MASTER

SOIL STUDIES
SOIL INVENTORY STUDIES:
MAPPING AND DESCRIPTION

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INTRODUCTION

Soil investigations on the Geokinetics Oil Shale Project LOFRECO site, Uintah County, Utah have four components:

1. physical and chemical analysis of soil samples taken from undisturbed native soils and from retort sites;
2. soil series indentification, classification, and mapping;
3. soil-plant interrelationship studies and;
4. soil productivity and toxicity studies.

Information obtained in each of these four components during the baseline study period will be accumulative. Data and analysis reports will be produced as information becomes available.

This interim report contains the baseline information for soil series occurring on the site (Component 2 above). Soil series were described, classified, and mapped during August, 1978.

OBJECTIVES

The objectives of the soil studies on the LOFRECO site are as follows:

1. to produce a descriptive baseline relative to physical, chemical, and distributional characteristics of soil;
2. to derive a functional set of data that can be used to better understand soil-plant interrelationships;
3. to further derive functional relationships in other parts of the food chain, particularly those relating soil-plant relationships to herbivores and their predators;
4. to employ the descriptive and functional data gathered as a decision-making tool in the process of isolating impacts and designing mitigation methods.

METHODS

Preliminary identification of soil units was made using black and white aerial photography (scale-1"=200'). Soil units identified in this first step were verified in the field. Soil test pits were dug to a depth approximating the lithologic contact of the soil.

Each test pit was described using standard Soil Conservation Service (SCS) techniques. Each soil was sampled by horizon. Approximately 900gm (2 lbs) of material were collected from each horizon and bagged in seam-closure type plastic bags for laboratory analysis.

The soil units identified and sampled were mapped and ground-truthed. Soil units were classified according to the USDA soil nomenclature. Soil series names were obtained through the Utah state correlators office.

RESULTS AND DISCUSSION

Nomenclature for soils identified on the LOFRECO site is presented in Table 1. The soil series units are mapped on the pocket figure (inside back cover).

Soil series on the LOFRECO site have been classified according to the U.S. Department of Agriculture Soil Classification System. This hierarchical system defines soil at six levels of classification. The broadest category of classification (soil order) is used to compare soil over large areas. The suborder category is used to define soil based on certain critical horizontal properties indicating essential features about soil development. The third level (great group) arranges soils according to characteristics that are indicative of moisture and temperature regimes, as well as the total arrangement of the horizons. The fourth level of the soil classification system is the series which is used to differentiate soil families into groups that display a range of properties more

TABLE 1
SOILS OF THE LOFRECO SITE

<u>ORDER</u>	<u>SUBORDER</u>	<u>GREAT GROUPS</u>	<u>SUBGROUP</u>	<u>FAMILY</u>	<u>SERIES</u>
Aridisoils	Orthids	Calciorthids	Borollic	Fine-Loamy Mixed (calcareous)	Luhon
Entisoils	Fluvents	Torrifluvents	Ustic	Fine-Loamy Mixed (calcareous) frigid	Havre
	Orthents	Torriorthents	Ustic	Loamy-Shetatal Mixed (calcareous) frigid	JR
				Loamy-Mixed (calcareous) frigid shallow	LR

narrow than the soil family group.

Interpretation of Soil Taxonomic Units with Respect to Soil Moisture:

The classification of soils at the level of order, suborder, and great group includes the identification of the soil moisture regime. The soil moisture regime refers to the presence of water held in the soil at the tension of less than 15 bars during various periods of the year in the "soil moisture control section". The soil moisture control section is roughly defined by depth and particle size, so that the depth of the soil moisture control section increases as particle size increases from clay to sand-sized particles. The soil moisture control sections of the soils occurring on the LOFRECO site are given in the appendix, Tables 1-4.

The soil moisture regimes of the soils on the LOFRECO site are classified as ustic*. Ustic soils have limited moisture regimes, but there is a surplus of moisture (where precipitation exceeds evapotranspiration) in fall and early winter. Leaching can occur during the summer; limiting the growth and establishment of vegetation.

Interpretations of Soil Taxonomic Units with Respect to Soil Temperature

The soils of the LOFRECO site are classified in the frigid temperature regime. A frigid soil is one having a mean annual temperature lower than 8°C (47°F).

General Description of Soil Taxonomic Units:

The soils of the LOFRECO site are classified in three subgroups, as described below:

*the classification of ustic torrifluvents and ustic torriorthents in Table 2 indicates that these soils border on more dry moisture regimes than those that are strictly "ustic".

Orthids

The orthid soils are characterized as having thin, light-colored surface horizons that are low in organic matter and may have a horizon of salt accumulation. As a result of low organic matter and fine particle size, these soils tend to take up water slowly so that much of the precipitation received runs off. In many orthid soils development has been retarded by a combination of factors. As a result, these soils may occur on active erosion surfaces; the degree of erosion hazard and droughtiness may be great on these sites. The Luhon series is an orthid soil further classified as a calciorthid because of significant calcium carbonate accumulations in the profile.

Fluvents

Fluvent soils are subject to flooding, but not perpetually saturated. The parent materials of these soils are alluvial sediments that may contain significant amounts of organic matter. Subhorizons of these soils have very fine sandy loamy texture. Organic matter regularly decrease with depth in this group and depth to bedrock is greater than 25cm (10 inches). The Havre series is a fluvent soil further classified as an ustic torrifluvent because of an ustic moisture regime that borders on torric (torric, in terms of the study area, indicates an absence of summer precipitation).

Orthents

Orthents are found in areas where little or no soil development has taken place, such as uplands and erosion surfaces. These soils are low in organic content and are subject to frequent erosion disturbance. The JR and LR soils are orthent soils classified as ustic torriorthents as a result of their low moisture regimes, which do, however, support a moderate vegetation cover.

Classification of Soils:

The soils of the LOFRECO site are classified as shown on Table 1. Characteristics common to all of these soils are elevation: approximately 2073m, (6800 ft); mean annual precipitation range: from 254 to 330mm (10 to 13 inches) mean annual soil temperature regime: from 6 to 8°C (43 to 47°F) and frost-free period: approximately from 90 to 110 days. The soil sites in the study area are suitable as wildlife habitat and for livestock grazing. The vegetation types associated with the soil described below are given in Table 2.

JR LOAM, 5 to 40 PERCENT SLOPES (Profile Pit #2):

(series not named or correlated in Utah but is being mapped as JR series in the Duchesne soil survey).

Classification: Loamy, skeletal, mixed, (calcareous) frigid, Ustic Torriorthent (Table 1).

This mapping unit consists of moderately deep, well-drained soils that formed in residuum on colluvium from Green River shale. The JR series is located on north-and east-facing ridges. Present native vegetation is dominated by Utah Juniper, pinyon pines, shrubs, and grasses. About 50 percent of the surface is covered by juniper and pinyon duff 5 to 10cm (2 to 4 inches) thick. In a typical profile the surface layer is grayish-brown, strongly calcareous loam about 31cm (12 in) thick. The underlying subsoil layer consists of weathered angular shale fragments and is about 40 percent of the soil by volume. This layer is about 31cm (12 inches) thick. The lowest subsoil layer consists of about 95 percent slightly-weathered, angular shale fragments with some silt loam. About 61cm (24 in) thick. Below this lowest subsoil horizon is hard, unweathered and fractured shale.

SOIL MAP

SECTION 2, T14S, R22E, UTAH COUNTY, UTAH

LEGEND

- LR GRAVELLY LOAM
- JR LOAM • TEST PIT
- HAVRE SILT LOAM
- LUHON LOAM
- ROCK OUTCROP

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KG

0 500' 1000'
SCALE

TABLE 2

TABLE 2 SOIL AND VEGETATION ASSOCIATIONS ON THE LOFRECO SITE

<u>Vegetation Type</u>	<u>LR Gravelly Loam</u>	<u>JR Loam</u>	<u>Havre Silt Loam</u>	<u>Luhon Loam</u>
Pinyon-Juniper Woodland (South-Facing)	X	(X)		
Pinyon-Juniper Woodland (North-Facing)	(X)	X		
Sagebrush-Saltbush Lowland			X	(X)
Sagebrush-Grass Upland	(X)		(X)	X

(X) indicates a lesser degree of positive association, usually occurring because of the transition from on vegetation/soil association to the next (this is particularly true in the transition from sagebrush-grass upland/Luhon loam associations to sagebrush-saltbrush lowland Havre silt loam associations.

Representative Profile:

All 0-18cm (0-7 in), grayish-brown (10YR 5/2) loam; dark grayish-brown (10YR 4/2) moist; weak, medium granular structure; slightly hard, friable; non-sticky and slightly plastic; strongly calcareous; moderately alkaline; gradual, wavy boundary (3 to 9 in) thick.

A12 18-31cm (7-12 in) light brownish-gray (10YR 6/2) loam; brown (10YR 4/3) moist; weak coarse granular structure; slightly hard, friable; non-sticky and slightly plastic; strongly calcareous, moderately alkaline; gradual, wavy boundary (4 to 6 in) thick.

C1 31-61cm (12-24 in), very pale brown (10YR 7/3); very gravelly silt loam; light yellowish-brown (10YR 6/4) moist; weak, medium subangular blocky structure; slightly plastic; strongly calcareous, moderately alkaline; gradual, wavy boundary (22 to 26 in) thick.

C2 R 61-122cm (24-48 in) 95 percent weathering fragmental shale.

R 122cm+ (48 in+) unweathered fragment shale.

Pit Location: 533m W(1750 ft) and 762m S(2500 ft) of NE corner of Section 2, T-14 S, R-22 E, Uintah County, Utah. This soil is in the semi-desert, stony-loam, pinyon-juniper summer precipitation range site.

LR GRAVELLY LOAM 5 to 40 PERCENT SLOPES (Profile Pit #4):

(series not named or correlated in Utah but is being mapped by LR series in the Duchesne Soil Survey).

Classification: loamy, mixed (calcareous) frigid, shallow, Ustic Torriorthent.

This soil series consists of shallow, well-drained soils that formed in residuum from Green River shale. The LR series occurs on south and west-facing side slopes and ridges. Present native vegetation is dominated by Utah juniper, (*Juniperus scopulorum*) pinyon pine (*Pinus edulis*) and bunch-grasses. About 2.5cm (1 in) of juniper or pinyon duff occurs under the trees on about 10 percent of the ground surface.

In a typical profile, the surface layer is light brownish-gray, strongly calcareous, gravelly loam. The underlying material is composed chiefly of slightly weathered, hard, angularly-oriented shale fragments.

Representative Profile:

A1 0-15cm (0-6 in) light brownish-gray (10YR 6/2) gravelly loam brown (10YR 5/3) moist (The gravel consists of about 25 percent angular shale fragments. A gravel pavement of angular shale fragments covers approximately 50 percent of the ground surfaces); very weak, medium, platy structure; slightly plastic; strongly calcareous moderately alkaline; abrupt, wavy boundary 10 to 20cm (4 to 8 in) thick.

CR 15-91cm (6-36 in) 95 percent slightly weathered, hard angularly oriented shale fragments; 5 percent silt loam and roots.

Pit Location: 549m E(1800 ft) and 533m S(1750 ft) of NW corner of Section 2, T-14 S, R-22 E, Uintah County, Utah. This soil is in the semi-desert shallow loam, pinyon-juniper summer precipitation range site.

LUHON LOAM, 3 to 8 PERCENT SLOPES (Profile Pit #3):

Classification: Fine loamy, mixed, (calcareous) Borrolic Calciorthid (Table 1).

This mapping unit consists of deep, well-drained soils that formed from mixed alluvium and in residuum from Green River shale. Luhon soils occur on gently sloping to gently rolling fans and valley side slopes. Present native vegetation is mainly big sagebrush, (Artemisia tridentata) four-wing saltbush, (Atriplex canescens) winterfat, (Ceratoides lanata), western wheatgrass, (Agropyron smithii), blue grama grass, (Bouteloua gracilis) and blue-bunch wheatgrass (Agropyron spicatum).

In a typical profile the surface layer is a pale brown, silty clay loam about 23cm (9 in) thick. The substratum consists of about 18cm (7 in) of very strongly calcareous loam underlain by gravelly loam. (The gravelly loam is about 90 percent soft, weathered shale fragments; about 60 percent of these shale fragments slake when soaked in water.)

Representative Profile:

A1 0-18cm (0-7 in), pale brown (10YR 6/3) loam brown (10YR 4/3) moist; weak medium subangular-blocky structure; hard, friable; non-sticky and slightly plastic; strongly calcareous, moderately alkaline; clear, smooth boundary.

B2 18-41cm (7-16 in), very pale brown (10YR 7/4) silty-clay loam, yellowish-brown (10YR 5/4) moist; moderate, medium angular-blocky structure; very hard, firm; slightly sticky and plastic; very strongly calcareous, strongly alkaline; gradual wavy boundary.

C1ca 41-58cm (16-23 in) light gray (10YR 7/2) loam, pale brown (10YR 6/3) moist; weak medium subangular-blocky structure; slightly hard, very friable; non-sticky and slightly plastic; strongly calcareous, strongly alkaline; gradual wavy boundary.

II C2 58-152cm (23-60 in) light gray (10YR 7/3) gravelly loam, brown (10YR 5/3) moist; (this gravelly loam is

about 90 percent soft, weathered shale; about 60 percent shale fragments slake when soaked in water); strongly calcareous and strongly alkaline.

Pit Location: 183m E(600 ft) and 610m S(2000 ft) of NW corner of Section 2, T-14 S, R-22 E Uintah County, Utah.

This soil is in the semi-desert loam, summer precipitation range site.

HAVRE SILT LOAM, 2 to 8 PERCENT SLOPES (Profile Pit #1):

Classification: Fine loamy, mixed (calcareous) frigid, Ustic Torrifluvent (Table 1).

This mapping unit consists of deep, well-drained soils that formed in mixed alluvium. The Havre series occupies nearly level to moderate-sloping stream terraces and flood plains. The present native vegetation community is composed chiefly of big sagebrush, rabbitbrush (Chrysothamnus nauseosus) and flowering saltbush. In a typical profile, the surface layer is grayish brown, strongly calcareous silt loam, about 20cm (8 in) thick. The surface layer is typically covered by a layer of sage duff about 2.5cm (1 in) thick. The underlying material is light brownish-gray, strongly calcareous loam to a depth of 152cm (60 in) or more.

Representative Profile:

A0 2.5 to 0cm (1 in) duff consisting of sage leaves and twigs.

A1 0-20cm (0-8 in), grayish-brown (10YR 5/2) silt-loam, brown (10YR 4/3) moist; very weak, coarse platy structure; soft, very friable; non-sticky and non-plastic; strongly calcareous, moderately alkaline; clear, smooth boundary 18-25cm (0-7 in) thick.

C1 20 to 71cm (8-28 in) light brownish-gray (10YR 6/2) loam, brown (10YR 4/3) moist, weak, medium subangular-blocky structure; slightly hard, friable; non-sticky and slightly plastic; strongly calcareous, moderately alkaline; gradual, wavy boundary 41 to 61cm (16-24 in) thick.

C2 71-152cm (28.- 60 in) pale brown (10YR 6/3) heavy loam, brown (10YR 4/3) moist; masive; slightly hard, friable; slightly-sticky and slightly plastic; strongly calcareous, moderately alkaline.

Pit Location: 549m W(1800 ft) 732m S(2400 ft) of NE corner of Section 2, T-14 S, R-22 E, Uintah County, Utah. This soil is in the semi-desert loam summer precipitation range site.

APPENDIX
SOIL SERIES DESCRIPTIONS

Soil Type LR gravelly loam 5 to 40 percent slopes

Area: Geokinetics Oil Shale Project LOFRECO Site		Date: 8-1-78	Pit No. 4
Classification: loamy, mixed (calcareous) frigid, shallow Ustic torriorthents			
Location: 1800' E and 1750' S of NW corner of Se. 2, T-14S, R-22E, Uintah County, Utah			
Vegetation: pinyon-juniper and bunchgrasses		Climate: 10-13 in mean an. ppt.	
Parent Material: Green River shale			
Physiography: ridge slope			
Relief: gentle, short slope		Drainage: well-drained	Salt or Alkali: none
Elevation: 6800'	Gr. Water: none		Stoniness: surface flaggy, 95% angular shale fragments
Slope: 20% (5-40)	Moisture: dry		
Aspect: south-facing	Root Distrib.: see part II		% Clay: 18%
Erosion: moderate	% Coarse Fragments*: 95%	% Coarser than v.f.s*: 20%	
Permeability: moderate			
Additional Notes: 1" duff on 10% of area			
Semi-desert shallow loam (pinyon-juniper) summer percipitation-range site			
pinyon-juniper woodland-south facing slope			
		*Control Section Average: 0-6"	

LR series in Duchesne Soil Survey area (series not named or correlated)

SOIL DESCRIPTION PART I
TABLE 1

B-AI-

Soil Type

Date

Pit Number 4

Horizon	Depth	Color		Texture	Structure	Consistence			Reaction	Boundary	Roots		
		Dry	Moist										
A1	0-6"	10YR 6/2	10YR 5/3	gr lo 25% angular gravel	vlmpl	sh	fr	sops	es 8.4	aw	few coarse medium fine	few	
CR	6-36"			95% angular shale fragments									

B-A2-

Soil Type JR loam 5 to 40 percent slopes

Area: See first table		Date: 8-1-78	Pit No. 2
Classification: loamy skeletal, mixed (calcareous) frigid, Ustic torriorthent			
Location: 1750' W and 2500' S of NE corner of Sec. 2, T-14S, R-22, Uintah County, Utah			
Vegetation: pinyon-juniper woodland, north-facint		Climate: 10-12 in mean an. ppt.	
Parent Material: Green River shale, sedimentary mixed residuum			
Physiography: ridge slope			
Relief: gentle slope, short		Drainage: well	Salt or Alkali: none
Elevation: 6800'	Gr. Water: none		Stoniness: pavement 80% covered by angular gravel to 6" diam.
Slope: 20%	Moisture: dry		
Aspect: north-facing	Root Distrib.: see back		% Clay: 18%
Erosion: mod few shallow gulleys	% Coarse Fragments*:	90%	% Coarser than v.f.s*: 20%
Permeability: moderate			
Additional Notes: 50% surface covered by pine duff x depth 4"			
semi-desert stony loam (pinyon-juniper) summer precipitation-range site			
pinyon-juniper north-facing slopes			
		*Control Section Average: 10-40"	

JR series in Duchesne soil Survey (series not yet named or correlated)

Soil Type

Date

Pit Number 2

Hori- zon	Depth	Color		Texture	Structure	Consistence			Reaction	Boundary	Roots	
		Dry	Moist									
A11	0-F"	10YR 5/2	10YR 4/2	LO	10% angular 1 mgr	gravel sh	fr	sops	es 8.4	grw	few coarse common med common fine	
A12	F012"	10YR 6/2	10YR 4/3	LO	100gr	sh	fr	sops	es 8.4	aw	few coarse common med common fine	
C1	12-24"	10YR F/3	10YR 6/4	highly weathered in v-gravelly 40% agr silo 1msbk	place	sh	f	sops	8.6	grw	common medium & fine	
C2r	24-48"	95% fragmental weathering shale							es 8.4		few medium and fine	
R1	48	unweathered fragmental shale							-		-	

B-A4-

BAS-

TABLE 3

Soil Type

Date

Pit Number

Horizon	Depth	Color		Texture	Structure	Consistence			Reaction	Boundary	Roots		
		Dry	Moist										
A0	1"-0	sage duff	-----	---	---	---	---	---	---	---	---	---	---
A1	0-8"	10YR 5/2	10YR 4/3	sil	lvso pl	s	ufr	so-po	es 8.4	cs	few med, few coarse, common fine		
C1	8-28"	10YR 6/2	10YR 4/3	Lo	lmsbk	sh	f	sops	es 8.4	gw	few med, few fine		
C2	28-60+	10YR 6/3	10YR 4/3	Lo	m	sh	f	ssps	es 8.4		few fine		

B-A6-

B-A7-

SOIL DESCRIPTION PART 1
TABLE 4

Soil Type

Date

Pit Number

Horizon	Depth	Color		Texture	Structure	Consistence			Reaction	Boundary	Roots	Profile #3	Lab lime test
		Dry	Moist										
A1	0-F'	10YR 6/3	10YR 4/3	Lo	lmsbk	h	fr	50ps	8.4 es	cs		fm cf	
B2	F-16	10YR 7/4	10YR 5/4	Sic 1	2msbk	vh	fr	ss p	8.6 es	gw		fm ff	17% lime
C1ca	16-23	10YR 7/2	10YR 6/3	L	lmsbk	sh	vfr	sops	8.8 ev	gw		fm ff	25% lime
II C2	23-60	10YR 7/3	10YR 5/3	Gr Lo					8.8 es			ff	
				9090 shale frag. 2/3 slake in water									

B-A8-

LUHON SERIES

The Luhon series is a member of the fine-loamy, mixed family of Borollic Calciorthids. Typically, Luhon soils have very friable calcareous granular A horizons, and light clay loam calcareous C horizons having strong subhorizons of visible secondary calcium carbonate accumulation.

Typifying Pedon: Luhon loam - grassland
(Colors are for dry soil unless otherwise noted.)

- A1 0-8"--Pinkish gray (7.5YR 6/2) loam, dark brown (7.5YR 4/2) moist; weak fine subangular blocky structure that parts to moderate fine granules; slightly hard, very friable; few pebbles and cobbles; calcareous; moderately alkaline (pH 8.0); diffuse wavy boundary.
- Clca 8-30"--White (10YR 8/2) light clay loam, pale brown (10YR 6/3) moist; massive to weak medium subangular blocky structure; hard, very friable, slightly plastic; much visible secondary calcium carbonate occurring mostly in finely divided marl-like forms; 5 percent gravel and cobble; calcareous; moderately alkaline (pH 8.4); diffuse wavy boundary.
- C2ca 30-60"--Light brownish gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2) moist; massive; hard, very friable, slightly plastic; some visible secondary calcium carbonate occurring as concretions, and in thin seams and streaks but less than above; 5 percent gravel; calcareous; moderately alkaline (pH 8.0).

Type Location: Montrose County, Colorado; approximately 1/4 mile east and 250 feet north of the center of sec. 15, T.49N., R.8W.

Range in Characteristics: The mean annual soil temperature is 45°F., and mean summer soil temperature is 64°F. Depth to uniformly calcareous material ranges from 0 to 5 inches. Depth to the calcic horizon ranges from 5 to 35 inches. The soil above the calcic horizon is moderately or strongly alkaline but subhorizons of the calcic horizon are very strongly alkaline in some pedons. Exchangeable sodium ranges from 0 to 15 percent and conductivity ranges from 0 to 14 millimhos above the calcic horizon except that a few discontinuous subhorizons less than 4 inches in thickness may exceed these limits in some pedons. Rock fragments range from 0 to 35 percent and are dominantly 1 to 10 inches in diameter. Hue ranges from 5Y through 7.5YR except that a few subhorizons having hue redder than 7.5YR occur discontinuously in some pedons and occupy less than half the thickness of the control section.

Competing Series and their Differentiae: This is the Rootel series. Rootel soils have a lithic contact at 20 to 40 inches below the surface.

Setting: Luhon soils are on gently to moderately sloping alluvial fans and valley sideslopes. Slope gradients range from 1 to 15 percent. The soils formed in calcareous alluvial fan sediments principally from

LUHON SERIES (Cont)

soft sedimentary rock. At the type location, the average annual precipitation is 14 inches with peak periods of precipitation during the spring and early summer months. Mean annual temperature is 41°F., and mean summer temperature is 66°F.

Principal Associates Soils: These are the Fruita and McFadden soils. Fruita soils lack calcic horizonz. McFadden soils are moderately coarse textured.

Drainage and Permeability: Well-drained; medium runoff; moderate permeability.

Use and Vegetation: These soils are used principally as native pastureland, however, they are irrigated in some localities. Principal native plants are short grass, sage, cactus, and weeds.

Distribution and Extent: Central and northern Colorado and southern Wyoming. The series is of moderate extent.

Series Established: Montrose County (Delta-Montrose Area), Colorado, 1965.

(Colorado series description - Established Series Rev. AJC 7/72)

HAVRE SERIES

The Havre series consists of deep, well drained soils that formed in stratified alluvium. Havre soils are on stream terraces and flood-plains and are nearly level to moderately sloping. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 41°F.

Taxonomic Class: Fine-loamy, mixed (calcareous), frigid Ustic Torri-fluvents.

Typical Pedon: Havre loam, cultivated. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 8 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak granular structure; soft, very friable, slightly sticky and slightly plastic; moderately effervescent; moderately alkaline; abrupt wavy boundary. (5 to 10 inches thick)

C1--8 to 36 inches; light brownish gray (2.5Y 6/2) loam with thin lenses of fine sandy loam, dark grayish brown (2.5Y 4/2) moist; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common to many medium and fine pores; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (18 to 30 inches thick)

C2--36 to 60 inches; light brownish gray (2.5Y 6/2) loam with thin lenses of fine sandy loam and silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; common medium and fine pores; strongly effervescent; moderately alkaline (pH 8.2).

Type Location: Blaine County, Montana; 1,050 feet north and 2,640 feet east of SW corner of section 33, T.32N., R.23E.

Range in Characteristics: Mean annual soil temperature is 41° to 47°F. Hue is 10YR or 2.5Y, value is 5 or 6 dry, 4 or 5 moist, and chroma is 2 or 3 throughout the soil. The 10- to 40-inch control section is typically stratified loam and fine sandy loam and average 20 to 30 percent clay and 15 to 35 percent coarser than very fine sand. The principal surface textures are loam, clay loam, silt loam, silty clay loam and silty clay. Some pedons have 1/2- to 3-inch thick lenses of either coarser or finer material. Gravelly substate occur below depths of 40 inches in some pedons. Reaction is mildly or moderately alkaline.

Competing Series: These are the Benz series in the same family and the Havrelon, Hysham, and Haverson series. Benz soils have more than 15 percent exchangeable sodium throughout. Havrelon soils have an ustic moisture regime. Haverson and Hysham soils have annual soil temperature of 47° to 59°F.

HAVRE SERIES (Cont)

Geographic Setting: Havre soils are nearly level to moderately sloping and are on flood plains and stream terraces at elevations of 2,000 to 3,500 feet. They formed in calcareous stratified loamy alluvium. Mean annual temperature is 38° to 46°F; mean January temperature is 9° to 20°F., and mean July temperature is 65° to 70°F. Annual precipitation is 10 to 14 inches, most of which falls during the spring and early summer. The (32°F) growing season is 90 to 135 days.

Geographically Associates Soils: These are the Bowdoin, Glendive, Harlem, and Wolf Point soils. Bowdoin soils have a very-fine control section. Glendive soils have a coarse-loamy control section. Harlem and Wolf Point soils have a fine control section.

Drainage and Permeability: Well drained; slow runoff; moderate permeability.

Use and Vegetation: These soils are used mainly for irrigated cropland and hayland. Native plants are western wheatgrass, bluebunch wheatgrass, green needlegrass, prairie junegrass; needleand thread, blue grama, sagebrush and low density strands of cottonwood trees.

Distribution and Extent: Northern and central Montana. The soils are extensive.

Series Established: Milk River Area, Montana, 1928.

(This series description is from Montana. Vegetation is not completely applicable to Utah. - Established Series Rev. AAA/SHB 11/76)