1979-1

ADDENDUM TO SOIL CLASSIFICATION

and

CHARACTERIZATION FOR GRASSLAND ECOLOGY STUDY

in

CYPRESS HILLS, ALBERTA

by

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Soils Division
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PREFACE

This is an addendum to a report written in 1978 wherein 13 soil profiles were described and sampled to classify and characterize the soils associated with different plant communities identified in a grassland ecology study in the Cypress Hills of Alberta (Greenlee 1978). As mentioned in that report, the study is being conducted by Glennis Lewis, a graduate student in the Department of Biology at the University of Calgary, under a contract with the Provincial Parks Division of Alberta Recreation, Parks and Wildlife. Nineteen additional soil profiles were described and sampled during the summer of 1978, and the ensuing report presents results of the chemical and physical analyses (Table 1), and the profile descriptions of these nineteen.

ACKNOWLEDGMENTS

The Parks Planning Branch of Alberta Recreation, Parks and Wildlife provided the funds for this program, while the Alberta Research Council provided the staff and office space and also published the report. Laboratory space was provided by the University of Alberta.

Mrs. Pal Foster typed and assisted in compiling and proof reading the report, while the soil chemical and physical analyses were determined by Messrs. A. Schwarzer and W. McKean.

Able field assistance was given by Mr. D. Skinner.

CHEMICAL AND PHYSICAL ANALYSES

Analytical data pertinent to soil classification and characterization is presented in Table 1. A brief explanation of the significance of each analysis is presented in the initial report (Greenlee 1978).

Table 1. Chemical and Physical Analyses of Soil Samples from Cypress Hills.

Map Unit	Site #	Horizon	Depth cm	pH $CaCl_2$	pH H_2O	Exchangeable cations [1] meq/100g				[2] CEC meq/100g	[3] OC %	$CaCO_3$ equiv. %	Mechanical analysis % from fract. <2 mm diam.			[4] % C.F.	Texture		Moisture %	
						Na	K	Ca	Mg				Sand	Silt	Clay		Lab det	Field est	1/3 bar	15 bar
7	1	Ah	0-10	5.8	6.4	0.05	1.57	13.28	4.42	29.1	3.99	[5] nd	43	37	20	1	L	L	27	18
		Btnj	10-54	6.1	6.6	0.37	1.13	11.41	7.48	25.5	1.28	nd	45	28	27	1	SCL	CL	25	16
		BC	54-74	7.1	7.7	nd	nd	nd	nd	nd	nd	0.2	56	26	18	1	SL	SCL	19	11
		Cca	74-100	7.8	8.4	nd	nd	nd	nd	nd	nd	1.7	51	33	16	1	L	L	nd	nd
7	2	Ah	0-10	5.4	5.9	0.04	1.37	10.59	3.89	25.5	3.60	0.1	47	34	19	1	L	L	30	21
		Btnj	10-54	6.4	6.9	0.32	1.20	12.19	8.25	26.8	0.94	0.2	45	26	29	1	CL-SCL	CL	25	16
		BC	54-74	7.4	8.0	nd	nd	nd	nd	nd	nd	0.3	53	28	19	1	SL	SCL	19	11
		Cca	74-100	7.9	8.4	nd	nd	nd	nd	nd	nd	3.39	52	35	13	1	L-SL	L	nd	nd
7	3 (heavily grazed)	Ah	0-10	5.9	6.4	0.03	2.10	16.96	8.20	31.4	4.07	nd	35	28	37	10	CL	L	34	28
		Bm	10-60	5.9	6.5	0.11	1.03	14.03	8.71	25.7	1.72	nd	37	27	36	10	CL	CL	26	21
		BC	60-100	6.8	7.2	0.55	0.93	12.00	9.48	22.7	nd	0.1	46	25	29	15	SCL	CL	nd	nd
7	3 (non-grazed)	Ah	0-10	5.7	6.2	0.06	2.04	17.50	7.43	31.5	4.83	nd	30	36	34	10	CL	L	38	28
		Bm	10-60	6.0	6.5	0.27	1.24	14.72	9.99	26.8	1.73	nd	35	25	40	10	CL-C	CL	29	22
		BC	60-100	7.3	7.7	nd	nd	nd	nd	nd	nd	0.1	39	27	34	15	CL	CL	nd	nd
7	4	Ah	0-6	7.0	7.5	nd	nd	nd	nd	nd	3.09	nd	47	36	17	1	L	L	23	17
		Bm	6-22	7.3	7.8	nd	nd	nd	nd	nd	1.91	0.1	39	39	22	1	L	L	23	16
		Cca	22-100	8.0	8.1	nd	nd	nd	nd	nd	nd	20.5	35	53	12	1	SiL	VFSL	23	9
9	5	Ah	0-18	5.8	6.3	0.02	1.95	20.12	5.44	37.0	5.33	nd	32	46	22	10	L	SiL	36	27
		Bm	18-74	5.8	6.2	0.09	0.72	11.09	6.97	23.5	0.95	nd	38	40	22	10	L	SiCL	22	13
		BC	74-88	6.5	6.9	0.11	0.65	11.66	6.97	21.7	nd	0.3	40	41	19	10	L	SCL	nd	nd
		Cca	88-100	7.6	7.9	nd	nd	nd	nd	nd	nd	7.4	29	44	27	70	L-CL	[6] v.gv. SCL	nd	nd

1 meq/100g = milliequivalents/100 gm soil

2 CEC = cation exchange capacity

3 OC = organic carbon

4 CF = coarse fragments (>2 mm diam)(field estimate)

5 nd = not determined

6 gv. = gravelly, v.gv. = very gravelly

Table 1. Chemical and Physical Analyses of Soil Samples from Cypress Hills (cont..)

Map Unit	Site #	Horizon	Depth cm	pH $CaCl_2$	pH H_2O	Exchangeable cations [1] meq/100g				[2] CEC meq/100g	[3] OC %	$CaCO_3$ equiv. %	Mechanical analysis % from fract. <2mm diam.			[4] % C.F.	Texture		Moisture %	
						Na	K	Ca	Mg				Sand	Silt	Clay		Lab det	Field est	1/3 bar	15 bar
1	6 (moderately grazed)	Ah	0-10	6.1	6.5	0.03	1.69	19.02	4.99	31.9	4.16	nd	31	39	30	15	CL	L	32	23
		Bm	10-33	6.4	7.0	0.03	0.95	16.50	6.20	28.0	1.67	2.32	34	33	33	10	CL	L	25	17
		Cca	33-100	7.7	8.1	nd	nd	nd	nd	nd	nd	21.84	21	42	37	10	CL	SICL	29	14
1	6 (slightly grazed	Ck	0-25	7.6	8.0	nd	nd	nd	nd	nd	1.53	9.1	52	31	17	60	L-SL	v.gv. L	20	13
		Cca	25-100	7.7	8.1	nd	nd	nd	nd	nd	0.61	13.1	32	41	27	60	L-CL	v.gv. L	22	12
9	7	Ah	0-14	5.2	5.5	0.04	1.62	23.44	4.46	43.2	8.47	nd	11	60	29	0	SICL	SIL	52	40
		Bm	14-24	4.8	5.4	0.08	1.07	9.94	2.61	22.3	3.06	nd	15	57	28	70	SICL	v.gv SIL	29	17
		BC	24-45	4.8	5.1	0.04	1.23	16.59	6.97	31.5	nd	0.1	22	39	39	90	CL	v gv SICL	33	21
9	8	Ah	0-18	5.8	6.3	0.02	1.58	18.28	4.15	34.5	4.29	nd	40	37	23	1	L	L	32	23
		Bm	18-50	5.6	6.0	0.03	0.75	11.59	3.84	21.7	1.19	nd	54	26	20	1	SL-SCL	L	20	12
		BC	50-95	5.9	6.3	0.07	0.58	12.06	4.15	21.7	nd	nd	47	31	22	5	L	L	20	11
		Cca	95-100	7.5	7.8	nd	nd	nd	nd	nd	nd	13.7	31	44	25	80	L	v.gv CL	nd	nd
13	9	Ah	0-12	5.5	5.9	0.12	1.75	26.41	7.22	53.7	10.10	nd	23	47	30	10	CL	SIL	52	40
		Bm	12-42	5.5	5.8	0.11	0.68	13.13	6.20	25.5	1.54	nd	27	45	28	20	CL	[6] gv. SiCL	28	16
		BC	42-65	5.8	6.1	0.05	0.78	15.47	6.97	29.0	nd	0.2	29	37	34	70	CL	v.gv CL	27	17
1	10	Ah	0-10	6.1	6.6	0.01	1.59	16.88	6.71	32.5	4.91	nd	40	34	26	30	L	gv.L	31	25
		Bm	10-25	7.4	7.8	nd	nd	nd	nd	nd	2.59	nd	38	42	20	30	L	gv.L	26	16
		Cca	25-100	7.9	8.3	nd	nd	nd	nd	nd	nd	26.1	35	38	27	30	L-CL	gv.CL	26	11
17	11	Ahk	0-18	7.0	7.5	0.60	0.61	42.34	8.50	55.7	5.89	2,6	7	53	40	0	SiCL-SIC	L	49	35
		Bmgk	18-33	7.4	7.7	nd	nd	nd	nd	nd	2.53	2.5	2	49	49	0	SiC	SICL	41	29
		Ccag	33-100	7.7	8.1	nd	nd	nd	nd	nd	nd	12.6	1	54	45	0	SiC	SICL	38	24

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						Na	K	Ca	Mg				Sand	Silt	Clay		Lab det	Field est	1/3 bar	15 bar
1	12	Ah	0-12	6.3	6.7	0.03	1.42	24.13	6.97	40.2	6.21	nd	26	45	29	30	CL	gv.L	39	32
		Bm	12-30	6.7	7.2	0.06	0.59	20.63	7.74	34.3	1.98	nd	35	19	46	30	C	gv.CL	29	19
		Cca	30-100	7.6	8.0	nd	nd	nd	nd	nd	nd	14.3	24	38	38	50	CL	v.gv CL	26	15
2	13 (moderately grazed)	Ah	0-24	5.1	5.5	0.03	0.80	25.38	2.82	38.6	5.40	0.1	25	43	32	10	CL	L	38	27
		Bmk	24-50	7.0	7.5	0.04	0.49	24.34	1.23	24.6	1.26	0.3	33	39	28	15	CL	L	24	14
		BCk	50-88	7.4	7.8	nd	nd	nd	nd	nd	nd	0.3	20	46	34	25	SICL-CL	gv. SICL	25	16
		Cca	88-100	7.6	7.9	nd	nd	nd	nd	nd	nd	13.0	11	50	39	45	SICL	gv SICL	nd	nd
2	13 (non-grazed)	Ah	0-24	5.1	5.7	0.08	1.48	27.07	3.91	46.6	9.44	nd	21	49	30	10	CL	L	52	37
		Bm	24-50	4.8	5.3	0.48	0.64	12.22	3.18	24.4	2.33	nd	36	35	29	15	CL	L	26	15
		BC	50-88	5.4	5.9	0.10	0.55	19.50	4.35	30.4	nd	0.2	17	53	30	25	SICL	gv. SICL	27	15
		Cca	88-100	7.6	7.9	nd	nd	nd	nd	nd	nd	14.0	8	59	33	45	SICL	gv. SICL	nd	nd
9	14 slightly grazed)	Ah	0-34	4.9	5.9	0.10	1.02	20.54	2.85	41.5	7.23	nd	7	69	24	15	SIL	SIL	50	35
		Ahe	34-44	5.1	6.0	0.07	0.49	14.50	2.62	26.7	1.48	nd	10	59	31	15	SICL	SIL	29	13
		Bt	44-90	5.2	5.6	0.13	0.61	21.28	4.20	40.4	0.61	0.1	10	51	39	25	SICL	gv. SICL	26	17
		BC	90-100	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	90	nd	v.gv. SiCL	nd	nd
9	14 (non-grazed	Ah	0-34	5.3	5.6	0.02	1.40	23.79	3.29	50.7	8.13	nd	7	69	24	15	SiL	SiL	50	37
		Ahe	34-44	5.1	5.6	0.03	0.66	10.78	2.20	29.1	2.08	nd	9	64	27	15	SiL-SICL	SiL	32	16
		Bt	44-90	5.0	5.3	0.10	0.58	19.25	3.02	34.5	0.99	0.1	13	53	34	25	SICL	gv. SICL	30	16
13	15	Ah	0-10	6.8	7.3	0.10	0.69	26.17	7.75	37.8	6.56	nd	36	39	25	10	L	SIL	36	26
		Bm	10-48	4.9	5.3	0.09	0.47	17.47	6.97	37.4	1.40	nd	17	43	40	20	SICL-SiC	gv. SICL	27	19
		BC1	48-86	5.2	6.0	0.05	0.16	5.84	1.54	9.8	nd	nd	71	17	12	30	SL	gv.SL	nd	nd
		BC2	86-100	5.6	6.2	0.06	0.16	6.09	1.49	8.8	nd	0.2	74	17	9	0	SL	LS	nd	nd

1 meq/100g = milliequivalents/100 gm soil

2 CEC = cation exchange capacity

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4 CF = coarse fragments (> 2 mm diam) (field estimate)

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SOIL PROFILE DESCRIPTIONS

Site 1 (non-grazed)

Map Unit:	7 (Greenlee 1978)
Classification:	Solonetzic Dark Brown Chernozemic
Date sampled:	24 September, 1978
Location:	SE 1-8-4-4, 12 UWK 425960
Parent material:	medium to moderately coarse textured till
Landform:	steep morainal (Ms)
Relief:	about 10 m over a frequency of about 100 m
Slope and topography class:	about 10% (e)
Slope range:	9 to 12%
Elevation:	about 1150 m
Aspect:	30° north of west
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 20% shrub cover with sagebrush (Artemisia cana); about 30% herb cover with pasture sagewort (Artemisia frigida), pussy-toes (Antennaria, spp.), common yarrow (Achillea millefolium), cinquefoil (Potentilla, spp.)and others; and about 80% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-10	Dark yellowish brown (10YR 3/4 m), dark grayish brown (10YR 4/2 d) loam; moderate, medium granular; very friable, moist; plentiful, micro to fine, vertical roots; moderately porous; estimated angular gravelly coarse fragments about 1%; clear, wavy boundary; neutral.

Btnj	10-54	Dark Brown (10YR 3/3 m, d) sandy clay loam; moderate, medium prismatic breaking to strong, medium and coarse subangular blocky; very friable, moist and very hard, dry; few, micro to fine, oblique roots; slightly porous; estimated angular gravelly coarse fragments about 1%; gradual, wavy boundary; neutral.
BC	54-74	Yellowish brown (10YR 5/4 m) sandy loam; moderate, medium subangular blocky; hard, dry; very few, micro to very fine, oblique roots; moderately porous; estimated angular gravelly coarse fragments about 1%; clear, wavy boundary; neutral.
Cca	74-100	Pale brown (10YR 6/3 m) loam; amorphous; hard, dry; very few, micro, oblique roots; moderately porous; strong effervescence; estimated angular gravelly coarse fragments about 1%; alkaline.

Site 2 (heavily grazed)

Map Unit:	7
Classification:	Solonetzic Dark Brown Chernozemic
Date sampled:	24 September, 1978
Location:	SW6-8-3-4, 12 UWK 426960, about 3 m east of site 1. The same description applies to both Sites 1 and 2, except that Site 2 has only a 1% shrub cover, as compared with 20% for Site 1.

Site 3 (heavily grazed)

Map Unit:	7
Classification:	Orthic Dark Brown Chernozemic
Date sampled:	19 September, 1978
Location:	NW6-8-3-4, 12 UWK 429963
Parent material:	moderately fine textured till
Landform:	steep morainal (Ms)
Relief:	about 13 m over a frequency of about 100 m
Slope and topography class:	about 13% (e)
Slope range:	13 to 20%
Elevation:	about 1175 m
Aspect:	40° west of north
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 10% shrub cover with sagebrush (Artemisia cana); about 70% herb cover with pussy-toes (Antennaria, spp.), pasture sagewort (Artemisia frigida) and others; and about 90% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-10	Very dark brown (10YR 2/2 m), dark brown (10YR 3/3 d) clay loam; moderate, fine and medium granular; friable, moist; plentiful, micro to fine and few, medium, vertical roots; moderately porous; estimated angular gravelly and shaly coarse fragments about 1%; clear, wavy boundary; neutral.
Bm	10-60	Very dark grayish brown (10YR 3/2 m), dark brown (10YR 3/3 d) clay loam; moderate, medium prismatic breaking to weak, fine and medium subangular blocky;

friable, moist and hard, dry; few, very fine, vertical roots; moderately porous; estimated angular gravelly and shaly coarse fragments about 10%; gradual, wavy boundary; neutral.

BC	60–100	Dark brown (10YR 4/3 m) sandy clay loam; weak, medium prismatic breaking to strong, fine and medium subangular blocky; very hard, dry; very few, micro, vertical roots; slightly porous; estimated angular gravelly and shaly coarse fragments about 15%; neutral.

Site 3 (non-grazed)

Map Unit:	7
Classification:	Orthic Dark Brown Chernozemic
Date sampled:	19 September, 1978
Location:	same as Site 3 (heavily grazed), about 3 m west of the other sample pit. The same description applies to both the Site 3 sample pits (heavily grazed and non-grazed locations).

Site 4 (heavily grazed)

Map Unit:	7
Classification:	Orthic Melanic Brunisol
Date sampled:	24 September, 1978
Location:	SW6-8-3-1, 12 UWK 431961
Parent material:	medium textured till, containing a high proportion of weathered sandstone.
Landform:	hummocky morainal (Mh)

Relief:	about 5 m over a frequency of about 100 m.
Slope and topography class:	about 5% (c)
Slope range:	5 to 30%
Elevation:	about 1235 m
Aspect:	40° east of north
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 30% herb cover with pasture sagewort (Artemisia frigida), pussy-toes (Antennaria, spp.) and others; and about 50% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0–6	Dark yellowish brown (10YR 3/4 m), grayish brown (10YR 5/2 d) loam; weak, fine and medium granular; very friable, moist; few, micro to fine, vertical and few, medium, horizontal roots; moderately porous; estimated angular gravelly coarse fragments about 1%; clear, wavy boundary; neutral.
Bm	6–22	Dark yellowish brown (10YR 3/4 m) loam; moderate, medium prismatic breaking to weak, medium subangular blocky; very friable, moist; few, micro to fine, vertical roots; moderately porous; estimated angular gravelly coarse fragments about 1%; clear, wavy boundary; neutral.
Cca	22–100	Yellowish brown (10YR 5/4 m), pale brown (10YR 6/3 d) (pockets of reddish yellow – 5YR 6/6 d) silt loam;

amorphous breaking to weak, medium subangular blocky; very friable, moist and slightly hard, dry; very few, micro and very fine, oblique roots; moderately porous; strong effervescence; estimated angular gravelly coarse fragments about 1%; alkaline.

Site 5 (very slightly grazed)

Map Unit:	9
Classification:	Orthic Black Chernozemic
Date sampled:	24 September, 1978
Location:	SW5-8-3-4, 12 UWK 443957
Parent material:	medium to moderately fine textured loess overlying conglomerate
Landform:	eolian veneer overlying level fluvial (Ev/Fl)
Relief:	about 1 m over a frequency of about 100 m
Slope and topography class:	about 1% (b)
Slope range:	0.5 to 2.5%
Elevation:	about 1355 m
Aspect:	40° west of south
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 40% herb cover with prairie sagewort (Artemisia ludoviciana), pasture sagewort (Artemisia frigida), golden bean (Thermopsis rhombifolia), wild lupine (Lupinus, spp.), goldenrod (Solidago, spp.), cinquefoil (Potentilla, spp.), common yarrow (Achillea millefolium), wild rose (Rosa, spp.), pussy-toes (Antennaria, spp.) and others; and 100% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-18	Black (10YR 2/1 m) loam; weak, medium granular; very friable, moist; plentiful, micro to medium, vertical and oblique roots; moderately porous; estimated gravelly and angular gravelly coarse fragments about 10%; gradual, wavy boundary; neutral.
Bm	18-74	Dark brown (10YR 3/3 m, 4/3 d) loam; moderate, medium prismatic breaking to moderate, medium subangular blocky; friable, moist and hard, dry; few, micro to fine, vertical and oblique roots; slightly porous; estimated gravelly and angular gravelly coarse fragments about 10%; gradual, wavy boundary; neutral.
BC	74-88	Yellowish brown (10YR 5/4 m) loam; weak, medium prismatic breaking to weak, medium subangular blocky; slightly hard, dry; very few, micro to very fine, oblique roots; moderately porous; estimated gravelly and angular gravelly coarse fragments about 10%; clear, wavy boundary; neutral.
Cca	88-100	Brown (10YR 5/3 m) loam to clay loam; amorphous breaking to weak, medium subangular blocky; firm, moist; very few, micro to very fine, oblique roots; moderately porous; strong effervescence; estimated gravelly to cobbly coarse fragments about 70%; alkaline.

Site 6 (slightly grazed)

Map Unit:	1
Classification:	Orthic Regosol
Date sampled:	25 September, 1978
Location:	NW 19-8-2-4, 12 UWL 527018
Parent material:	moderately coarse textured to moderately fine textured till
Landform:	steep morainal (Ms)
Relief:	about 45 m over a frequency of about 100 m
Slope and topography class:	about 45% (g)
Slope range:	40 to 50%
Elevation:	about 1295 m
Aspect:	10° west of south
Erosion:	slight
Surface stoniness:	very stony (3)
Estimated drainage:	well drained
Vegetation:	about 20% shrub cover with buckbrush (Symphoricarpos occidentalis) and wild rose (Rosa, spp.); about 30% herb cover with pasture sagewort (Artemisia frigida), wild lupine (Lupinus, spp.), wild blue flax (Linum lewisii), goats-beard (Tragopogon dubius), golden bean (Thermopsis rhombifolia) and others; and about 80% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ck	0-25	Dark brown (10 YR 4/3 m) loam to sandy loam; moderate, medium prismatic breaking to weak, medium subangular blocky; very friable, moist; plentiful, micro to fine, vertical and few, medium and coarse, horizontal roots; moderately porous; moderate effervescence;

		estimated gravelly and angular gravelly to cobbly and angular cobbly coarse fragments about 60%; gradual, wavy boundary; alkaline.
Cca	25–100	Yellowish brown (10YR 5/4 m) loam to sandy loam; amorphous; very friable, moist; few, micro to fine, oblique roots; moderately porous; strong effervescence; estimated gravelly and angular gravelly to cobbly and angular cobbly coarse fragments about 60%; alkaline.

Site 6 (moderately grazed)

Map Unit:	1
Classification:	Orthic Dark Brown Chernozemic
Date sampled:	25 September, 1978
Location:	NW19-8-2-4, 12 UWL 526017, about 120 m south, downslope from the other Site 6 sample pit.
Parent material:	moderately fine textured till
Landform:	steep morainal (Ms)
Relief:	about 20 m over a frequency of about 100 m
Slope and topography class:	20% (f)
Slope range:	20 to 45%
Elevation:	about 1255 m
Aspect:	30° south of west
Erosion:	nil
Surface stoniness:	moderately stony (2)
Estimated drainage:	well drained
Vegetation:	about 1% shrub cover with wild rose (Rosa, spp.); about 20% herb cover with pasture sagewort (Artemisia frigida), common yarrow (Achillea millefolium),

Canada thistle (Cirsium arvense), northern bedstraw (Galium boreale) and others; and about 70% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-10	Dark brown (10YR 3/3 m) clay loam; moderate, medium granular; very friable, moist; few, micro to fine, vertical and very few, medium, horizontal roots; moderately porous; estimated gravelly and cobbly coarse fragments about 15%; clear, wavy boundary; neutral.
Bm	10-33	Dark brown (10YR 4/3 m) clay loam; strong, medium prismatic breaking to moderate, medium subangular blocky; friable, moist; very few, micro to very fine, vertical roots; moderately porous; estimated angular gravelly and angular cobbly coarse fragments about 10%; abrupt, wavy boundary; neutral.
Cca	33-100	Pale brown (10YR 6/3 m) clay loam; amorphous breaking to weak, medium subangular blocky; friable, moist; very few, micro to very fine, oblique roots; slightly porous; strong effervescence; estimated angular gravelly and angular cobbly coarse fragments about 10%; alkaline.

Site 7 (non-grazed)

Map Unit: 9

Classification: Orthic Black Chernozemic

Date sampled: 22 September, 1978

Location:	SE 28-8-2-4, 12 UWL 570021
Parent material:	moderately fine textured loess overlying conglomerate
Landform:	eolian veneer overlying inclined fluvial (Ev/Fi)
Relief:	about 3 m over a frequency of about 100 m
Slope and topography class:	0% (a)
Slope range:	0 to 5%
Elevation:	about 1415 m
Aspect:	level
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 30% shrub cover with shrubby cinquefoil (Potentilla fruticosa) and wild rose (Rosa, spp.); about 50% herb cover with cinquefoil (Potentilla, spp.), common yarrow (Achillea millefolium); cut-leaved anemone (Anemone multifida), meadow parsnip (Zizia aptera) and others; and 100% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-14	Very dark brown (10YR 2/2 m) silty clay loam;weak, medium granular; very friable, moist; plentiful, micro to fine, vertical and few, fine to medium, oblique roots; moderately porous; clear, wavy boundary; acid.
Bm	14-24	Dark yellowish brown (10YR 3/4 m) silty clay loam; weak, medium prismatic breaking to moderate, medium subangular blocky; very friable, moist; few, micro to fine, oblique roots; estimated gravelly coarse fragments about 70%; clear, wavy boundary; acid.

BC	24-45	Brown (7.5YR 5/4 m) clay loam; moderate, medium subangular blocky; friable, moist; very few, micro to very fine, oblique roots; slightly porous; estimated gravelly and cobbly coarse fragments about 90%; acid.

Site 8 (slightly grazed)

Map Unit:	9
Classification:	Orthic Black Chernozemic
Date sampled:	26 September, 1978
Location:	SW28-8-1-4, 12 UWL 655020
Parent material:	medium textured loess overlying conglomerate
Landform:	eolian veneer overlying level fluvial (Ev/Fl)
Relief:	about 1 m over a frequency of about 100 m
Slope and topography class:	about 1% (b)
Slope range:	0.5 to 2.5%
Elevation:	about 1380 m
Aspect:	south
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 1% shrub cover with shrubby cinquefoil (Potentilla fruticosa); about 40% herb cover with pasture sagewort (Artemisia frigida), common yarrow (Achillea millefolium), wild lupine (Lupinus, spp.), loco-weed (Oxytropis, spp.), prairie sagewort (Artemisia ludoviciana), golden bean (Thermopsis rhombifolia) and others; and about 95% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0–18	Very dark brown (10YR 2/2 m), very dark grayish brown (10YR 3/2 d) loam; moderate, medium granular; very friable, moist; plentiful, micro to medium, horizontal roots; moderately porous; estimated gravelly coarse fragments about 1%; gradual, wavy boundary; neutral.
Bm	18–50	Dark brown (10YR 4/3 m) sandy loam to sandy clay loam; strong, medium prismatic breaking to moderate, medium subangular blocky; friable, moist; few, micro to fine, horizontal and oblique roots; moderately porous; estimated gravelly coarse fragments about 1%; gradual, wavy boundary; neutral.
BC	50–95	Yellowish brown (10YR 5/4 m), light yellowish brown (10YR 6/4 d) loam; moderate, medium prismatic breaking to weak, medium subangular blocky; very friable, moist and hard, dry; few, micro to very fine, oblique roots; moderately porous; estimated gravelly coarse fragments about 5%; clear, wavy boundary; neutral.
Cca	95–100	Pale brown (10YR 6/3 m) loam; amorphous; hard, dry; very few, micro, oblique roots; slightly porous; strong effervescence; estimated gravelly and angular gravelly to cobbly and angular cobbly coarse fragments about 80%; alkaline.

Site 9 (slightly grazed)

Map Unit:	13
Classification:	Orthic Black Chernozemic
Date sampled:	26 September, 1978
Location:	SW28-8-1-4, 12 UWL 658026
Parent material:	very coarse textured fluvial sediments (gravel)
Landform:	steep fluvial (Fs)
Relief:	about 20 m over a frequency of about 100 m
Slope and topography class:	about 20% (f)
Slope range:	16 to 30%
Elevation:	about 1360 m
Aspect:	20° west of north
Erosion:	nil
Surface stoniness:	exceedingly stony (4)
Estimated drainage:	well drained
Vegetation:	about 20% shrub cover with shrubby cinquefoil (Potentilla fruticosa) and wild rose (Rosa, spp.), about 40% herb cover with common yarrow (Achillea millefolium), wild lupine (Lupinus, spp.), pasture sagewort (Artemisia frigida), golden bean (Thermopsis rhombifolia), northern bedstraw (Galium boreale), goldenrod (Solidago, spp.), loco-weed (Oxytropis, spp.) and others; and about 90% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-12	Black (10YR 2/1 m) clay loam; moderate, medium granular; very friable, moist; plentiful, micro to medium, vertical and oblique roots; moderately porous; estimated gravelly and cobbly coarse fragments about 10%; gradual, irregular boundary; neutral.

Bm	12-42	Dark yellowish brown (10YR 4/4 m) clay loam; strong, medium prismatic breaking to moderate, medium subangular blocky; friable, moist; few, micro to fine, oblique roots; slightly porous; estimated gravelly and cobbly coarse fragments about 20%; gradual, wavy boundary; neutral.
BC	42-65	Dark grayish brown (2.5Y 4/2 m) clay loam; moderate, medium subangular blocky; firm, moist; few, micro to very fine, oblique roots; slightly porous; estimated gravelly and cobbly coarse fragments about 70%; neutral.

Site 10 (slightly grazed)

Map Unit:	1
Classification:	Orthic Dark Brown Chernozemic
Date sampled:	26 September, 1978
Location:	NW 28-8-1-4, 12 UWL 658033
Parent material:	medium to moderately fine textured till
Landform:	hummocky morainal (Mh)
Relief:	about 24 m over a frequency of about 100 m
Slope and topography class:	about 24% (f)
Slope range:	16 to 30%
Elevation:	about 1260 m
Aspect:	30° south of west
Erosion:	nil
Surface stoniness:	exceedingly stony (4)
Estimated drainage:	well drained

Vegetation: about 5% shrub cover with wild rose (Rosa, spp.) and shrubby cinquefoil (Potentilla fruticosa); about 30% herb cover with pasture sagewort (Artemisia frigida), prairie sagewort (Artemisia ludoviciana), owl-clover (Orthocarpus luteus) and others; and about 70% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-10	Very dark grayish brown (10YR 3/2 m), dark grayish brown (10YR 4/2 d) loam; strong, medium granular; very friable, moist; plentiful, micro to fine, vertical and few, medium, oblique roots; moderately porous; estimated angular gravelly and angular cobbly coarse fragments about 30%; clear, wavy boundary; neutral.
Bm	10-25	Dark brown (10YR 3/3 m) loam; strong, medium prismatic breaking to moderate, medium subangular blocky; very friable, moist; few, micro to very fine, vertical roots; moderately porous; estimated angular gravelly and angular cobbly coarse fragments about 30%; clear, wavy boundary; neutral.
Cca	25-100	Yellowish brown (10YR 5/4 m) loam to clay loam; amorphous breaking to weak, medium subangular blocky; friable, moist; very few, micro and very fine, oblique roots; slightly porous; strong effervescence; estimated angular gravelly and angular cobbly coarse fragments about 30%; alkaline.

Site 11 (moderately grazed)

Map Unit:	17
Classification:	Gleyed Black Chernozemic, Carbonated phase
Date sampled:	25 September, 1978
Location:	SE 21-8-1-4, 12 UWL 669011
Parent material:	fine textured fluvial sediments
Landform:	level fluvial (Fl)
Relief:	about 1 m over a frequency of about 100 m
Slope and topography class:	about 1% (b)
Slope range:	0.5 to 2.5%
Elevation:	about 1205 m
Aspect:	40° north of east
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	imperfect
Vegetation:	about 30% shrub cover with willow (Salix, spp.); about 70% herb cover with alsike clover (Trifolium hybridum), common yarrow (Achillea millefolium) and others; and 100% grass cover with timothy (Phleum, spp.) and others.

Profile description:

Horizon	Depth (cm)	Description
Ahk	0-18	Very dark grayish brown to very dark brown (10YR 3/2 - 2/2 m) silty clay loam to silty clay; strong, medium granular; very friable, moist; few, micro to medium, vertical and oblique roots; moderately porous; very weak effervescence; clear, wavy boundary; neutral.
Bmgk	18-33	Dark grayish brown (10YR 4/2 m), pockets of black (2.5Y 2/0 m) silty clay; common, fine, prominent

		yellowish red (5YR 4/3 m) mottles; strong, fine subangular blocky; very friable, moist; few, micro to fine, oblique roots; slightly porous; very weak effervescence; clear, wavy boundary; neutral.
Ccag	33-100	Light brownish gray (10YR 6/2 m) silty clay; many, fine, prominent yellowish red (5YR 4/8 m) mottles; amorphous; friable, moist; very few, micro to fine, oblique roots; slightly porous; strong effervescence; alkaline.

Site 12 (non-grazed)

Map Unit:	1
Classification:	Orthic Dark Brown Chernozemic
Date sampled:	26 September, 1978
Location:	NW 24-8-1-4, 12 UWL 707017
Parent material:	moderately fine textured till
Landform:	hummocky morainal (Mh)
Relief:	about 25 m over a frequency of about 100 m
Slope and topography class:	about 25% (f)
Slope range:	16 to 30%
Elevation:	about 1295 m
Aspect:	west
Erosion:	nil
Surface stoniness:	very stony (3)
Estimated drainage:	well drained
Vegetation:	about 10% shrub cover with shrubby cinquefoil (Potentilla fruticosa) and wild rose (Rosa, spp.); about 30% herb cover with pasture sagewort (Artemisia frigida), wild lupine (Lupinus, spp.),

loco-weed (Oxytropis, spp.), northern bedstraw (Galium boreale), golden bean (Thermopsis rhombifolia), common yarrow (Achillea millefolium) and others; and about 70% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-12	Very dark grayish brown (10YR 3/2 m) clay loam; moderate, medium granular; very friable, moist; plentiful, micro to fine, vertical and oblique, and few, medium, oblique roots; moderately porous; estimated angular gravelly to angular cobbly coarse fragments about 30%; gradual, wavy boundary; neutral.
Bm	12-30	Dark brown (10YR 4/3 m) clay; moderate, medium prismatic breaking to weak, medium subangular blocky; friable, moist; few, micro to fine, oblique roots; moderately porous; estimated angular gravelly to angular cobbly coarse fragments about 30%; clear, wavy boundary; neutral.
Cca	30-100	Grayish brown (10YR 5/2 m) clay loam; amorphous breaking to weak, medium subangular blocky; firm, moist; few, micro to fine, oblique roots; slightly porous; strong effervescence; estimated angular gravelly to angular cobbly coarse fragments about 50%; alkaline.

Site 13 (moderately grazed)

Map Unit: 2

Classification: Calcareous Black Chernozemic

Date sampled:	23 September, 1978
Location:	SE 11-8-1-4, 12 UWK 700977
Parent material:	moderately fine textured till
Landform:	level morainal (Ml)
Relief:	about 2 m over a frequency of about 100 m
Slope and topography class:	about 2% (b)
Slope range:	0.5 to 2.5%
Elevation:	about 1380 m
Aspect:	30° east of north
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 20% shrub cover with shrubby cinquefoil (Potentilla fruticosa), wild rose (Rosa, spp.) and buckbrush (Symphoricarpos occidentalis); and about 40% herb cover with common yarrow (Achillea millefolium), goldenrod (Solidago, spp.), cut-leaved anemone (Anemone multifida), northern bedstraw (Galium boreale), cinquefoil (Potentilla, spp.), wild strawberry(Fragaria virginiana), wild lupine (Lupinus, spp.) and others; and about 95% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-24	Very dark brown (10YR 2/2 m) clay loam; moderate, medium granular; very friable, moist; plentiful, micro to fine, vertical and oblique, and plentiful, medium, horizontal roots; moderately porous; estimated gravelly and angular gravelly coarse fragments about 10%; clear, irregular boundary; acid.

Bmk	24-50	Dark yellowish brown (10YR 3/4 m) clay loam; weak, medium prismatic breaking to weak, medium subangular blocky; very friable, moist; few, micro to medium, oblique roots; moderately porous; weak effervescence; estimated gravelly and angular gravelly coarse fragments about 15%; gradual, wavy boundary; neutral.
BCk	50-88	Dark brown (10YR 4/3 m) silty clay loam to clay loam; moderate medium prismatic breaking to moderate, medium subangular blocky; firm, moist; very few, micro to fine, oblique roots; slightly porous; moderate effervescence; estimated gravelly and angular gravelly coarse fragments about 25%; clear, wavy boundary; neutral.
Cca	88-100	Yellowish brown (10YR 5/6 m) silty clay loam; amorphous; friable, moist; very few, micro and very fine, oblique roots; slightly porous; strong effervescence; estimated gravelly to cobbly and angular gravelly to angular cobbly coarse fragments about 45%; alkaline.

Site 13 (non-grazed)

Map Unit:	2
Classification:	Orthic Black Chernozemic
Date sampled:	23 September, 1978
Location:	same as Site 13 (moderately grazed), about 3 m east of the other sample pit. The same description applies to both the Site 13 sample pits (moderately grazed and non-grazed), with the exception that this profile is not calcareous.

Site 14 (slightly grazed)

Map Unit:	9
Classification:	Eluviated Black Chernozemic
Date sampled:	23 September, 1978
Location:	NW 34-7-1-4, 12 UWK 672955
Parent material:	moderately fine textured loess overlying conglomerate
Landform:	eolian veneer overlying level fluvial (Ev/Fl)
Relief:	about 2 m over a frequency of about 100 m
Slope and topography class:	0% (a)
Slope range:	0.5 to 2.5%
Elevation:	about 1395 m
Aspect:	level
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 50% shrub cover with shrubby cinquefoil (Potentilla fruticosa); about 40% herb cover with common bearberry (Arctostaphylos uva-ursi), cinquefoil (Potentilla, spp.), cut-leaved anemone (Anemone multifida), common yarrow (Achillea millefolium), meadow parsnip (Zizia aptera), ground juniper (Juniperus communis), wild strawberry (Fragaria virginiana), northern bedstraw (Galium boreale) and others; and 100% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-34	Black (10YR 2/1 m) silt loam; weak, medium granular; very friable, moist; plentiful, micro to medium, vertical and few, medium to coarse, horizontal roots; moderately porous; estimated gravelly and angular gravelly coarse fragments about 15%; clear, irregular boundary; acid.

Ahe	34-44	Dark brown (10YR 3/3 m) silty clay loam; amorphous; friable, moist; few, micro to fine, vertical roots; moderately porous; estimated gravelly and angular gravelly coarse fragments about 15%; gradual, wavy boundary; acid.
Bt	44-90	Yellowish brown (10YR 5/4 m) silty clay loam; moderate, medium prismatic breaking to moderate, medium subangular blocky; very firm, moist; very few, micro to fine, oblique roots; slightly porous; estimated gravelly and angular gravelly coarse fragments about 25%; clear, wavy boundary; acid.
BC	90-100	Yellowish brown (10YR 5/4 m) very gravelly silty clay loam (field texture); weak, medium subangular blocky; firm, moist; very few, micro to very fine, oblique roots; slightly porous; estimated gravelly to cobbly and angular gravelly to angular cobbly coarse fragments about 90%; acidity not determined.

Site 14 (non-grazed)

Map Unit:	9
Classification:	Eluviated Black Chernozemic
Date sampled:	23 September, 1978
Location:	same as Site 14 (slightly grazed), about 3 m north of the other sample pit. The same description applies to both the Site 14 sample pits, except that this non-grazed site has only a 30% shrub cover, as compared to 50% for the slightly grazed site.

Site 15 (non-grazed)

Map Unit:	13
Classification:	Orthic Black Chernozemic
Date sampled:	25 September, 1978
Location:	SW 36-7-3-4, 12 UWK 508945
Parent material:	moderately coarse textured glaciofluvial sediments (gravelly sand)
Landform:	hummocky glaciofluvial (F_h^G)
Relief:	about 20 m over a frequency of about 100 m
Slope and topography class:	0% (a)
Slope range:	0 to 20%
Elevation:	about 1375 m
Aspect:	level
Erosion:	nil
Surface stoniness:	nonstony (0)
Estimated drainage:	well drained
Vegetation:	about 1% shrub cover with shrubby cinquefoil (Potentilla fruticosa); about 40% herb cover with golden bean (Thermopsis rhombifolia), northern bedstraw (Galium boreale), wild lupine (Lupinus, spp.), prairie sagewort (Artemisia ludoviciana), pasture sagewort (Artemisia frigida), common yarrow (Achillea millefolium), cinquefoil (Potentilla, spp.) and others; and 100% grass cover.

Profile description:

Horizon	Depth (cm)	Description
Ah	0-10	Black (10YR 2/1 m) loam; moderate, medium granular; very friable, moist; plentiful, micro to fine, vertical roots; moderately porous; estimated gravelly and angular gravelly to cobbly and angular cobbly coarse fragments about 10%; clear, wavy boundary; neutral.

Bm	10-48	Dark yellowish brown (10YR 3/4 m), yellowish brown (10YR 5/4 d) silty clay loam to silty clay; strong, medium prismatic breaking to strong, medium subangular blocky; very friable, moist and slightly hard, dry; few, micro to very fine, vertical roots; slightly porous; estimated gravelly and angular gravelly to cobbly and angular cobbly coarse fragments about 20%; gradual, wavy boundary; acid.
BC1	48-86	Yellow (10YR 7/6 d) sandy loam; moderate, medium prismatic breaking to moderate, medium subangular blocky; hard, dry; very few, micro to very fine, oblique roots; moderately porous; estimated gravelly to cobbly coarse fragments about 30%; gradual, wavy boundary; acid.
BC2	86-100	Yellow (10YR 7/6 d) sandy loam; amorphous; soft, dry; highly porous; neutral.

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