivity of more than 4 mmhos.

GEOGRAPHIC SETTING: Zell soils are on uplands having convex surfaces. Slope gradients typically are less than 15 percent but ranges from 0 to 25 percent. The soils formed in silty calcareous glaciolacustrine sediments. The mean annual air temperature ranges from 36 to 45 degrees F., and the mean annual precipitation ranges from 16 to 24 inches. Growing season is about 105 to 165 days; average growing season precipitation ranges from 14 to 20 inches; and growing degree days are about 2500 to 3500. Elevation above sea level ranges from 650 to 2350 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Huffton soils and the Beotia, Eckman, Gardena, Glyndon, and Great Bend soils. Huffton soils are on similar landscapes. Beotia and Gardena soils have mollic epipedons greater than 16 inches thick and are in swales. Eckman and Great Bend soils have cambic horizons and are on nearly level to moderately sloping nearby landscapes. Glyndon soils have calcic horizons and are on nearly level nearby landscapes.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is medium or high. Permeability is moderate.

USE AND VEGETATION: Areas on steeper slopes are mainly in native grass. The principal species are sideoats grama, little bluestem, blue grama, big bluestem, needleandthread, western wheatgrass, prairie dropseed, sedges, and forbs. Most of the less sloping areas are cultivated. Small grain, corn, and alfalfa are the principal crops.

DISTRIBUTION AND EXTENT: Northeastern South Dakota, eastern North Dakota, and western Minnesota. The Zell series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Spink County, South Dakota, 1955.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 7 inches after mixing the top 7 inches (A horizon).

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