SOIL SURVEY OF

Smith County, Kansas

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1966-73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Smith County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability ability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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SOIL SURVEY OF SMITH COUNTY, KANSAS

By Vernon L. Hamilton, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Kansas Agricultural Experiment Station

SMITH COUNTY is in the north-central part of Kansas and has an area of about 571,520 acres, or 893 square miles (fig. 1).

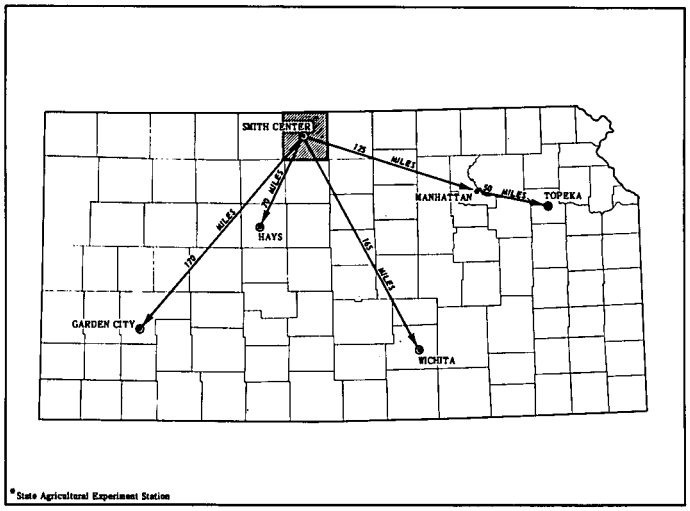


Figure 1.—**The location of Smith County in Kansas.**

Smith Center is the county seat and is near the center of the county. Other small towns in the county are Athol, Cedar, Gaylord, Harlan, Kensington, and Lebanon.

slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Harney and Holdrege, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface

some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. One such kind of mapping unit—soil complexes—is shown on the soil map of Smith County.

A soil complex consists of areas of two or more soils so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. McCook-Munjor complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names, such as "Alluvial land, loamy," which is a land type in Smith County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the [redacted] shed, a wooded tract, or a wildlife area, or for broad planning of recreation facilities, community development, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey area are described on the pages that follow.

1. Uly-Holdrege-Campus association

Deep and moderately deep, gently sloping to steep, well drained, silty and loamy soils that formed in loess and caliche sediment on uplands

This association consists of loess-covered uplands dissected by intermittent drainageways that have side slopes underlain by limy outwash sediments of soft caliche. The soils are mostly gently sloping to sloping, but they are steep in places along the entrenched upland drainageways.

This association makes up about 4 percent of the county and is mostly in the northwestern part. It is about 40 percent Uly soils, 30 percent Holdrege soils, 15 percent Campus soils, and 15 percent minor soils (fig. 2).

Uly soils are strongly sloping to steep. They are on slightly convex side slopes along upland drainageways. The surface layer is typically grayish brown silt loam about 8 inches thick. The subsoil is friable, light brown-

[redacted]

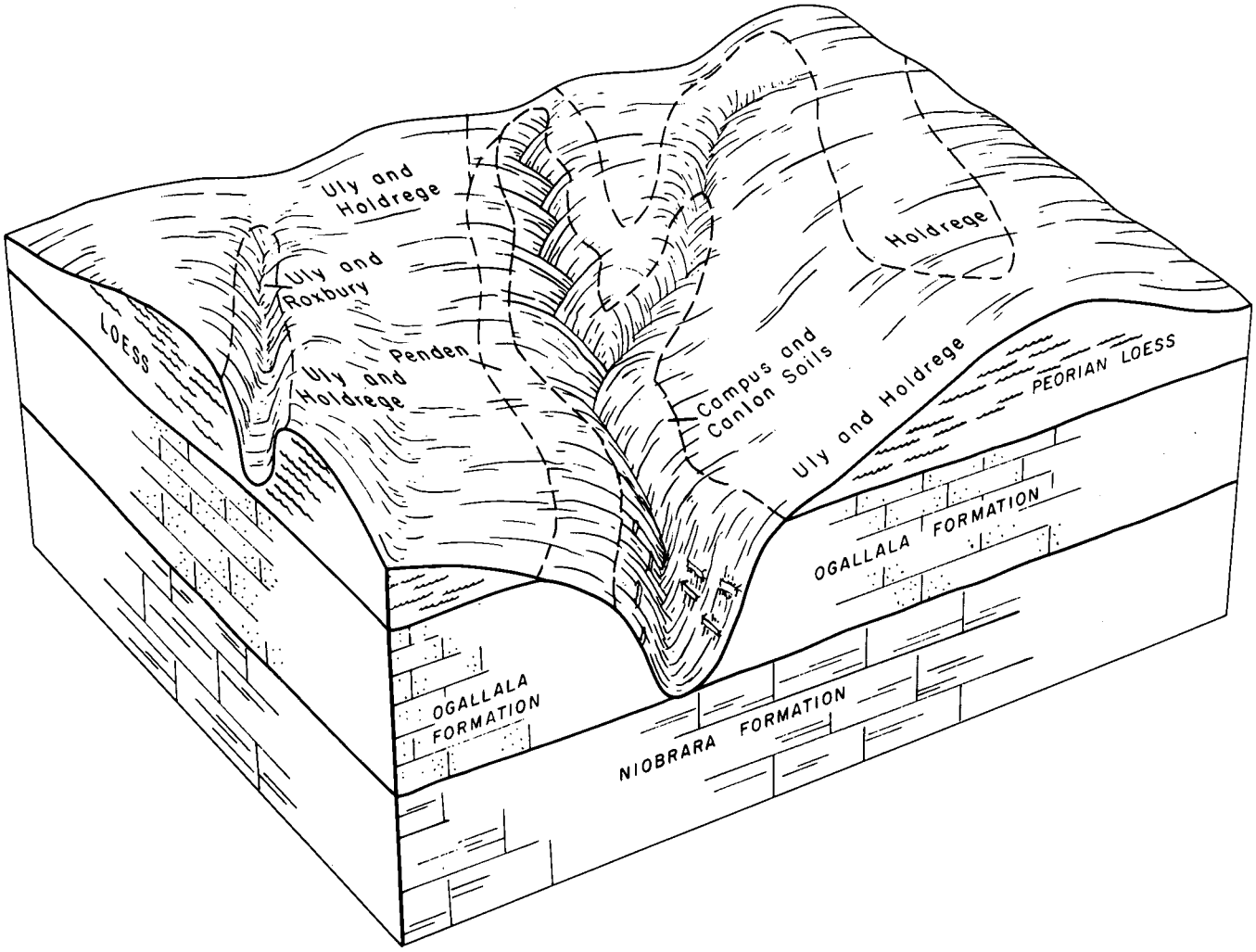


Figure 2.—**Pattern of soils and underlying material in the Uly-Holdrege-Campus association.**

These soils are best suited to use as range because strongly sloping, but they are steep in places where

are on slightly convex side slopes. The surface layer is typically dark grayish brown silt loam about 10 inches thick. The subsoil is friable, pinkish gray and light brown light silty clay loam and heavy silt loam. Light

enterprises are growing cash crops and feeding beef cattle.

The main concerns of management are controlling erosion, conserving soil moisture, and maintaining

Of minor extent in this association are Campus, Canlon, Harney, Roxbury, and Wakeen soils. Canlon soils are sloping to steep and shallow over caliche. They are in areas along entrenched upland drainageways. Harney soils are nearly level to gently sloping and are on uplands. They have a subsoil of silty clay loam forming in loess. Roxbury soils are on the floors of narrow upland drainageways. Campus and Wakeen soils are sloping to moderately steep and moderately deep over caliche and soft chalky sediments. They are on side slopes along entrenched upland drainageways.

The available water capacity is high. The content of organic matter is high except where the sloping soils have been eroded.

The soils have a potential for all cultivated crops grown in the county, but the sloping soils are better suited to native grasses. About half of this association is used for cultivated crops. Winter wheat, sorghums, and grasses grow well on the gently sloping to strongly sloping soils. Native grasses grow on the strongly sloping, moderately deep, and deep soils. The steep areas along entrenched upland drainageways and moderately deep soils are in native grass pasture used as range. Most of the sloping and strongly sloping, eroded

3. *Roxbury-McCook-Hord association*

Deep, nearly level, well drained, silty soils that formed in alluvium on lowlands

This association consists of mostly nearly level soils on benches or terraces along streams and alluvial flood plains of streams and drainageways. In places slopes are steep and short between the benches and flood plains.

This association makes up about 7 percent of the county. It is about 40 percent Roxbury soils, 25 percent McCook soils, 15 percent Hord soils, and 20 percent minor soils (fig. 5).

Roxbury soils are nearly level. They are on flood plains. The surface layer is typically gray and dark gray silt loam about 30 inches thick. The subsoil is friable, grayish brown light silty clay loam. Very pale brown heavy silt loam is at a depth of about 50 inches.

McCook soils are nearly level. They are on terraces and flood plains. The surface layer is typically grayish brown coarse silt loam about 10 inches thick and slightly darkened with organic matter. The subsurface

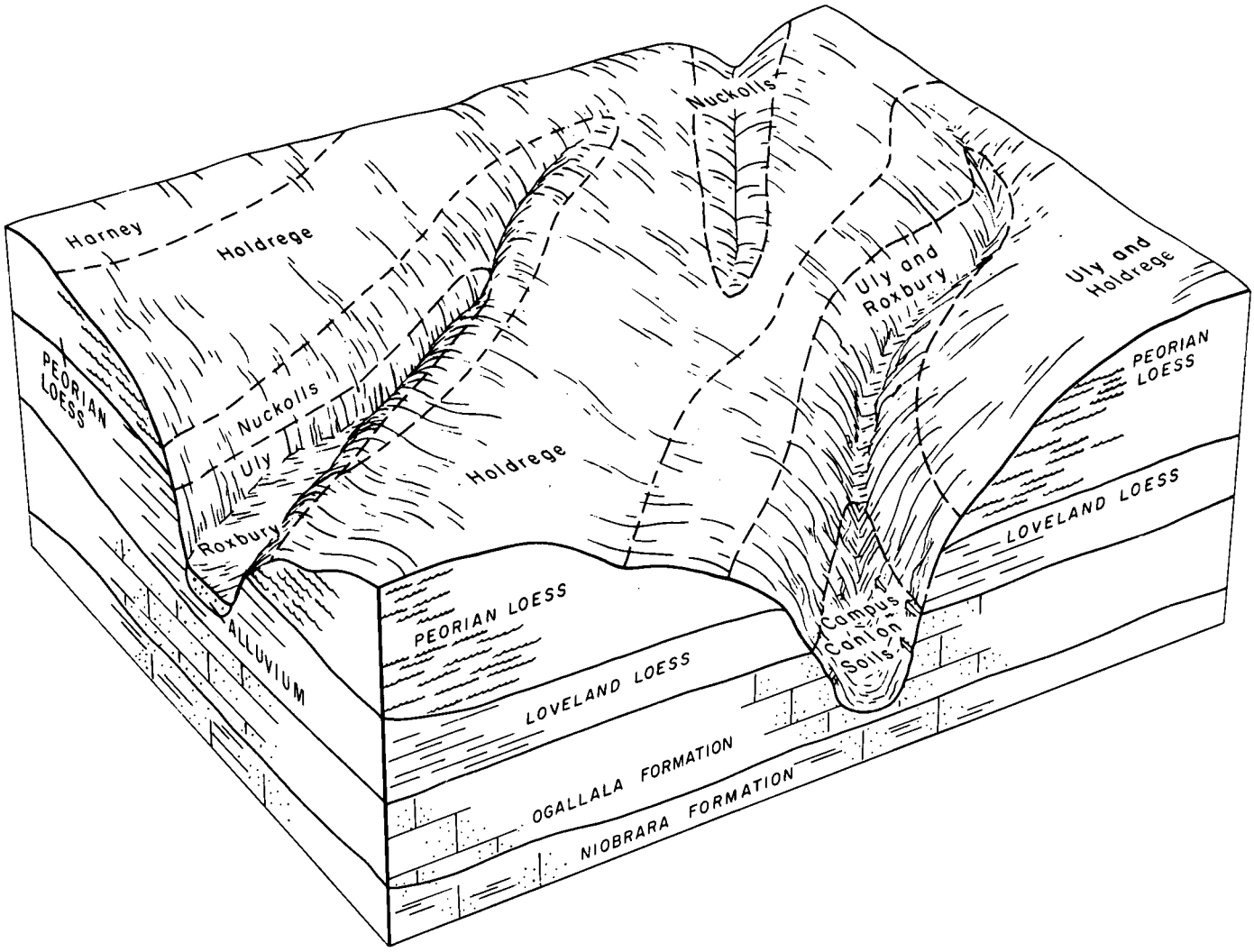
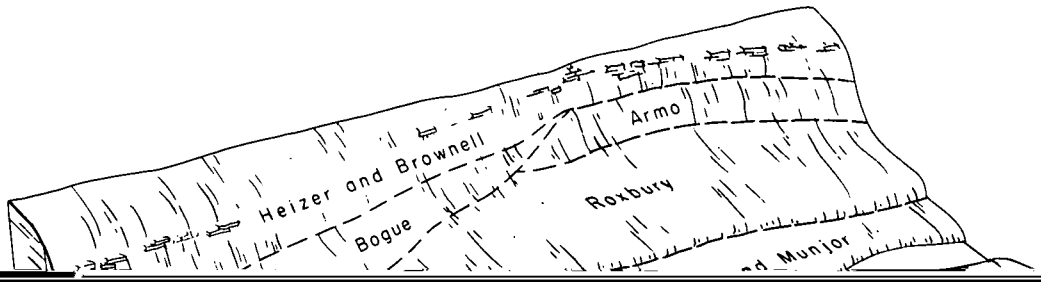


Figure 4.—**Pattern of soils and underlying material in the Holdrege-Uly-Nuckolls association.**

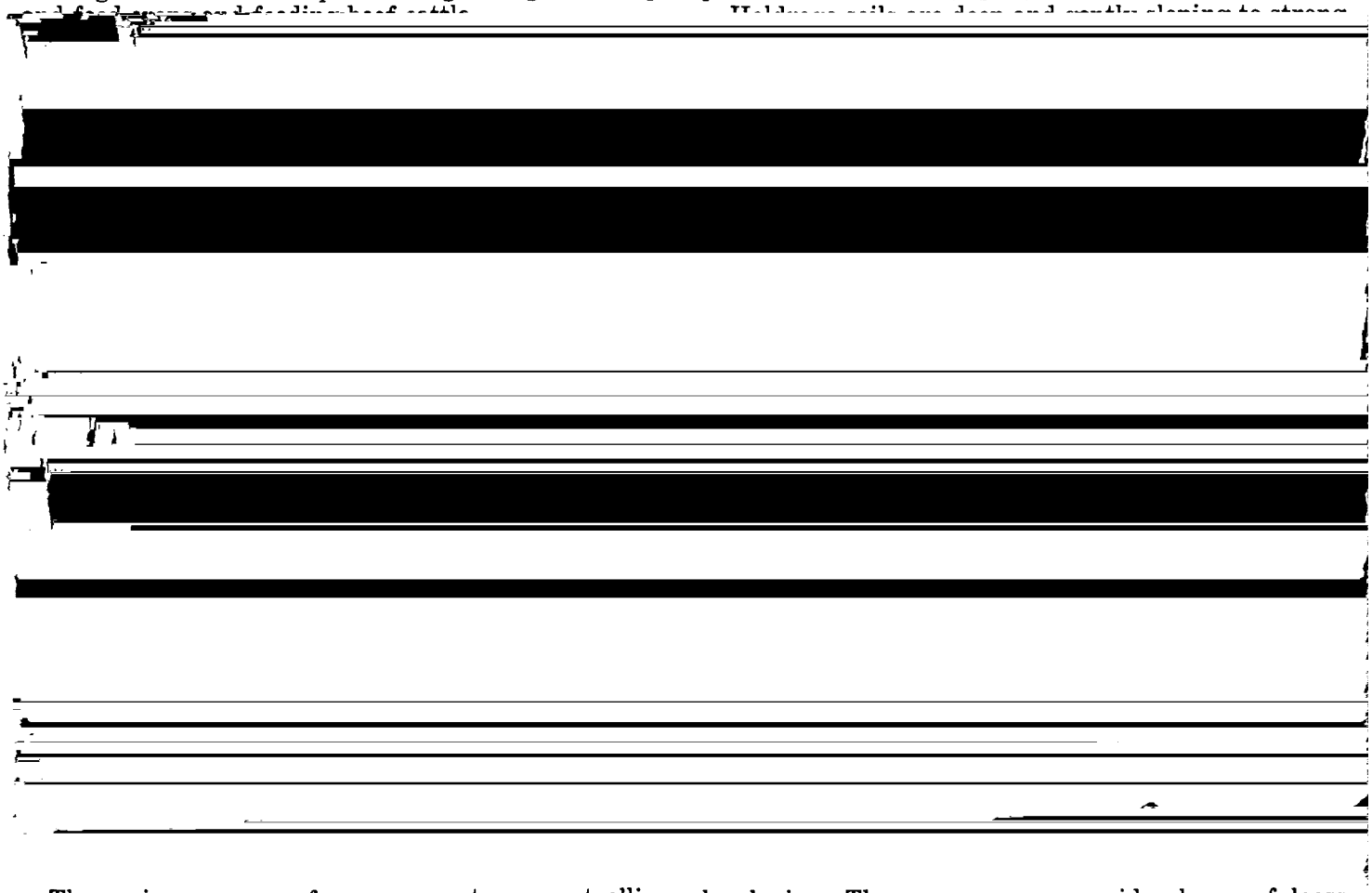
gray, calcareous silt loam is at a depth of about 18 inches.

Hord soils are nearly level. They are on benches or terraces. The surface layer is typically gray silt loam about 15 inches thick. The subsoil is friable, grayish

The soils of this association have high potential for all cultivated crops commonly grown in the county. Most areas are used for cultivated crops. Corn, sorghums, small grains, and alfalfa grow well on these soils. About half of the acreage is irrigated, many


Heizer and Brownell
Armo
Bogue
Roxbury
Munjor

steep uplands are mostly in native grass pasture used as range. The main enterprises are growing cash crops [redacted] feeding beef cattle.



The main concerns of management are controlling erosion, conserving soil moisture, and maintaining tilth and fertility.

5. *Holdrege-Wakeen-Roxbury association*

Deep and moderately deep, nearly level to moderately steep, well drained, silty soils that formed in loess and chalky shale on uplands and loamy alluvium on lowlands

This association consists of gently sloping to moderately steep soils on uplands and nearly level soils along the streams. The slopes are steepest along streams and along the large entrenched upland drainageways. The soils formed in loess and in soft chalky shale on uplands and in deep loamy alluvium along streams.

This association makes up about 30 percent of the county. It is about 40 percent Holdrege soils, 20 percent Wakeen soils, 10 percent Roxbury soils, and 30 percent minor soils (fig. 8).

Holdrege soils are deep and gently sloping to strongly sloping. They occupy convex side slopes of loess-covered uplands. The surface layer is typically grayish brown silt loam about 10 inches thick. The subsoil is friable, grayish brown and pale brown silty clay loam. Very pale brown, calcareous silt loam is at a depth of about 28 inches.

Wakeen soils are sloping to moderately steep and moderately deep. They are on convex side slopes. They formed in loess over chalky shale. The surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is friable, grayish brown silty clay loam in the upper 6 inches and is friable, very pale brown light silty clay loam in the lower 19 inches. Soft chalky shale is at a depth of 34 inches.

Roxbury soils are deep and nearly level. They are on terraces and flood plains of streams. The surface layer is gray and dark gray silt loam about 30 inches thick. The subsoil is friable, grayish brown light silty

Figure 7.—**Harvesting wheat on the contour on gently sloping Holdrege soils.**

clay loam. Very pale brown heavy silt loam is at a depth of about 50 inches.

Of minor extent in this association are Alluvial land, loamy, and Armo, Harney, Nuckolls, Penden, and Uly soils. Alluvial land, loamy, is on flood plains that have entrenched stream channels. The areas are frequently flooded. Armo soils are sloping and are on fans and foot slopes. Harney soils are nearly level to gently sloping and are on uplands. They have a subsoil of silty clay loam. Nuckolls soils are on side slopes. They have a subsoil of silty clay loam and a light brown

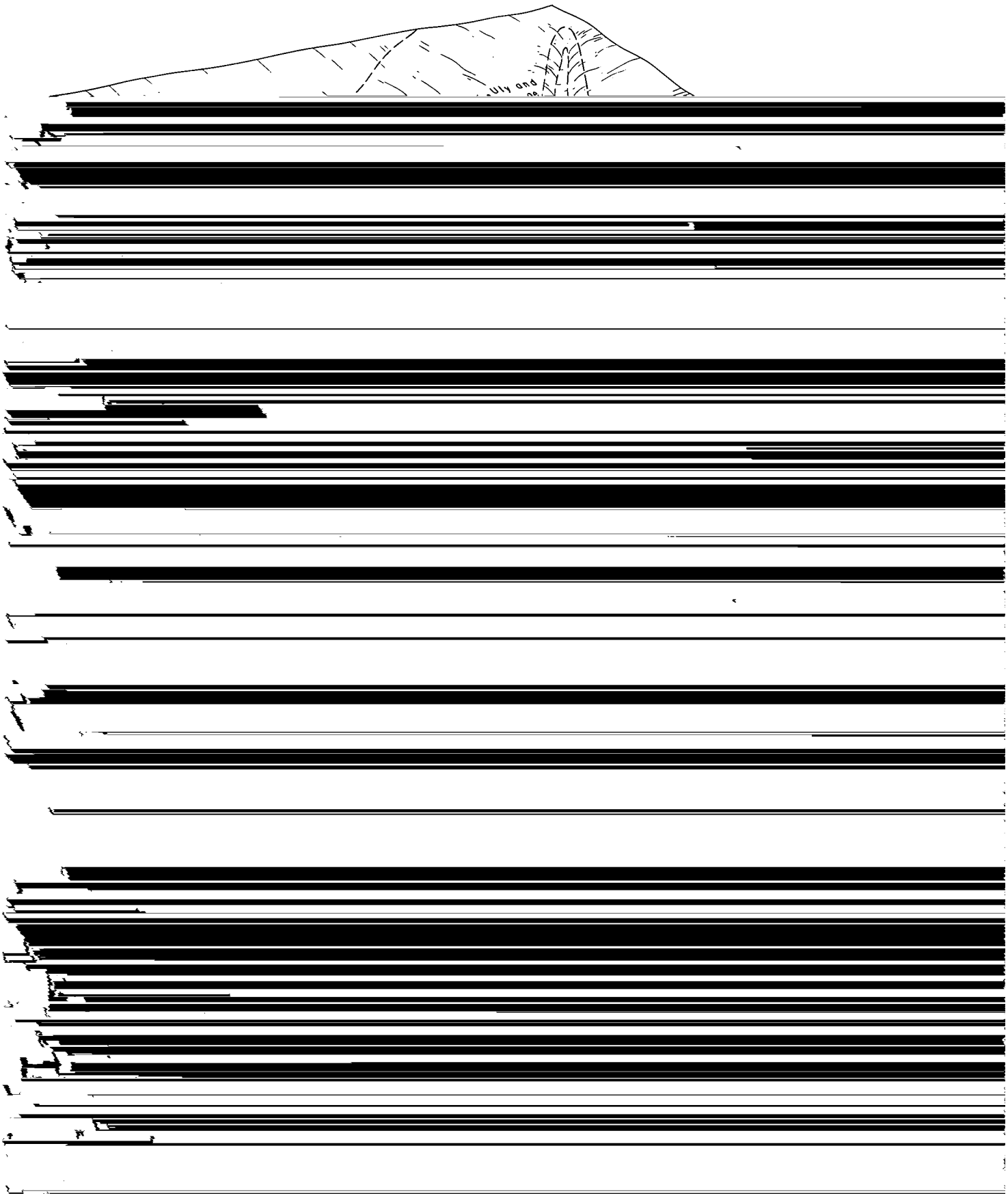
and feed grains and sorghum and feeding beef cattle.

The main concerns of management are controlling erosion, conserving soil moisture, and maintaining tilth and fertility.

6. *Harney-Mento-Brownell association*

Deep and moderately deep, nearly level to strongly sloping, well drained, silty to gravelly loamy soils that formed in loess and chalky limestone on uplands

This association consists of nearly level to sloping soils on broad divides of uplands and strongly sloping



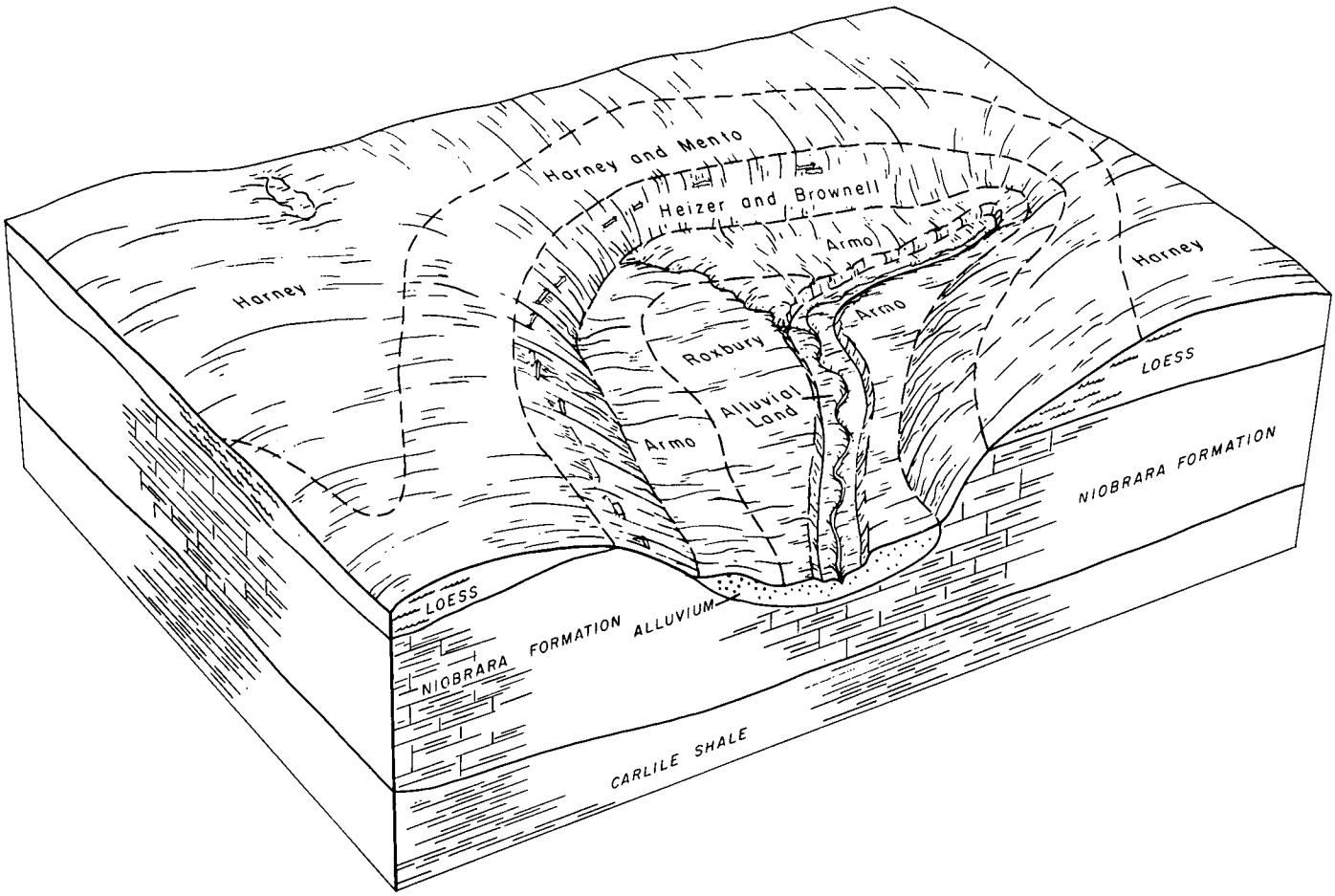
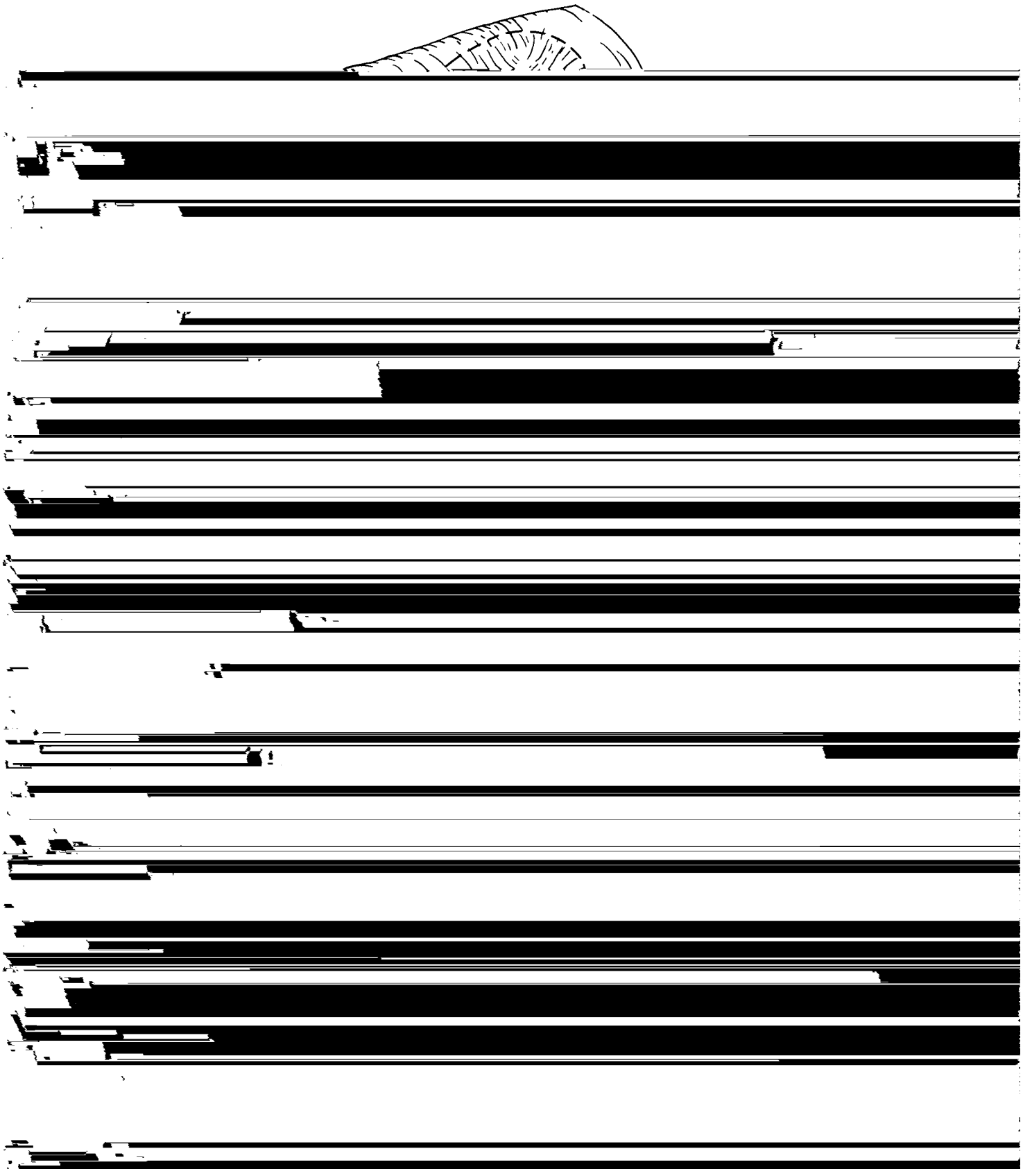


Figure 9.—**Pattern of soils and underlying material in the Harney-Mento-Brownell association.**

This association consists of sloping to steep soils on uplands. The soils formed in material weathered from [redacted] loam that contains many fragments of rounded limestone pebbles.

[redacted]



the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak group in which the mapping unit has been placed.

of moderately deep or deep soils that do not generally have outcrops of bedrock. Rock outcrops interfere with tillage, planting, and harvesting as well as the construction of terraces and waterways.

Sand spot. Each symbol represents an area 2½ acres or less in size where crop growth during dry seasons is hampered by low moisture storage. These sandy areas are on uplands where the loess is thin.

Gravel spot. Each symbol represents an area 2½

The soils range from loam to silty clay loam and are neutral to alkaline. They are highly stratified in places and contain small limestone pebbles. In most places the surface layer is silt loam; underlying layers are stratified with coarse silt loams and loamy sediments. Generally, the soil material is more than 40 inches thick, but it ranges to more than 72 inches in the upland drainageways.

Included in mapping are areas of Roxbury silt loam, frequently flooded, and small areas of McCook-Munjor complex.

The water intake is medium, and the available water capacity is high. The depth to water is generally more than 6 feet. Surface runoff is slow to medium, depending on flooding. Frequent flooding limits the use of the soils. Erosion is a hazard and deposition of fresh sediments occurs in some places. Scouring and erosion occur in the stream channel.

The vegetation consists of tall and mid grasses on the flood plains, and most areas are still in native grass. Broadleaf trees grow along the broken slopes and channels. Alluvial land is used mainly for livestock and wildlife range (fig. 11). In places dugouts are constructed for watering of livestock.

Deferred grazing or rotation-deferred grazing can be used along with proper stocking rates to maintain or improve the vigor and composition of the grasses. Weeds can be controlled by mechanical methods or by chemicals. Watershed improvement helps control flooding. Capability unit Vw-1, dryfarmed; Loamy Lowland range site; windbreak group 1.

Armo Series

The Armo series consists of deep, well drained, moderately sloping soils on foot slopes and fans. These

Figure 11.—**An area of Alluvial land, loamy, in the Loamy Lowland range site.**

soils formed in loamy and gravelly alluvium and colluvium. The native vegetation was mainly mid and tall grasses.

Surface runoff is medium to rapid, and the hazard of erosion is severe.

This soil is suited to farming if erosion is controlled.

thick of yellowish brown (10YR 5/6) and dark gray (5Y 4/1) when moist; moderate medium platy structure; extremely hard, extremely firm; very few roots; very strongly acid; gradual smooth boundary.

C3—32 to 72 inches, gray (5Y 5/1) clay shale.

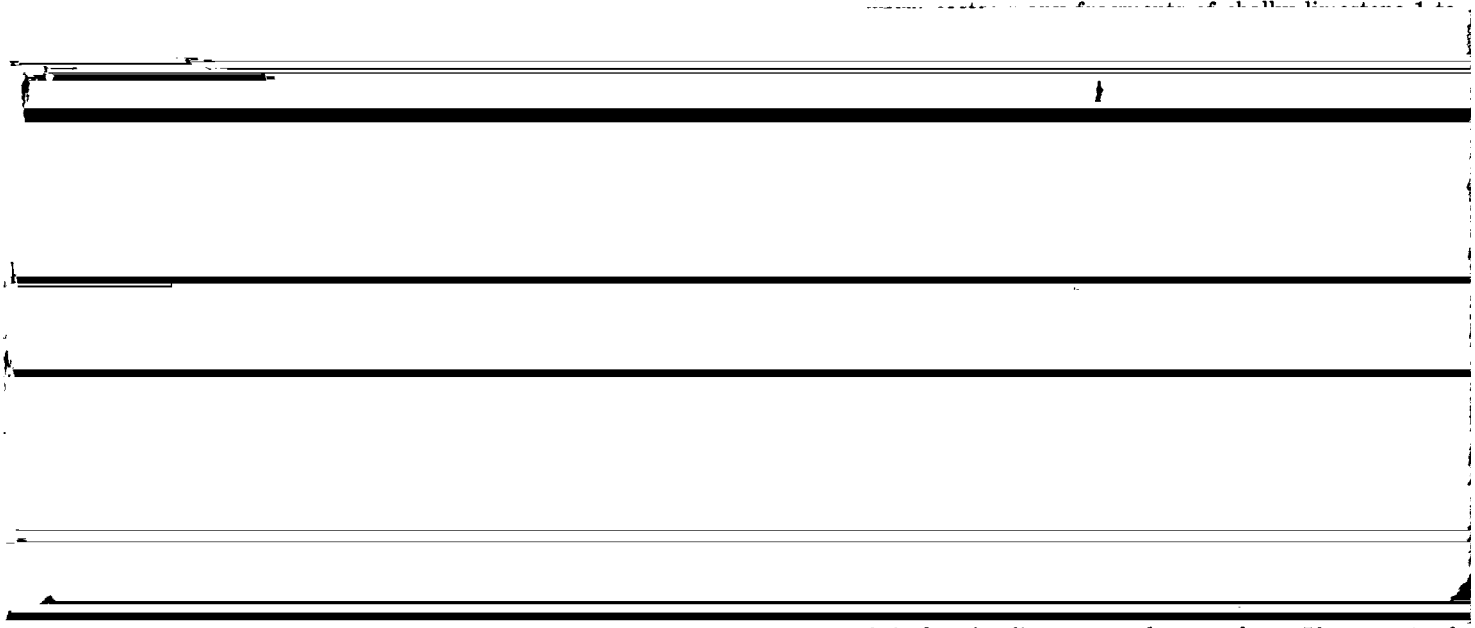
The A1 horizon ranges from clay to silty clay and is 4 to 8 inches thick. It is moderately alkaline to neutral.

The B2 horizon is 8 to 14 inches thick. The depth to unweathered acid shale ranges from 20 to 40 inches. The underlying shale ranges from medium acid to very strongly

Nearly all the acreage is used for range, but a few small areas have been cultivated. The effective root zone is 20 to 40 inches. The soil is droughty during periods of low rainfall.

Grazing should be at a rate that will maintain or improve the vigor of the most desirable grasses. Deferred grazing or rotation deferred grazing can be used, along with a proper stocking rate, to improve

when moist; moderate fine granular structure; slightly hard, friable; many fine roots; numerous common



2 inches in diameter make up about 50 percent of the mass; strong effervescence; moderately alkaline; gradual wavy boundary.

C—16 to 30 inches, very pale brown (10YR 8/4) channery loam, very pale brown (10YR 7/3) when moist; weak granular structure; slightly hard, friable; few fine roots; few worm casts; many coarse fragments of soft limestone 2 to 3 inches in diameter make up 70 percent of the mass, and loamy sediments fill interstices; strong effervescence; moderately alkaline; gradual smooth boundary.

R—30 inches, white (10YR 8/2) chalky limestone.

The solum is mildly alkaline to moderately alkaline throughout. The depth to limestone bedrock ranges from 20 to 40 inches.

The A1 horizon is gray to grayish brown silt loam to gravelly loam and is 4 to 9 inches thick. The B2 horizon is gray to grayish brown. The amount and size of limestone fragments increase with depth.

Brownell soils are near Heizer and Wakeen soils and occupy positions similar to those of Campus and Canlon soils. Brownell soils are deeper over bedrock than Heizer and Canlon soils. They are underlain by hard limestone, while Campus soils are underlain by soft caliche and Wakeen soils are underlain by soft chalky shale.

Br—Brownell gravelly loam, 3 to 15 percent slopes. This is a sloping to strongly sloping soil mostly on small hills, low ridges, and side slopes of drainageways in the uplands.

Included with this soil in mapping are small areas of steep Heizer soils. Also included are small areas of sloping Armo soils on the uplands below Brownell soils.

Surface runoff is medium. Root zone is limited, and the available moisture capacity is low. Soil blowing and erosion are hazards if the grass is overgrazed.

This soil is best suited to use as range. Some of the areas are sources of rock for use in building roads. Most areas of this soil are in native grass and are used as range.

Grazing should be managed to maintain or improve the cover of grass. Good management practices include rotation, deferment, distribution of grazing, and re-

Figue 13.—**Representative profile of Brownell gravelly loam, 3 to 15 percent slopes.**

moderate. Fertility is medium. Surface runoff is medium to rapid.

Campus soils are not well suited to cultivated crops. They are highly susceptible to erosion if they are cultivated. These soils are generally better suited to native grasses used as range. They are well suited to habitat for openland wildlife. Their limitations for many nonfarm uses are moderate.

Most areas of these soils are used for native grasses.

Representative profile of Campus loam, in an area of Campus-Canlon complex, 5 to 30 percent slopes, in native grass, about 2,000 feet west and 400 feet north of the southeast corner of sec. 9, T. 1 S., R. 15 W.

A1—0 to 8 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many fine roots; few worm casts; slight effervescence; mildly alkaline; clear smooth boundary.

B2—8 to 18 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; slightly hard, friable; many fine roots; common fragments of soft caliche; strong effervescence; moderately alkaline; gradual smooth boundary.

C1ca—18 to 32 inches, light gray (10YR 7/2) light loam, light brownish gray (10YR 6/2) when moist; weak granular structure; hard, friable; numerous roots; violent effervescence; soft caliche makes up about 25 percent of the mass; mildly alkaline; clear smooth boundary.

C2—32 to 72 inches, white (10YR 8/2) partly consolidated soft caliche.

The solum is mildly alkaline to moderately alkaline. The depth to soft caliche ranges from 20 to 40 inches. The depth to the C1ca horizon is less than 24 inches, and the calcium carbonate content of this horizon is greater than 25 percent.

The A1 horizon ranges from dark grayish brown to brown when dry and is very dark grayish brown or slightly lighter when moist. It ranges from silt loam to sandy loam with loam as the dominant texture. The A1 horizon is 5 to 10 inches thick. The B2 horizon ranges

grass is well managed, good yields of forage are obtained.

Grazing must be carefully controlled for high production of forage. Rotation grazing should be practiced to maintain a good cover of grass, increase the intake of water, and conserve more soil moisture.

There are sites for dams and ponds in places. Material for surfacing roads is obtained in places from the substratum. Capability unit VIe-2, dryfarmed; Campus soils in Limy Upland range site and windbreak group 3; Canlon soils in Shallow Limy range site and no windbreak group.

Canlon Series

The Canlon series consists of shallow, somewhat excessively drained, strongly sloping to steep soils on uplands. These soils formed in material weathered from hard caliche. The native grass vegetation was mainly mid grasses.

In a representative profile the surface layer is grayish brown loam about 6 inches thick. The underlying material is light brownish gray, friable light gravelly loam that contains many fragments of hard caliche. Hard caliche is at a depth of 14 inches.

Permeability is moderate, and the available water capacity is very low. Fertility is low. Surface runoff is rapid.

Canlon soils are not suited to cultivation because they are shallow over caliche. They are better suited to native grasses. They are well suited to habitat for openland wildlife. Their limitations for many nonfarm uses are moderate to severe.

Most areas of these soils are used for native grasses.

Representative profile of Canlon loam, in an area of Campus-Canlon complex, 5 to 30 percent slopes, in native grass, about 1,600 feet north and 400 feet east of the southwest corner of sec. 28, T. 1 S., R. 13 W.

Harney Series

The Harney series consists of deep, well drained, nearly level to sloping soils on loess-covered uplands. These soils formed in deep calcareous silty loess. The native vegetation was mainly short and mid grasses.

water capacity is high. Fertility is high. Surface runoff is slow to medium.

Harney soils are well suited to farming if erosion is controlled. They are also well suited to habitat for openland wildlife. The limitations for many nonfarm uses are moderate to severe.

but the surface layer is 8 to 10 inches thick and the depth to free carbonates ranges from 24 to 30 inches.

Included with this soil in mapping, and shown on the map by the symbol for a depressed area, are small depressions in the uplands. Also included are small areas of Holdrege soils and a silt loam soil similar to Harney soil but deeper to free carbonates.

Surface runoff is slow, and the hazard of erosion is slight. Soil blowing is a hazard if conditions are dry and the soil is not protected.

This soil is well suited to farming if moisture is stored and tilth is maintained. It is suited to native grass, wheat, alfalfa, and sorghums. It holds a large

and stripcropping are effective management practices. The cropping system most commonly used consists of sorghum, summer fallow, and wheat. The summer fallow allows moisture to be stored in the soil.

Good management of irrigated areas helps control erosion, maintain fertility, and preserve tilth. Effective management practices are use of crop residue.

fertilization, and effective irrigation. Bench leveling and contour and sprinkler irrigation help apply water effectively. Drop structures or underground pipes help control erosion and conserve water.

This soil has moderate to severe limitations for recreational or urban development. Low rainfall limits

Heizer Series

The Heizer series consists of shallow, somewhat excessively drained, strongly sloping to steep soils over limestone on uplands. These soils formed in material weathered from chalky limestone. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is gray gravelly loam about 8 inches thick. The underlying layer is grayish brown channery loam. Hard chalky limestone is at a depth of 14 inches.

Permeability is moderate, and the available water capacity is very low. Fertility is low. Surface runoff is rapid.

Heizer soils are not suited to crops because they are shallow to bedrock. They are suited to habitat for [redacted] and wildlife and are best suited to native grass ly in range used for livestock. Much of the original grass cover has been thinned by overgrazing in some areas, but the soils support a good stand of native grasses.

The chief concerns of management are the low to very low available water capacity and controlling erosion. If the native grass is well managed, good yields of forage are obtained.

Grazing must be carefully controlled for high production of forage. Rotation grazing is needed to maintain a good cover of grass, increase the intake of water, and conserve moisture. Capability unit VIIs-1, dryfarmed; Heizer soil in Shallow Limy range site and not placed in a windbreak group; Brownell soils in Limy Upland range site and windbreak group 3.

is a gently sloping soil in broad areas that range from small to large. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thicker. The depth to free carbonates ranges from 28 to 40 inches.

Included with this soil in mapping are small areas of Harney and Uly soils. Also included, and shown on the map by the symbol for a severely eroded spot, are a

in color than this mapping unit and has a surface layer of light silty clay loam.

Surface runoff is medium, and the hazard of erosion is slight to medium.

This is a good soil for cultivated crops. It is suitable for wheat, sorghums used for both grain and silage, alfalfa, and sweetclover. Because this soil erodes easily, it is not well suited to irrigation. It is well suited to farming if erosion is controlled and tilth is maintained.

Figure 16.—Harvesting forage sorghum for silage on sloping Holdrege soils.

The main concern of management is reducing erosion. This soil erodes if not protected by a growing

Surface runoff is rapid, and the hazard of erosion is severe. Soil blowing is a serious hazard where the

Hord Series

The Hord series consists of deep, well drained, nearly level soils on benches or terraces along streams. These soils formed in silty alluvium. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is gray silt loam about 15 inches thick. The subsoil is grayish brown, friable silt loam about 27 inches thick. The underlying material is light brownish gray heavy silt loam.

Permeability is moderate, and the available water capacity is high. Fertility is high. Surface runoff is slow.

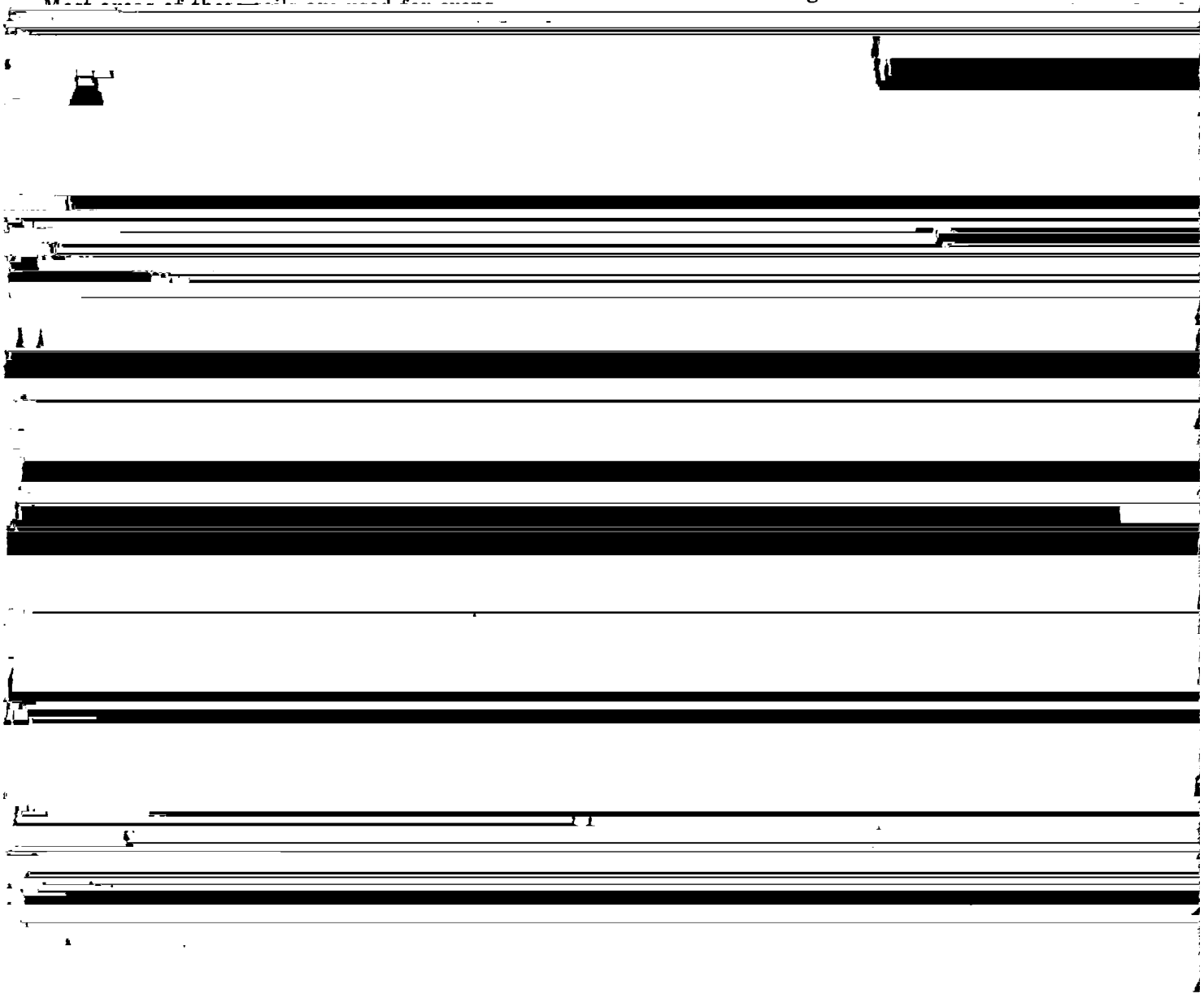
Hord soils are well suited to cultivation. They are also well suited to habitat for openland wildlife and to range. The limitations for nonfarm uses are slight.

The main concern of management is the lack of soil moisture that limits crop production in some years. Crop residue management is needed to control soil blowing and conserve moisture. In some years summer fallowing is needed to store moisture.

This soil is irrigated in fields where it is below the Kirwin Ditch or where wells have been established for irrigation water. Land leveling, use of underground pipes, and careful management of irrigation water are needed to control erosion and evaporation on irrigated lands. These practices also insure uniform penetration of water.

Fertilizer needs to be added to maintain the level of fertility. Proper tillage and management are needed to maintain good tilth. These soils produce large amounts of forage when properly managed.

This soil has slight limitations for recreational and



Im—Inavale-Munjor complex. These are nearly level to gently sloping soils on flood plains. Slope is 0 to 2 percent. The complex is about 60 percent Inavale soils and about 40 percent Munjor soils.

Inavale soils have a profile similar to the one described as representative of the series, but the surface layer is mainly loamy fine sand in smoother areas and fine sand in undulating areas. The fine sand wind hummocks are shown by the symbol for a fine sand spot. These sandy areas are best suited to native grasses.

Soil blowing, erosion in places, and inadequate soil moisture are hazards.

moist; moderate fine granular structure; slightly hard, friable; many fine and medium roots; many worm casts; slight effervescence; mildly alkaline; gradual smooth boundary.

AC—10 to 18 inches, light brownish gray (10YR 6/2) coarse silt loam, dark grayish brown (10YR 4/2) when moist; weak fine granular structure; slightly hard, friable; numerous roots; strong effervescence; mildly alkaline; gradual smooth boundary.

C1—18 to 40 inches, light gray (10YR 7/2) coarse silt loam, grayish brown (19YR 5/2) when moist; weak granular structure; slightly hard, friable; porous; numerous roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—40 to 72 inches, light gray (10YR 7/2) coarse silt loam, grayish brown (10YR 5/2) when moist; massive; porous, slightly hard, friable; few roots; firm

plex is about 60 percent McCook soils and 40 percent Munjor soils.

McCook soils have a profile similar to the one described as representative of the series, but the surface layer ranges from loam to coarse silt loam. Below a depth of 40 inches these soils are stratified in places with coarse silty and sandy alluvium. They are in slightly higher areas of the complex.

Munjor soils have a profile similar to the one described as representative of the Munjor series, but the surface layer is fine sandy loam and loam. Munjor loam is stratified with loams and fine sands in most places below a depth of 40 inches. Munjor soils are occasionally flooded.

Included with this unit in mapping are small areas of Roxbury silt loam, frequently flooded, on the nearly level flood plains; and small areas of Alluvial land, loamy, along the streams.

Runoff is slow, and erosion is not a hazard. Excess water from overflow tends to limit [illegible]

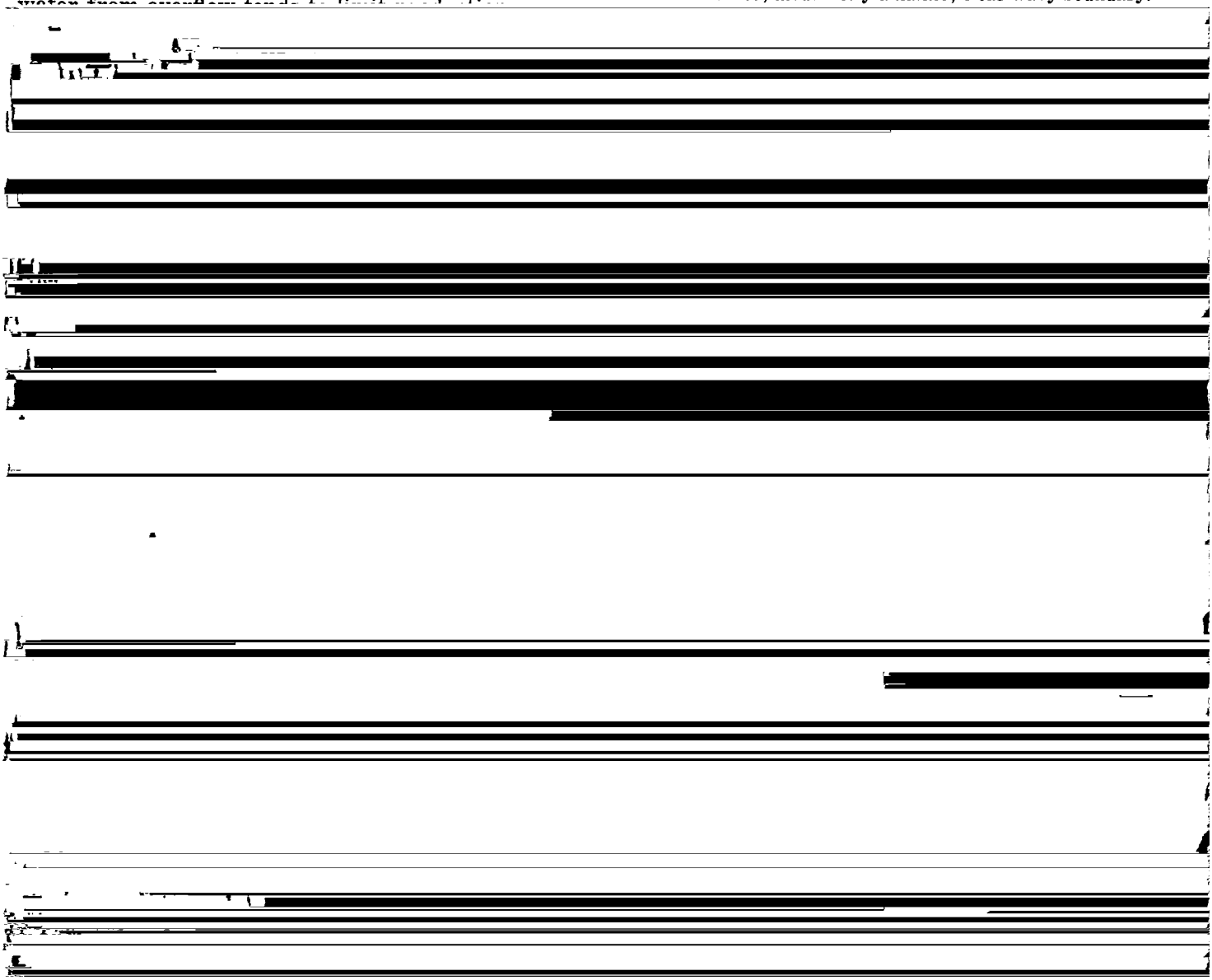
native vegetation, about 1,200 feet south and 600 feet east of the northwest corner of sec. 17, T. 14 S., R. 11 W.

A1—0 to 8 inches, grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

B2t—8 to 18 inches, dark grayish brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate fine columnar structure breaking to moderate medium subangular blocky; very hard, very firm; few fine roots; mildly alkaline; gradual smooth boundary.

B3ca—18 to 32 inches, pale brown (10YR 6/3) light silty clay loam, dark brown (10YR 4/3) when moist; moderate fine subangular blocky structure; hard friable; few roots; common soft calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

Cca—32 to 64 inches, pale brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; weak fine granular structure; hard, friable; violent effervescence; moderately alkaline; clear wavy boundary.



weak fine granular structure; slightly hard, very friable; few roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C—6 to 38 inches, light brownish gray (10YR 6/2) light fine sandy loam, grayish brown (10YR 5/2) when moist; weak medium granular structure in the upper part ranging to massive in the lower part; slightly hard, very friable; few roots; strong effervescence; [illegible]

medium subangular blocky structure to massive; very hard, firm; few fine roots; films and threads of calcium carbonate, many small soft accumulations of calcium carbonate concretions; strong effervescence; moderately alkaline.

The solum is mildly alkaline to moderately alkaline. The A1 horizon is heavy silty clay loam to silty clay and is 9 to 12 inches thick. The B21 horizon is gray to light

A1—0 to 10 inches, dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, friable; many fine roots; occasional worm casts; slightly acid; clear smooth boundary.

B2—10 to 20 inches, pinkish gray (7.5YR 6/2) light silty clay loam, brown (7.5YR 5/2) when moist; moderate fine to medium subangular blocky structure; very hard, friable; few roots; neutral; gradual smooth boundary.

B3—20 to 30 inches, light brown (75.YR 6/4) heavy silt loam, brown (7.5YR 5/4) when moist; weak medium subangular blocky structure; hard, friable; few roots; neutral; gradual smooth boundary.

C—30 to 72 inches, light brown (7.5YR 6/4) heavy silt loam, brown (7.5YR 5/4) when moist; weak granular structure; slightly hard, friable; common small concretions of calcium carbonate; slight effervescence; mildly alkaline.

The solum is slightly acid to neutral. Depth to free carbonates is 24 to 44 inches.

The A1 horizon ranges from grayish brown to dark grayish brown silt loam to light silty clay loam and is 7 to 12 inches thick. The B2 horizon is light brown to

This soil has moderate limitations for recreational or urban developments. Capability unit IVe-3, dryfarmed; Loamy Upland range site; windbreak group 2.

Nh—Nuckolls-Holdrege silt loams, 3 to 7 percent slopes. These are sloping soils on the sides and crests of uplands. The complex is about 60 percent Nuckolls silt loam, 30 percent Holdrege silt loam, and 10 percent Uly silt loam. The Uly silt loam is slightly lighter colored than the Holdrege silt loam.

In some of the more eroded areas, shown on the map by the symbol for a severely eroded spot, limy subsoil material is exposed at the surface. In some areas, tillage has mixed the subsoil material with the remaining original surface layer. Small areas of sandy sediment are shown on the map by a symbol for a sand spot.

Runoff is moderately rapid, and the hazard of erosion is severe. Soil blowing is also a hazard.

These soils are suited to cultivation. They are suit-

A1—0 to 10 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; slightly hard, friable; abundant fine roots; many worm casts; slight effervescence; mildly alkaline; gradual smooth boundary.

B2—10 to 20 inches, grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak medium granular structure; hard, friable; many roots; many worm casts; porous; few small quartz grains; few small concretions of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

C1ca—20 to 34 inches, very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) when moist; weak medium granular structure; very hard, firm; few roots; few concretions of calcium carbonate; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—34 to 72 inches, very pale brown (10YR 7/3) light clay loam, pale brown (10YR 6/3) when moist; massive; hard, friable; few roots; few small concretions of calcium carbonate; few quartz sand grains; porous; strong effervescence; mildly alkaline.

The solum is mildly alkaline to moderately alkaline. The depth to the C1ca horizon, which has a calcium carbonate content of 15 to 25 percent, is less than 30 inches.

The A1 horizon is dark grayish brown to brown loam or coarse silt loam and is 7 to 12 inches thick. The B2 horizon is grayish brown or brown and is 10 to 18 inches thick.

Penden soils are near Armo, Campus, Holdrege, and Uly soils. Penden soils have a more distinct Cca horizon than Armo soils. They have less calcium carbonate than Campus soils. Penden soils have free carbonates [illegible]

sive management is used to protect and conserve moisture.

This soil has moderate limitations for recreational or urban developments. Capability unit IIIe-4, dryfarmed; Limy Upland range site; windbreak group 3.

Roxbury Series

The Roxbury series consists of deep, well drained, nearly level to gently sloping soils on terraces and lowlands along major streams. These soils formed in alluvium. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is gray and dark gray silt loam about 30 inches thick. The subsoil is grayish brown, friable light silty clay loam about 20 inches thick. The underlying material is very pale brown heavy silt loam.

Permeability is moderate, and the available water capacity is high. Fertility is high. Surface runoff is slow.

Roxbury soils are well suited to cultivated crops. They are suited to habitat for openland wildlife and are suited to native grasses used as range. The limitations to many nonfarm uses are slight.

Most areas are used for crops and some are irrigated from the Kirwin Ditch.

This soil is fertile and is important for farming. It has the profile described as representative of the series. Slope is 0 to 1 percent. Included in mapping are small areas of Hord soils in slightly higher positions.

formed in deep alluvium on fans. This complex is about 50 percent Roxbury silt loam, 35 percent Armo loam, and 15 percent other soils.

Included with this unit in mapping are small areas

brownish gray or grayish brown silt loam to light silty clay loam. The C horizon is light gray to very pale brown.

Uly soils were mapped only with Holdrege or Roxbury soils. Uly soils are near Harney, Holdrege, Nuckolls, and Penden soils. They are less clayey than Harney soils. They are not leached as deeply as Holdrege soils, and they differ from Nuckolls soils in that they formed in younger, grayer loess. They are more silty and less sandy than Penden soils.

Uh—Uly-Holdrege silt loams, 7 to 12 percent slopes. These are strongly sloping soils on side slopes that are along drainageways on uplands. The complex is about 70 percent Uly silt loam and 30 percent Holdrege silt loam. Uly soils have the profile described as representative of the series.

Included with this unit in mapping are areas of an eroded soil that has a lighter colored surface layer. In some of the more eroded spots, limy subsoil material is exposed. In much of the cultivated acreage, tillage has mixed some of the subsoil material with the remaining original surface layer.

Runoff is rapid, and the hazard of erosion is severe. Soil blowing is a hazard where the soils do not have a rough surface or are not adequately protected by plant cover or crop residue.

These soils are not well suited to cultivation because of the erosion hazard. They are well suited to native grass. They are better suited to wheat than to other crops. They are suited to grain sorghum, but the sorghum is likely to be affected by chlorosis in the eroded areas.

[redacted]

acreage is cultivated and the rest is in native grasses. These areas are productive in years when rainfall is average or above average.

The main concern of management is controlling ero-

layer is slightly thinner. The Uly soil formed in deep loess.

The Roxbury soil has a profile similar to the one described as representative of the Roxbury series, but it

suited to range because of slope, alkalinity, and depth to bedrock. The soil limitations for many nonfarm uses are moderate to severe.

Many [illegible] of these soils are used for range, but

native grass for use as range. The soil is more pro-

Effects of Erosion

manent modification of the soil but also when it causes short-term damage to crops and forage. Replanting of crops, reseeding of range, and emergency tillage and smoothing operations can correct most of the temporary effects of erosion and restore full use of the land, but these practices are time consuming and costly.

Measures needed to control erosion vary according to the kind of soil, the degree of slope, and land use. One can generally choose a combination of practices that control erosion at a particular time (fig. 18). Some practices are suggested for each mapping unit in the section "Descriptions of the Soils." For more specific and detailed information on the control of erosion, consult a representative of the Soil Conservation Service.

Management of the Soils for Dryfarmed Crops[2]

In Smith County the management of soils for dryfarmed crops involves a combination of practices that reduces erosion and soil blowing, helps maintain good soil structure and an adequate organic matter content, and conserves as much rainfall as possible. Erosion control and water conservation are most successful if a proper combination of practices is used.

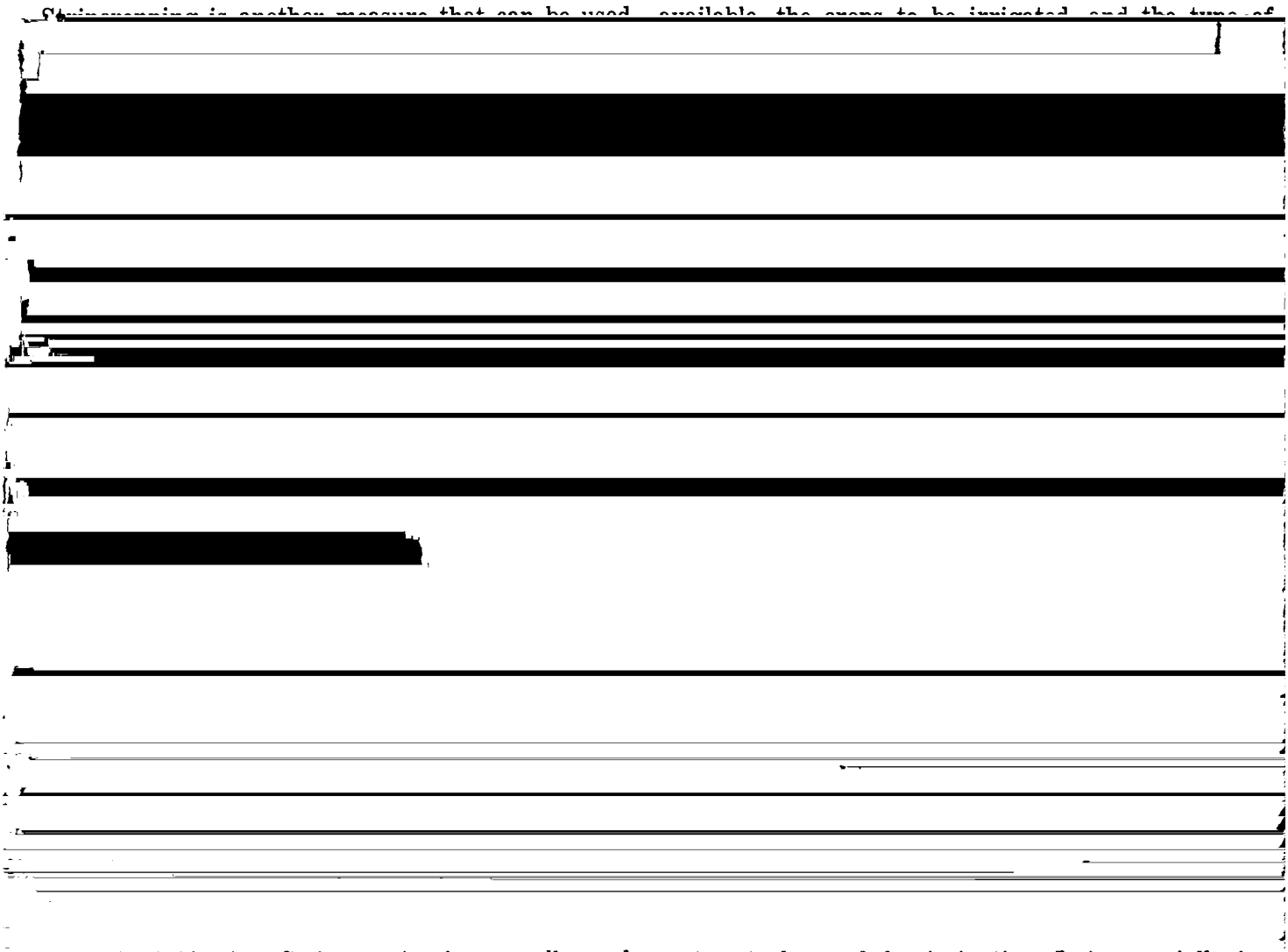
Terracing and contour farming can be used to reduce erosion and help conserve rainfall on most of the sloping soils in the county. These practices, alone or in combination, can also benefit some nearly level soils that have long slopes. Each row planted on the contour acts as a miniature terrace by holding back water and letting it soak into the soil. The water that is saved by terracing and contour farming increases crop growth, which in turn adds to the amount of residue available to protect the soil.

Crop residues should be properly managed on all of the soils in Smith County. Proper management of crop residues helps maintain good soil structure and control the infiltration of water, and helps control both erosion and soil blowing. A cover of residue on the surface helps hold the soil in place and helps reduce the puddling effect of beating raindrops.

Minimum or reduced tillage helps prevent the breakdown of soil aggregates and maintain more residue on the surface. Tilling when the soil is too wet causes a tillage pan to form, particularly in the loam and silt loam soils.

[2] By EARL J. BONDY, conservation agronomist, Soil Conservation Service, Salina.

Figure 18. Grain sorghum planted on the contour on Holdrege silt loam, 3 to 7 percent slopes. Terraces in this field drain into



to control soil blowing. Stripcropping is generally used in combination with good crop residue management, minimum tillage, and the addition of fertilizer. Stripcropping is especially applicable to some of the nearly level soils that have a surface layer of sandy loam or loam.

Wheat and grain sorghum are the main crops grown in Smith County. Some alfalfa is also grown on bottom land but sometimes on uplands. Forage sorghum is grown as well. The sequence of crops that are grown affects the combination of practices that is needed for a particular soil.

Close-growing crops, such as wheat, provide more protection for the soil than row crops. Also, the residues from wheat provide more protection than the residues from grain sorghum.

Management of the Soils for Irrigated Crops[3]

The factors to be considered in planning an irrigation system are the characteristics and properties of the soil, the quality and quantity of irrigation water system to be used for irrigation. It is especially important to know the quality of the irrigation water in order to evaluate the long-term effect of irrigation on the soil.

All natural waters used for irrigation contain some soluble salts. If water of poor quality is used on a soil having slow permeability, and if some leaching is not done, harmful salts are likely to accumulate. Leaching requires an application of water in excess of the needs of the crops so that some of the water can pass through the root zone.

Some of the soil factors that are important to irrigation are depth, available water capacity, permeability, drainage, slope (fig. 19), and susceptibility to stream overflow. All of these must be considered in designing the irrigation system. The frequency of irrigation depends on the requirements of the crop and the available water capacity of the soil. The available water capacity is determined mainly by the depth and texture of the soil. Permeability affects the water-intake rate and the internal drainage of the soil. The rate of water intake is also affected by the condition of the surface layer.

[3] By EARL J. BONDY, conservation agronomist, Soil Conservation Service, Salina.

This survey has determined the characteristics of each soil in the county. Permeability and available water capacity for each soil are listed in the table on estimated soil properties in the section "Engineering." Soil features affecting the use of soils for irrigation are given in another table in this same section.

Wheat, corn, grain sorghum, and alfalfa are the main crops grown under irrigation in Smith County.

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farms. These readers can make good use of the capability classification system, a grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of soils and the way they respond to management.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, they require about the same management, and they have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or VIIs-1.

The eight classes in the capability grouping system and the subclasses and units in Smith County are described in the list that follows. The capability unit of each soil in the county is listed in the "Guide to Mapping Units."

Class I. Soils have few limitations that restrict their use.

(No subclasses.)

the choice of plants, require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

strongly sloping, well drained gravelly loams over limestone; on uplands.

Unit VIe-5. Moderately deep, sloping to strongly sloping, moderately well drained

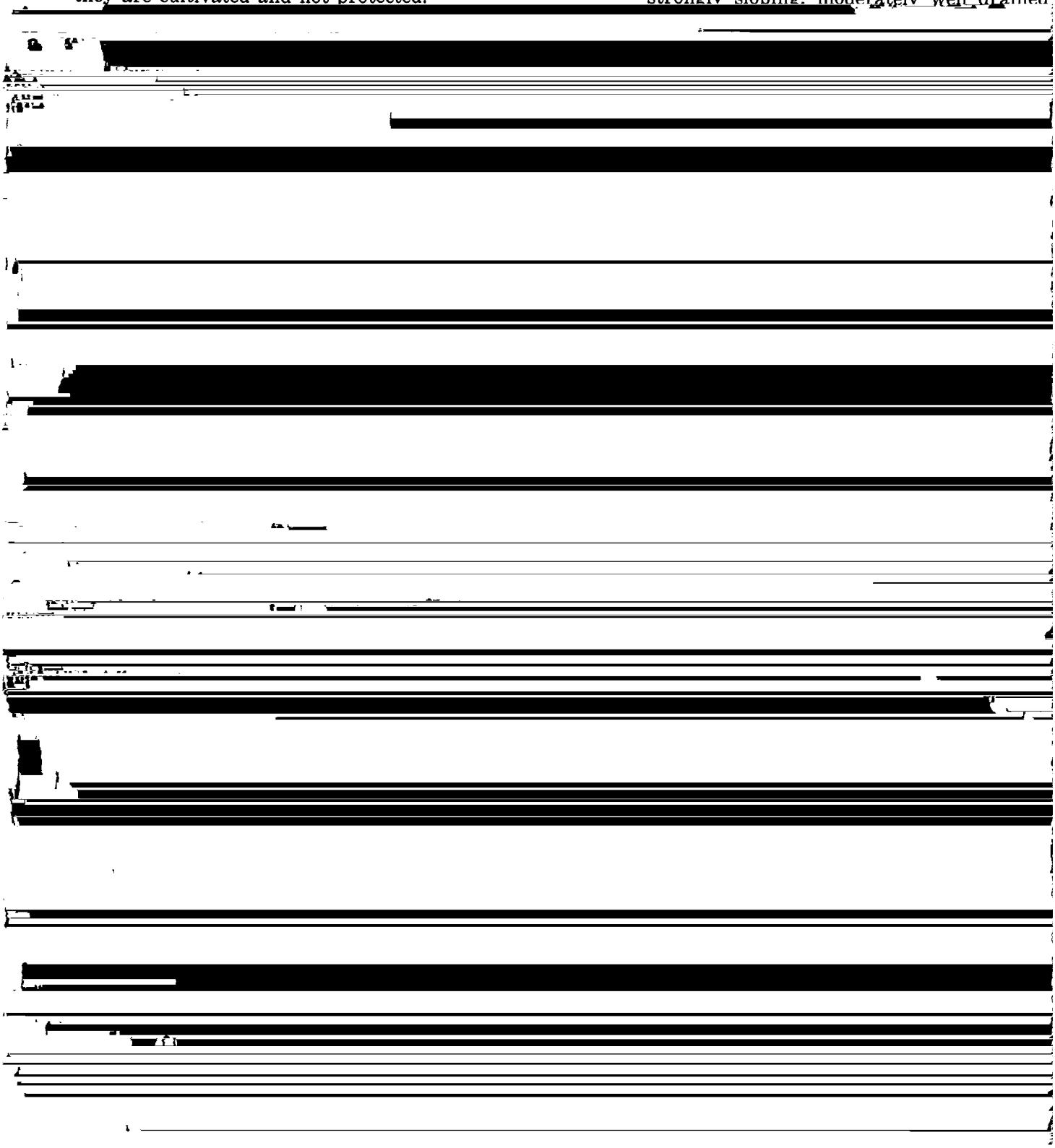


TABLE 2.—*Predicted yields per acre of dryfarmed crops*

[Soils not listed in this table are not suitable for the crops shown.]

Soil	Wheat	Grain sorghum	Alfalfa hay
	Bu	*Bu*	*Tons*
Armo loam, 2 to 7 percent slopes	26	39	2.2
Harney silt loam, 0 to 1 percent slopes	38	54	3.2
Harney silt loam, 1 to 3 percent slopes	34	51	3.0
Harney-Mento silt loams, 3 to 7 percent slopes	24	33	1.8
Holdrege silt loam, 1 to 3 percent slopes	34	51	3.0
Holdrege silt loam, 3 to 7 percent slopes	28	42	2.4
Holdrege silty clay loam, 3 to 7 percent slopes, eroded	26	42	2.4
Hord silt loam	40	60	4.0
Inavale-Munjor complex	20	30	1.6
McCook silt loam	38	54	4.0
McCook-Munjor complex	34	48	3.2
New Cambria silty clay	32	45	3.0
Nuckolls silt loam, 7 to 12 percent slopes	24	33	2.0
Nuckolls-Holdrege silt loams, 3 to 7 percent slopes	32	48	3.6
Penden loam, 3 to 7 percent slopes	26	36	2.4
Roxbury silt loam	38	60	4.0
Roxbury silt loam, frequently flooded	28	48	2.2
Roxbury-Armo complex, 0 to 3 percent slopes	36	54	3.4
Uly-Holdrege silt loams, 7 to 12 percent slopes	22	33	2.0
Wakeen silt loam, 3 to 7 percent slopes	24	30	1.6

TABLE 3—*Predicted yields per acre of irrigated crops*

Soil	Corn	Grain sorghum	Alfalfa
	Bu	*Bu*	*Tons*
Harney silt loam, 0 to 1 percent slopes	126	124	5.4
Harney silt loam, 1 to 3 percent slopes	112	117	5.4
Holdrege silt loam, 1 to 3 percent slopes	126	117	5.4
Hord silt loam	133	130	6.0
McCook silt loam	140	124	6.0
McCook-Munjor complex	126	110	5.4
New Cambria silty clay	91	98	4.8
Roxbury silt loam	140	130	6.0
Roxbury-Armo complex, 0 to 3 percent slopes	126	117	5.4

sion. Land leveling, contour furrowing, and the use of gated pipes and underground pipes are among the practices used.

2. The soils are tilled at the proper time.
3. The cropping system includes legumes, close-growing crops, and row crops.
4. Suitable varieties of crops are planted.
5. Seeding is at a rate that insures a maximum plant population.
6. Irrigation water is applied properly.
7. The amounts and kinds of fertilizer applied provide the level of fertility needed to produce optimum yields of the particular crop.
8. Manure, when available, is used to maintain the content of organic matter.

cording to the 1969 Farm Facts, Kansas Crop and Livestock Information, about 41 percent of the annual gross income from farms and ranches in the county was from the sale of beef cattle, sheep, and dairy products. The number of cattle, including calves, in the county generally ranges from 60,000 to 80,000.

The major source of livestock feed is native range, but large amounts of crops and their byproducts are used for supplemental feed. Approximately 38 percent of the land area in the county, or 210,568 acres, is range.

In addition to producing pasture and hay for livestock, range supplies food and cover for wildlife. Well managed range contributes to flood control when large amounts of the precipitation that falls soak into the

the capabilities of the various soils, the combinations [redacted] Knowledge of the climax plant communities of range [redacted]

grazing on the different kinds of plants. The ability to recognize signs of improvement or deterioration in the range vegetation is also important. A system for recording and evaluating range resources is discussed in the following paragraphs.

There are many differences in the soils and climate of Smith County. For this reason there are several different kinds of range recognized. These different kinds of range are called range sites.

Over the centuries, the plants best adapted to a range site have become established on the site. This group of plants is called the potential or climax plant community for the site. The climax plant community for a site varies slightly from year to year, but the kinds and amounts of plants remain about the same if undisturbed.

The original mixture of plants fitted the soil and in relation to that potential is important in planning and applying conservation measures. Such information is the basis for selecting management objectives, designing grazing systems, managing wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective for rangeland must provide for a plant cover that adequately protects or improves the soil and water resources and meets the needs of the operator. This usually involves maintaining or increasing desirable plants and restoring a degraded community to near climax conditions. Sometimes, however, a plant cover somewhat below climax better fits specific grazing needs, provides better wildlife habitat, or furnishes other benefits while still protecting the soil and water resources.

and subsoil are silt loam. Permeability is moderate, and deep plant root penetration is possible. McCook, Hord, and Roxbury silt loam are in this range site.

The climax plant community, by weight, is 25 percent big bluestem and 15 percent switchgrass. Indiangrass, little bluestem, and western wheatgrass each makes up 10 percent; sideoats grama, blue grama, tall dropseed, and Maximilian sunflower each makes up 5 percent; Canada wildrye and slimflower scurfpea each makes up 3 percent; and Illinois bundleflower and western ragweed each makes up 2 percent.

Prolonged overgrazing changes the plant community. The taller grasses, including big bluestem, indiangrass, switchgrass, and little bluestem, decrease in amount. Plants such as western wheatgrass, sideoats grama, blue grama, and tall dropseed increase. Palatable forbs, such as Maximilian sunflower and Illinois bundleflower, also decrease if the site is subjected to continuous overgrazing. Only minor amounts of western ragweed, heath aster, Baldwin ironweed, and Missouri goldenrod are in the plant communities, but they increase rapidly if the site is overgrazed.

If this site is in excellent condition, the average annual production of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

LOAMY UPLAND RANGE SITE

The soils in this range site are nearly level to steep, deep, and are on uplands. The surface layer is loamy, and the subsoil is loamy to clayey. Permeability is moderate to moderately slow. The available water capacity is high, and there is ample room for root growth. Holdrege (fig. 20), Nuckolls, Harney, and Uly soils are in this range site.

The climax plant community, by weight, is 25 percent big bluestem. Little bluestem, sideoats grama, blue grama, and western wheatgrass each makes up 10 percent; indiangrass, switchgrass, buffalograss, tall dropseed, and slimflower scurfpea each makes up 5 percent; western ragweed and Louisiana sagewort each makes up 3 percent; and prairie coneflower and dotted gayfeather each makes up 2 percent.

Continuous overgrazing changes the plant community. The preferred plants, including big bluestem, little bluestem, and switchgrass, are selectively grazed by livestock. When repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Plants that increase include sideoats grama, blue grama, buffalograss, western wheatgrass, western ragweed, and Louisiana sagewort.

If the site is overgrazed for many years, the vegetation degenerates to mainly blue grama, buffalograss, windmillgrass, and western ragweed.

If this site is in excellent condition, the average annual production of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

SANDS RANGE SITE

Only Inavale soils are in this range site. They are on undulating to rolling topography. The surface layer

Figure 20.—Cattle grazing on Holdrege soils in the Loamy Upland range site.

and subsoil are fine sand. These soils absorb moisture rapidly, but their available water capacity is low.

The climax plant community, by weight, is 30 percent sand bluestem and 20 percent little bluestem. Switchgrass and blue grama each makes up 10 percent; indiangrass, Illinois bundleflower, Louisiana sagewort, and sand plum each makes up 5 percent; sideoats grama and Scribner's panicum each makes up 3 percent; and sand dropseed and roundhead lespedeza each makes up 2 percent.

Prolonged overgrazing changes the plant community. The taller grasses, including sand bluestem, indiangrass, switchgrass, and little bluestem, decrease in amount. Plants such as blue grama, fall witchgrass, Scribner's panicum, sand paspalum, and sand dropseed

steep and are on uplands. The surface layer is loamy and ranges from 4 to 20 inches in depth over limestone. Permeability is moderate, and available water capacity is low and very low. Plant root penetration is limited by limestone and hard caliche in the subsoil. The soils are generally rough and broken and have many vertical ledges which make travel for livestock difficult. Canlon and Heizer soils are in this range site.

The climax plant community, by weight, is 25 percent little bluestem, 20 percent big bluestem, and 15 percent sideoats grama. Plains muhly makes up 10 percent; blue grama and hairy grama make up 10 percent; switchgrass makes up 5 percent; leadplant makes up 3 percent; and resinous skullcap, blacksamson, prairieclover, catclaw sensitivebrier, smooth sumac,

uplands. These soils naturally receive only the moisture that falls as precipitation.

The surface layer is silt loam or loam, and the subsoil is heavy silt loam or silty clay loam. Permeability is moderate to moderately slow, and available water capacity is high. The soils are well drained.

Windbreak Suitability Group 3.—The soils of suitability group 3 are on gently sloping to strongly sloping uplands. These soils are deep to moderately deep over chalky shales and limestone.

The surface layer is silt loam or loam, and the subsoil is mainly silty clay loam or clay loam. The available water capacity is low to high. The soils are well drained.

In table 4 the suitability of the soils in each group is rated for specified trees and shrubs. The ratings are excellent, good, fair, and poor. A suitability rating of *excellent* indicates that trees grow well on the soils in

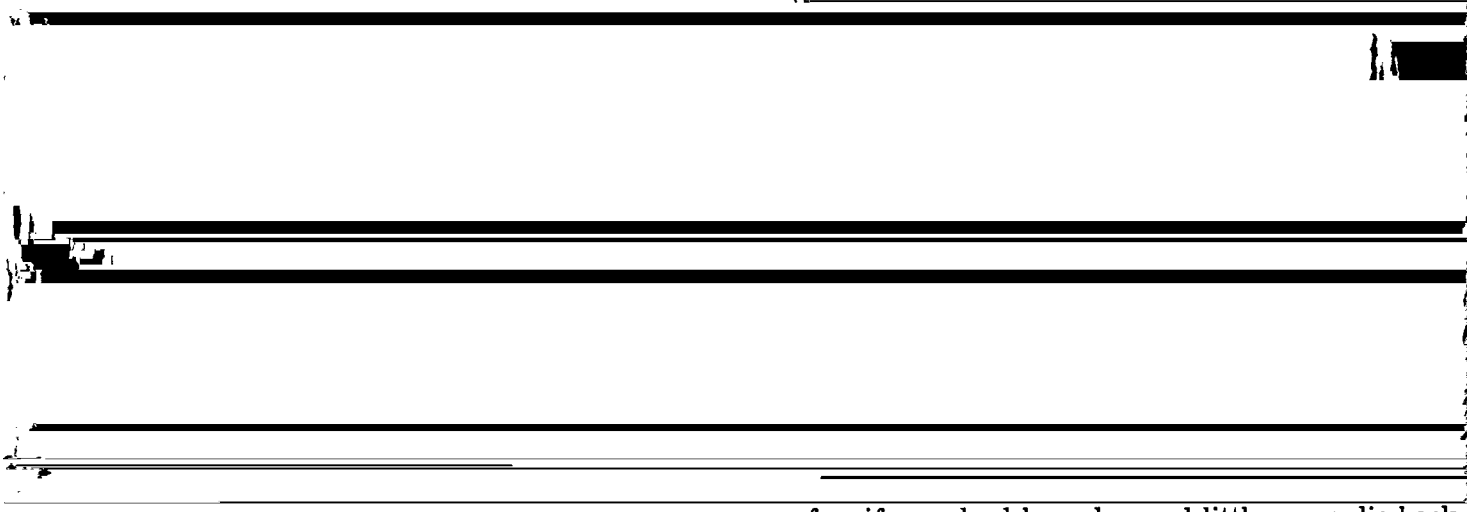


***Figure 21.*—Farmstead windbreak on Roxbury soils. These soils are in windbreak suitability group 1.**

trees need protection from fire, livestock, insects, rabbits, and rodents. Grasses and weeds must be controlled to prevent competition for available moisture. Cultivation controls weeds and also permits water and air to penetrate the soils easily. Extra moisture can be provided by diverting runoff from other areas, by diverting floodwaters, and by using water from irrigation and domestic wells. In some areas irrigation causes new windbreaks to grow faster and develop a good root system early.

are few if any dead branches and little or no die-back in the upper part of the crown, and there is no indication of damage by fungus or disease.

A rating of *good* indicates that trees grow moderately well, there are a few dead branches and some die-back in the upper part of crown, and there is slight damage by fungi or insects.

A rating of *fair* indicates that at least half of the trees have a significant number of dead branches in the upper part of the crown, about one-fourth of the trees are dead, tree growth is slow, and moderate damage by fungi or insects can be expected.

A rating of *poor* indicates that surviving trees have severe die-back, less than three-fourths of trees planted

TABLE 4.—*Vigor and height of trees and shrubs by windbreak suitability group*

[Estimates of height are for 20-year-old trees. Vigor ratings are explained in the text. No estimate of height is given if vigor is rated poor]

Trees and shrubs	Group 1 (Lowlands)		Group 2 (Uplands)		Group 3 (Limy uplands)	
	Vigor	Height	Vigor	Height	Vigor	Height
		Feet		*Feet*		*Feet*
Coniferous trees:						
Eastern redcedar	Excellent	20–25	Excellent	20–25	Fair	15–20
Rocky Mountain juniper	Good	25–30	Good	20–25	Poor	
Ponderosa pine	Excellent	25–30	Excellent	20–25	Fair	15–20
Austrian pine	Excellent	25–30	Excellent	30–35	Fair	10–15
Tall deciduous trees:						
Cottonwood	Excellent	40–50	Fair	25–35	Poor	
Siberian elm	Excellent	25–45	Excellent	30–40	Good	25–35
Medium deciduous trees:						
Green ash	Excellent	30–35	Excellent	20–25	Fair	10–15
Hackberry	Excellent	30–35	Excellent	20–25	Good	15–20
Bur oak	Excellent	25–30	Excellent	20–25	Fair	10–15
Black walnut	Excellent	25–30	Good	20–25	Poor	
Honeylocust	Good	25–30	Excellent	20–25	Fair	15–20
Short deciduous trees:						
Russian-olive	Excellent	15–20	Excellent	15–20	Good	10–15
Russian mulberry	Excellent	15–20	Good	10–15	Fair	10–15
Osageorange	Excellent	15–20	Excellent	15–20	Fair	10–15
Shrubs:						
American plum	Excellent	5–10	Excellent	5–10	Good	2–6
Tamarisk	Excellent	5–10	Good	5–10	Poor	
Common lilac	Excellent	5–10	Excellent	5–10	Poor	
Multiflora rose	Good	3–8	Fair	3–5	Poor	

White-tailed deer are increasing in the county. During hunting seasons each fall hunters are allowed to harvest surplus animals. The best white-tailed deer habitat in Smith County is along the wooded streams. Some mule deer can also be seen.

Cottontail rabbits and fox squirrel are other species associated with the woodlands along the streams. Migrating waterfowl use farm ponds and the large reservoirs as resting places during their migration through Kansas. Large numbers of ducks and geese often overwinter on the large reservoirs throughout Kansas. Raccoon, beaver, skunk, opossum, and muskrat are furbearers commonly associated with wet and wooded areas of the county.

Songbirds, such as meadowlarks, robins, mourning

itations are severe enough to make use of the soil questionable for wildlife habitat. *Very poor* means that extreme measures are needed to overcome the limitations and that usage generally is not practical. A rating of "poor" or "very poor" does not necessarily mean that a soil cannot be managed for wildlife, but it does show that a high level of management is required to overcome the limitation.

The eight elements of wildlife habitat are defined in the following paragraphs.

Grain and seed crops.—Among these crops are corn, wheat, oats, barley, rye, grain sorghum, and millet.

Grasses and legumes.—These are planted grasses and legumes commonly used for forage. Examples are bromegrass, fescue, clover, alfalfa, and sudangrass.

[redacted]

TABLE 5.—*Suitability of the soils for elements of wildlife habitat and kinds of wildlife*

[Absence of an entry indicates that the soil was not rated]

Soil series and map symbols	Elements of wildlife habitat								Kinds of wildlife			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Open-land	Wood-land	Wetland	Range-land
Alluvial land: Aa	Poor	Fair	Good	Good	Good	Good	Fair	Good	Fair	Good	Fair	
Armo: Ar	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor	Good		Very poor	Fair.
Bogue: Bo	Poor	Fair	Poor	Poor	Poor	Poor	Very poor	Poor	Poor		Very poor	Poor.
Brownell: Br	Poor	Fair	Fair	Poor	Very poor	Fair	Very poor	Very poor	Fair		Very poor	Fair.
Campus: Cc For Canlon part, see Canlon series.	Poor	Fair	Good	Poor	Poor	Fair	Very poor	Very poor	Fair		Very poor	Fair.
Canlon Mapped only with Campus soils.	Very poor	Very poor	Poor	Very poor	Very poor	Fair	Very poor	Very poor	Poor		Very poor	Very poor.
Harney: Ha, Hb, Hc For Mento part of Hc, see Mento series.	Fair	Good	Fair	Good	Poor	Fair	Very poor	Very poor	Fair		Very poor	Good.
Heizer: Hd For Brownell part, see Brownell series.	Very poor	Very poor	Poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor		Very poor	Very poor.
Holdrege: He, Hf, Hg	Good	Good	Good	Fair	Poor	Fair	Very poor	Very poor	Good		Very poor	Good.
Holdrege part of Uh	Fair	Good	Good	Fair	Fair	Fair	Very poor	Very poor	Good		Very poor	Good.
Hord: Hh	Good	Good	Good	Good	Good	Good	Very poor	Very poor	Good		Very poor	Good.
Inavale: Im For Munjor part, see Munjor series.	Fair	Fair	Good	Poor	Poor	Fair	Very poor	Very poor	Fair		Very poor	Good.
McCook: Ma, Mm For Munjor part of Mm, see Munjor series.	Good	Good	Good	Good	Fair	Good	Very poor	Very poor	Good		Very poor	Good.
Mento Mapped only with Harney series.	Fair	Good	Fair	Fair	Poor	Fair	Very poor	Very poor	Fair		Very poor	Fair.
Munjor Mapped with McCook series.	Fair	Fair	Good	Good	Good	Good	Fair	Poor	Fair		Poor	Good.
Munjor Mapped with Inavale series.	Fair	Good	Good	Good	Fair	Good	Poor	Very poor	Good		Very poor	Good.

Fair.	Fair.		Good.	Good.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Good.	Fair.		Fair.	Good.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Fair.	Very poor.		Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Fair.	Very poor.		Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Fair.	Very poor.		Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Good.	Fair.		Fair.	Good.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
Fair.	Very poor.		Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.

Shrubs are bushy wood plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are mountainmahogany, bitterbrush, snowberry, and big sagebrush. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland food and cover plants.—These are plants that grow on moist or wet sites and that provide food and cover for waterfowl and furbearing animals. Examples are cattails, sedges, bulrushes, smartweed, pondweed, duckweed, and burreed.

Shallow-water developments.—These are impoundments of shallow water in marshy areas and stream channels. They consist of low dikes, nearly level ditches, dugouts, and devices to maintain water at a depth suitable for wetland wildlife.

Openland wildlife.—This kind of wildlife is made up of birds and mammals that normally frequent cropland, pasture, meadow, and areas overgrown with

TABLE 6.—*Degree and kind of limitations of the soils for recreation facilities*

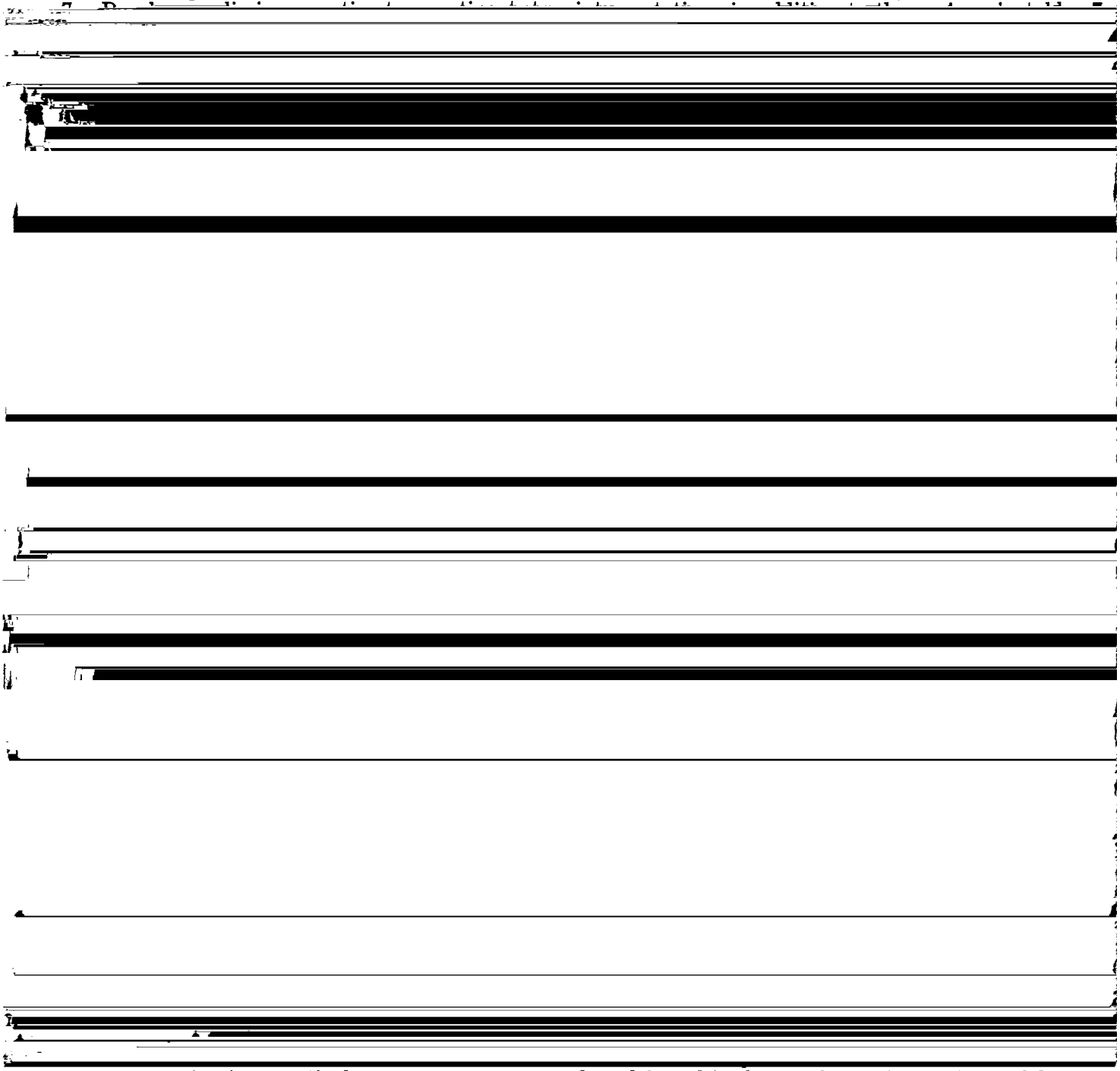
Soil series and map symbols	Campsites	Picnic areas	Playgrounds	Paths and trails

TABLE 6.—*Degree and kind of limitations of the soils for recreation facilities*—Continued

Soil series and map symbols	Campsites	Picnic areas	Playgrounds	Paths and trails
Penden: Pe	Slight	Slight	Moderate: slopes are 3 to 7 percent.	Slight.
Roxbury:				
Ro, Rr. For Armo part of Rr, see Armo series.	Slight	Slight	Slight	Slight.
Rp	Severe: flooding	Severe: flooding	Severe: flooding	Slight.
Uly: Uh, Ur. For Holdrege part, see Holdrege series. For Roxbury part, see Roxbury, Rp.	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe where slopes are more than 6 percent.	Slight.
Wakeen: Wc	Slight	Slight	Moderate where slopes are 2 to 6 percent.	Slight.
Wakeen: Wd	Moderate where slopes are 8 to 15 percent.	Moderate where slopes are 8 to 15 percent.	Severe where slopes are more than 6 percent.	Slight.

country movement of vehicles and construction equipment.

This information, along with the soil map and data in other parts of this publication, can be used to make



construction in a particular area.

Most of the information in this section is presented in tables. Table 7 shows estimated soil properties significant in engineering. Table 8 gives interpretations for various engineering uses. Table 9 evaluates the soils as sources of construction material. Table 10 shows the results of engineering laboratory tests on soil samples.

8, and 9, and it also can be used to make useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas

of a given soil can include small areas of other kinds of soil that have strongly contrasting properties and

fense, and others, and the system adopted by the American Association of State Highway and Transportation

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal water table			Unified	AASHTO
	Ft	*Ft*	*In*			
*McCook: Ma, Mm For Munjor part of Mm, see Munjor series.	>6	>10	0–72	Coarse silt loam	ML, CL	A–4, A–6
Mento Mapped only with Harney soils.	5	>5	0–8	Silt loam	ML, CL	A–4, A–6
			8–18	Heavy silty clay loam	CH	A–7–6
			18–64	Light silty clay loam	CL, CH	A–7–6
			64	Soft limestone.		
Munjor Mapped only with Inavale and McCook soils.	5	5	0–38	Fine sandy loam	SM–SC, SM	A–2–4
			38–72	Fine sand	SP, SM	A–3
New Cambria: Nc	>6	>6	0–72	Silty clay	CH, CL	A–7–6
*Nuckolls: Nd, Nh For Holdrege part of Nh, see Holdrege series.	>6	>10	0–10	Silt loam	ML, CL	A–4, A–6
			10–20	Light silty clay loam	CL	A–6, A–7–6
			20–72	Silt loam	CL, ML	A–4, A–6
Penden: Pe	>6	>10	0–10	Loam	CL	A–6
			10–72	Clay loam	CL	A–6, A–7–6
*Roxbury: Ro, Rp, Rr For Armo part of Rr, see Armo series.	>6	>6	0–72	Silt loam, silty clay loam	CL, ML	A–4, A–6
*Uly: Uh, Ur For Holdrege part of Uh, and Roxbury part of Ur, see Holdrege and Roxbury series.	>6	>10	0–72	Silt loam	ML, CL	A–4, A–6
Wakeen: Wc, Wd	3	>6	0–9	Silt loam	CL	A–6
			9–34	Silty clay loam	CL	A–6, A–7
			34	Soft chalky shale.		

[1] Coarse fragments larger than 3 inches in diameter make up 5 to 30 percent of the 0 to 16 inch layer and 10 to 40 percent of the 16 to 30 inch layer.

two classes are designated by symbols for both classes, for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 7. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the column headings in table 7.

Depth to bedrock is distance from the surface of the soil to the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground

significant in engineering—Continued

Percentage smaller than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In per in	*In per in of soil*	*pH*			
	100	90–100	70–100	25–35	4–7	0.6–2.0	0.17–0.19	7.4–8.4	Low	Low	Low.
	100	90–100	85–100	30–40	8–15	0.6–2.0	0.22–0.24	6.6–7.3	Low to moderate.	Low	Low.
100	95–100	90–100	85–100	55–70	40–50	0.06–0.2	0.18–0.20	7.4–7.8	High	High	Moderate.
100	95–100	90–100	85–100	41–65	20–45	0.2–0.6	0.18–0.20	7.9–8.4	Moderate	High	Moderate.
100	95–100	60–70	20–35	20–35	3–7	2.0–6.0	0.13–0.15	7.4–8.4	Low	Low	Low.
95–100	90–95	55–70	0–10	NP	NP	6.0–20.0	0.06–0.08	7.9–8.4	Low	Low	Low.
	100	95–100	90–100	41–60	30–45	0.06–0.2	0.12–0.14	7.4–8.4	High	High	Low.
	100	95–100	90–100	24–40	2–14	0.6–2.0	0.22–0.24	6.1–6.5	Low	Low	Low.
	100	95–100	85–98	28–48	20–35	0.6–2.0	0.18–0.20	6.6–7.3	Low to moderate.	Low	Low.
	100	95–100	85–95	28–45	5–18	0.6–2.0	0.20–0.22	6.6–7.8	Low	Low	Low.
	100	90–100	70–85	30–40	10–22	0.6–2.0	0.20–0.22	7.4–8.4	Moderate	Low	Low.

TABLE 8.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The
indicated in the

Soil series and map symbols	Degree and kind of limitations for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Roads and streets
Alluvial land: Aa. No interpretations.					
Armo: Ar	Slight	Moderate: moderate permeability.	Slight	Slight	Moderate: low strength.
Bogue: Bo	Severe: very slow permeability.	Moderate to severe: 3 to 15 percent slopes; shale at a depth of less than 40 inches.	Severe: shale at a depth of less than 40 inches; clayey.	Severe: high shrink-swell potential; slope.	Severe: high shrink-swell potential; slope; poor workability.
Brownell: Br	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe for dwellings with basements: bedrock at a depth of 20 to 40 inches. Moderate for dwellings without basements.	Moderate: bedrock at depth of 20 to 40 inches; 3 to 15 percent slopes.
*Campus: Cc For Canlon part, see Canlon series.	Severe: caliche bedrock at a depth of 20 to 40 inches.	Severe: caliche bedrock at a depth of 20 to 40 inches.	Moderate: caliche bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches. For dwellings without basements: slope is also a factor.	Moderate: caliche bedrock at a depth of 20 to 40 inches; 5 to 12 percent slopes.
Canlon Mapped only with Campus soils.	Severe: caliche bedrock at a	Severe: caliche bedrock at a	Severe: bedrock at a depth of 10	Severe: depth to bedrock.	Severe: bedrock at a depth of

engineering properties of the soils

soils in such mapping units have different properties and limitations, and for this reason it is necessary to refer to other series as first column of this table]

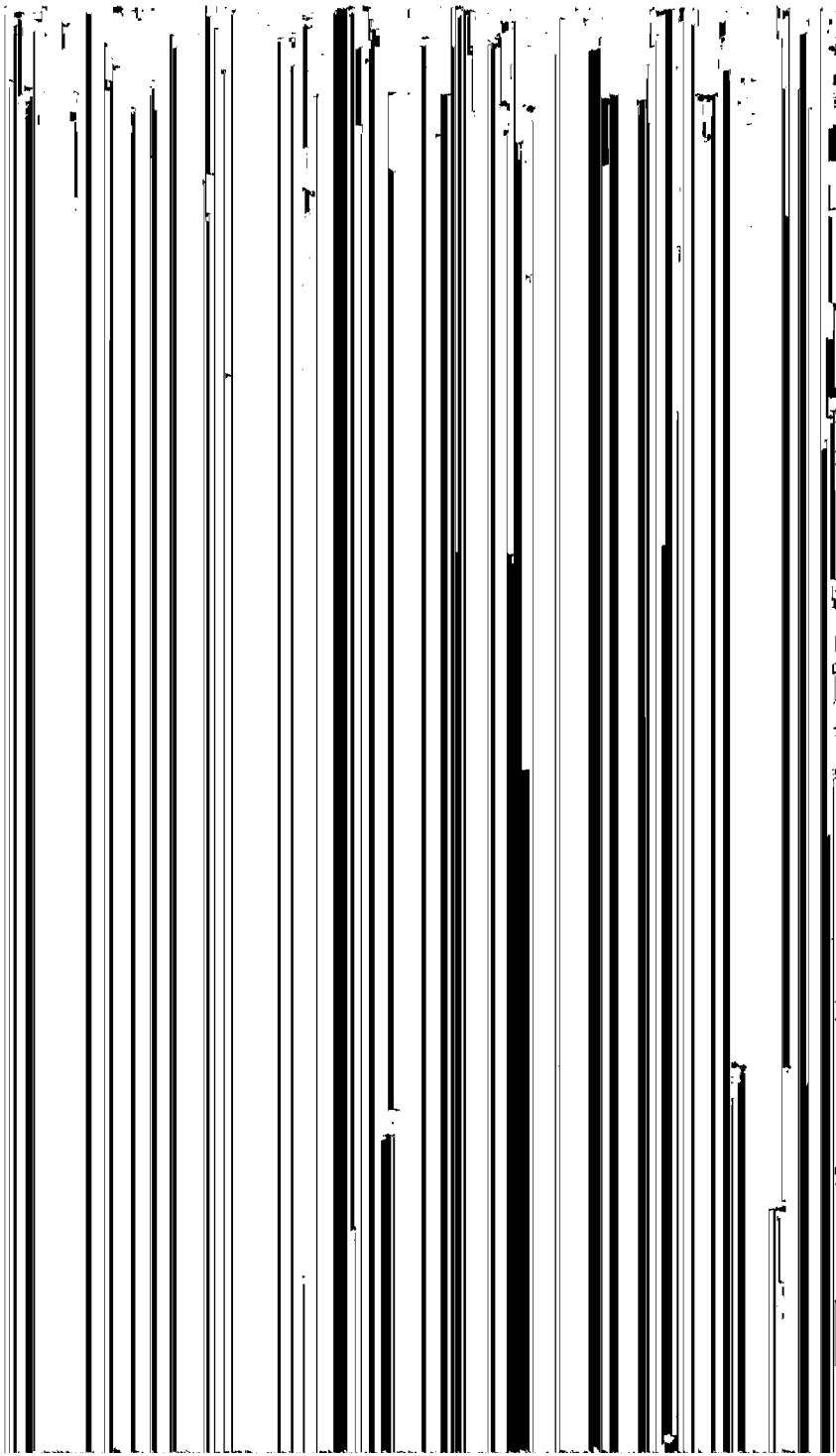
Degree and kind of limitations for—Cont.		Soil features affecting—				
Sanitary landfill (trench)	Sanitary landfill (area)	Highway location[1]	Pond reservoir areas	Embankments, dikes and levees	Terraces, diversions, and waterways	Irrigation
Severe: seepage....	Slight.....	Slopes of 2 to 7 percent; moderate erodibility.	High seepage losses.	Fair to good stability and compaction characteristics; medium compressibility; low shrink-swell potential.	Pockets of limestone gravel in places.	Slope; pockets of limestone gravel in places.
Severe: shale at a depth of 20 to 40 inches; clayey.	Moderate: slope.	Shale at a depth of less than 40 inches; 3 to 15 percent slopes; poor workability; difficult to revegetate.	Very slow permeability; shale at a depth of less than 40 inches.	High shrink-swell potential; poor shear strength; fair to poor stability.	Very slow permeability; clayey; slope; shale at a depth of less than 40 inches.	Very slow permeability; slope.
Severe: bedrock at a depth of 20 to 40 inches.	Moderate: 3 to 15 percent slope.	Slopes of 3 to 15 percent; bedrock at a depth of less than 40 inches.	Bedrock at a depth of 20 to 40 inches; seepage potential.	Limited borrow material; fair to good shear strength; good to fair stability; good compaction characteristics.	Severe: bedrock at a depth of 20 to 40 inches.	Low available water capacity; bedrock at a depth of 20 to 40 inches.
Severe: bedrock at a depth of 20 to 40 inches.	Moderate: 5 to 12 percent slopes.	High erodibility; 5 to 12 percent slopes; caliche bedrock at a depth of 20 to 40 inches.	Caliche bedrock at a depth of 20 to 40 inches; low shrink-swell potential.	Limited borrow material; fair stability and compaction characteristics.	Caliche bedrock at a depth of 20 to 40 inches; slope.	Moderate available water capacity; caliche bedrock at a depth of 20 to 40 inches.
Severe: bedrock at a depth of 10 to 20 inches; slope.	Moderate: 8 to 15 percent slopes. Severe: more than 15 percent slope.	Caliche bedrock at a depth of 10 to 20 inches; high erodibility; 5 to 30 percent slopes.	Bedrock at a depth of 10 to 20 inches; seepage in places.	Shallow soil erodibility.	Shallow soil over caliche.	Not applicable.
Moderate: medium soil texture.	Slight: slopes of less than 8 percent.	No detrimental features.	Moderately slow permeability.	Moderate to high shrink-swell potential; fair to poor compaction characteristics.	Clayey subsoil; 0 to 7 percent slopes.	Moderately slow permeability; 0 to 7 percent slopes.

TABLE 8.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Roads and streets
*Inavale: Im For Munjor part, see Munjor series.	Moderate: flooding rare; fluctuating water table; rapid permeability.	Severe: rapid permeability.	Severe: poor sidewall stability.	Severe: subject to flooding.	Moderate: subject to flooding.
*McCook: Ma, Mm For Munjor part of Mm, see Munjor series.	Slight if protected from flooding. Severe if subject to flooding.	Moderate if protected from flooding; moderate permeability. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.
Mento Mapped only with Harney soils.	Severe: slow permeability; bedrock at a depth of 40 to 72 inches.	Moderate: 3 to 7 percent slopes; bedrock at a of 40 to 72 inches.	Slight	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.
Munjor Mapped only with Inavale and McCook soils.	Severe: subject to flooding; moderately rapid permeability; fluctuating water table.	Severe: subject to flooding; moderately rapid permeability.	Severe: flooding hazard.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
New Cambria: Nc	Severe: slow permeability.	Slight: flood protection needed in places.	Severe: silty clay.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential; poor workability.
*Nuckolls: Nd, Nh For Holdrege part of Nh, see Holdrege series.	Slight if slopes of less than 8 percent. Moderate if 8 to 12 percent slopes.	Moderate if slopes of less than 7 percent. Severe if slope of more than 7 percent; moderate permeability.	Slight if slopes of less than 8 percent. Moderate if 8 to 12 percent slopes.	Moderate: 3 to 12 percent slopes; low to moderate shrink-swell potential.	Moderate: 3 to 12 percent slopes; low to moderate shrink-swell potential.
Penden: Pe	Moderate: moderate permeability.	Moderate: 3 to 7 percent slopes; moderate permeability.	Moderate: clay loam.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.
*Roxbury: Ro, Rr For Armo part of Rr, see Armo series.	Slight if protected from flooding. Severe if subject to flooding.	Moderate if protected from flooding; moderate permeability. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.	Slight if protected from flooding. Severe if subject to flooding.
Rp	Severe: frequent flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: flooding hazard.	Severe: subject to flooding.
*Ulysses: Ub, Uc	Moderate if 7 to 15	Severe if slopes of	Moderate if 7 to 15	Moderate if 7 to 15	

engineering properties of the soils—Continued

Degree and kind of limitations for—Cont.		Soil features affecting—				
Sanitary landfill (trench)	Sanitary landfill (area)	Highway location[1]	Pond reservoir areas	Embankments, dikes and levees	Terraces, diversions, and waterways	Irrigation
Severe: subject to flooding; rapid permeability.	Severe: rapid permeability.	Subject to flooding; high erodibility.	High seepage losses.	High erodibility.....	Too sandy.....	Low available water capacity; severe soil blowing hazard.
Slight if protected	Slight if protected	High erodibility;	Moderate perme-	Moderate erodi-	Nearly level;	Nearly level;



ls as a source of construction material

a this series is made up of two or more kinds of soil. The soils in such mapping units s necessary to refer to other series as indicated in the first column of this table]

il	Sand and gravel	Road subgrade[1]	Road fill[1]
e layer	Unsuited but pockets of limestone gravel in substratum.	Fair: medium soil support.	Fair: fair shear strength.
rm con-yey.	Unsuited	Poor: low soil support; high plasticity.	Poor: poor shear strength.
y loam	Sand: unsuited Gravel: fair source of road surface material.	Good for upper 16 inches. Poor below 16 inches: 3- to 6-inch rock fragments.	Good.
layer is 8 ; diffi-im area.	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
depth of erial.	Poor except for local sand pockets.	Poor: low soil support	Fair: fair shear strength.
below a nches.	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
an 8 inches.	Poor for gravel	Poor: 3- to 8-inch rock fragments.	Fair: fair workability; erodible.
below a inches.	Unsuitable	Fair: medium soil support.	Good.
	Unsuitable	Fair: medium soil support.	Good.
dy; low ter content.	Sand: fair. Gravel: unsuited.	Good if confined	Good.
	Unsuited	Good	Good.
below a nches.	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
loam and	Sand: poor; poorly graded in substratum. Gravel: unsuitable.	Good if confined	Good.
nsistence;	Unsuited	Poor: high plasticity; low soil support.	Poor: poor shear strength.
	Unsuitable	Fair: medium soil support.	Good.

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nformation

Shrink-swell potential is the relative change in volume of soil material to be expected with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Ex-

TABLE 10.—*Engineering*

[Tests performed by the State Highway Commission of Kansas according to standard procedures of the

Soil name and location	Parent material	Report No. S72Kans-	Depth	Moisture-density data[1]	
				Maximum dry density	Optimum moisture
			Inches	*Pounds per cubic foot*	*Percent*
Harney silt loam:					
2 miles south and 6 miles east of Smith Center; 1,200 feet west and 325 feet north of the southeast corner of section 33, T. 3 S., R. 12 W. (Modal)	Loess	92-2-1	0-8	98	20
		92-2-2	16-22	98	21
		92-2-3	28-42	99	21
		92-2-4	42-72	100	20
Holdrege silt loam:					
10 miles north and 2 miles west of Athol; 1,700 feet west and 525 feet south of the northeast corner of section 36, T. 1 S., R. 15 W. (Modal)	Loess	92-3-1	0-10	95	19
		92-3-2	14-20	95	22
		92-3-3	28-72	103	19
Hord silt loam:					
8 miles north and 1 mile west of Kensington; 1,200 feet east and 750 feet north of the southwest corner of section 7, T. 2 S., R. 15 W. (Modal)	Silty alluvium	92-4-1	0-15	100	19
		92-4-2	15-32	98	20
		92-4-3	32-42	100	20
		92-4-4	42-72	96	22
McCook silt loam:					
1 mile west of Gaylord; 500 feet west and 300 feet south of the northeast corner of section 2, T. 5 S., R. 14 W.	Coarse silty alluvium	92-1-1	0-10	104	17
		92-1-2	18-40	105	16

[1] Based on AASHTO designation T99-61, method A (*1*) with the following variations: (1) all material is ovendried at 230° F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analyses based on AASHTO designation T88-57 (*1*) with the following variations: (1) all material is ovendried at 230° F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently may differ somewhat from results that

also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage, within a depth of 2 to 5 feet, long enough for bacteria to decompose the solids. A lagoon has a nearly level floor; its sides, or embankments, are of soil material compacted to medium density, and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic matter, and slope; if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are those that influence the ease of excavation and compaction of the embankment material—the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amount of stones, if any.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, for example,

Dwellings, as rated in table 8, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Roads and streets, as rated in table 8, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand,

test data

American Association of State Highway and Transportation Officials (AASHTO) (*1*), except as noted]

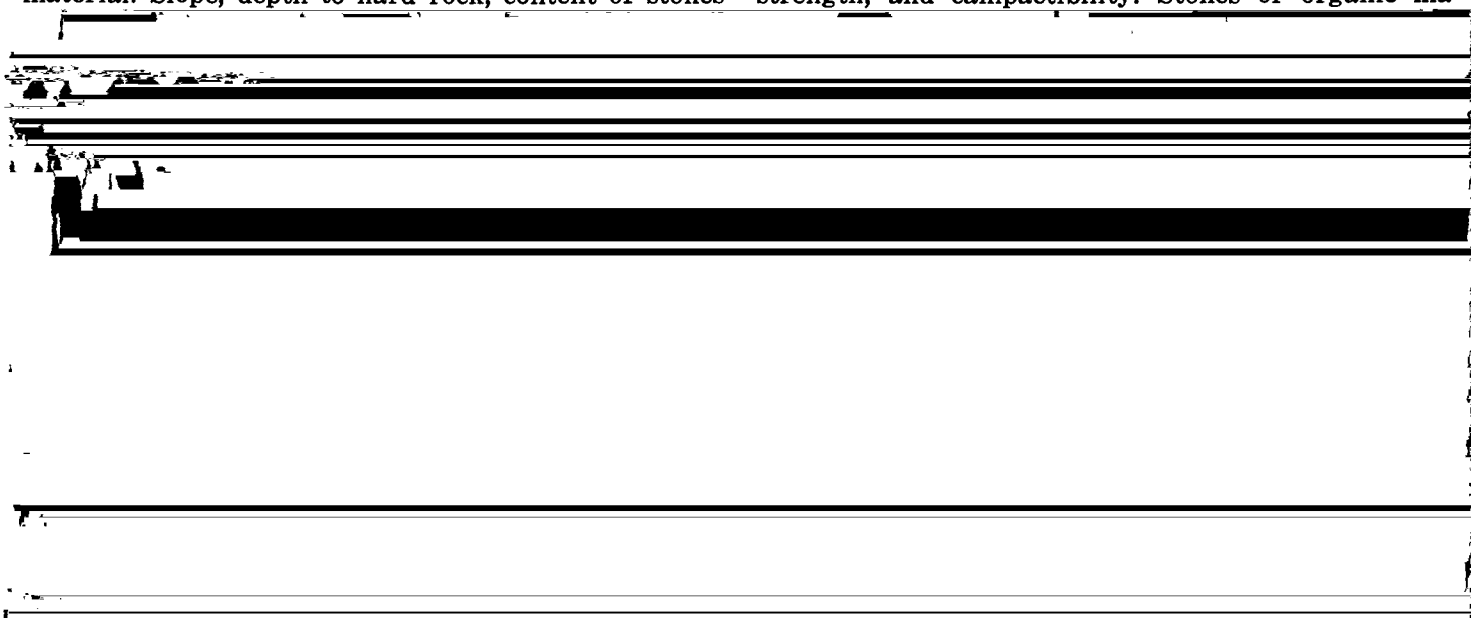
Mechanical analysis[2]							Liquid limit	Plasticity index	Classification	
Percentage smaller than 3 inches passing sieve—			Percentage smaller than—						AASHTO[3]	Unified[4]
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							Percent			
.....	100	98	90	52	23	16	36	11	A–6	CL–ML
.....	100	99	95	70	45	37	52	27	A–7–6	CH
.....	100	98	93	63	33	24	42	20	A–7–6	CL
.....	100	98	93	58	27	21	39	17	A–6	CL
.....	100	96	87	51	23	16	39	11	A–6	ML
.....	100	98	91	65	42	38	52	28	A–7–6	CH
.....	100	96	89	58	26	18	38	13	A–6	CL–ML
.....	100	94	87	51	22	15	33	8	A–4	CL–ML
.....	100	97	91	60	28	22	40	18	A–6	CL
100	99	98	81	59	33	25	40	20	A–6	CL
100	99	94	88	67	37	30	46	24	A–7–6	CL
100	99	90	79	37	14	8	29	5	A–4	CL–ML
.....	100	95	89	42	12	7	30	6	A–4	CL–ML

would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHTO designation M145-49 (*1*).

[4] Based on the Unified soil classification system (*2*).

shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones



rial that is resistant to seepage and piping and that is of favorable stability, shrink-swell potential, shear strength, and campactibility. Stones or organic ma-

Figure 22.—**Maintaining terraces on Holdrege soils.**

planations of some of the columns in table 9.

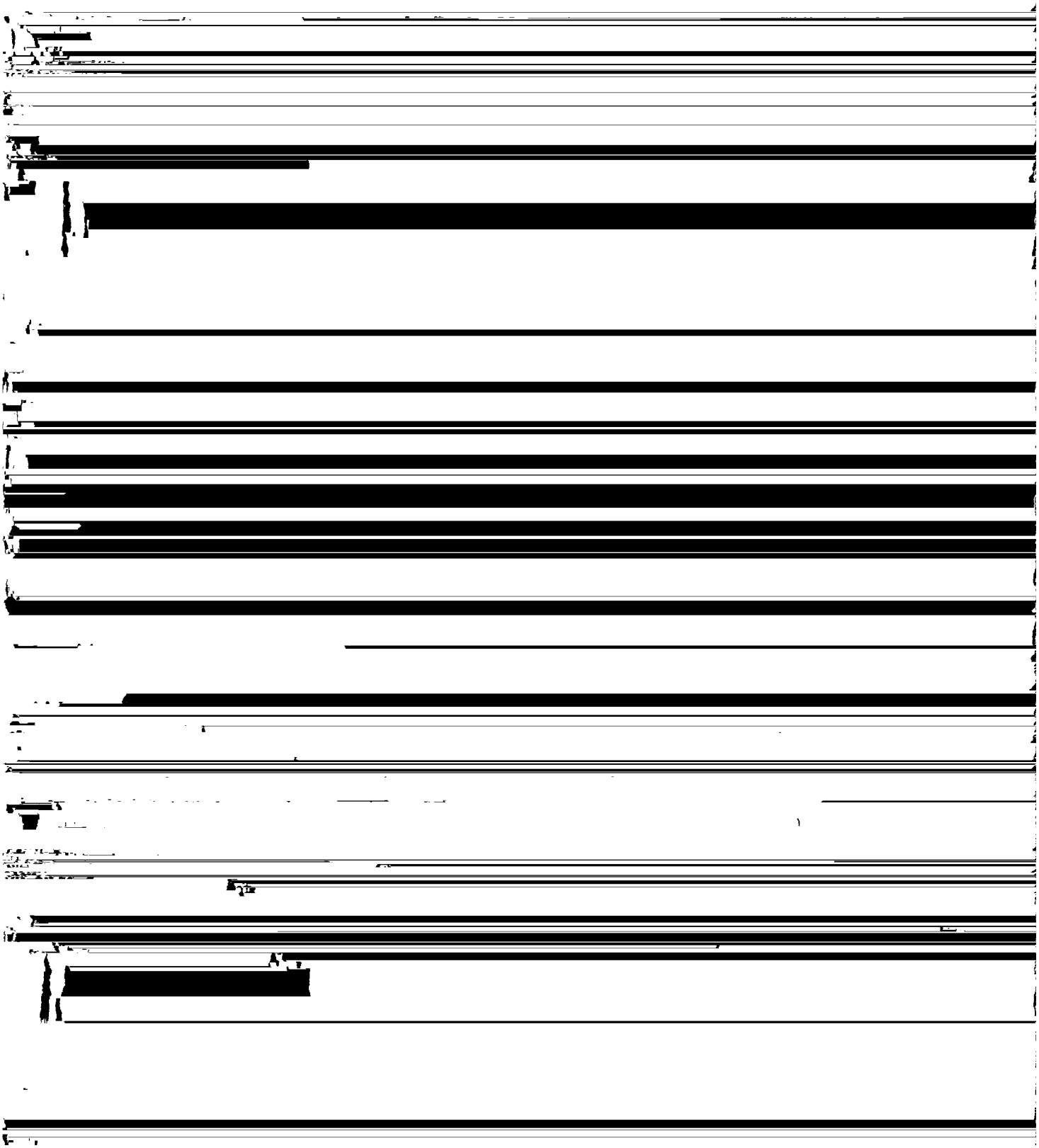
Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material or plant response when fertilizer is added to the soil; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability. Also, can

poses. The engineering classifications are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by combined sieve and hydrometer methods.

Moisture-density (or compaction) data are important in earthwork. If a soil material is compacted at successively higher moisture contents, assuming that the compactive effort remains constant, the density

forces. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under

streams shifted back and forth across the area they built up an eastward sloping alluvial plain called the Ogallala Formation, which may have extended from



through its effect on the plant and animal life on and in the soil. Where precipitation has been sufficient to maintain plant and animal life, the soils that develop have a dark-colored surface layer.

Smith County has a temperate, continental, subhumid climate. The average annual precipitation is about 22 to 24 inches, a large part of which falls during the growing season. Evaporation is high because of warm temperature and winds.

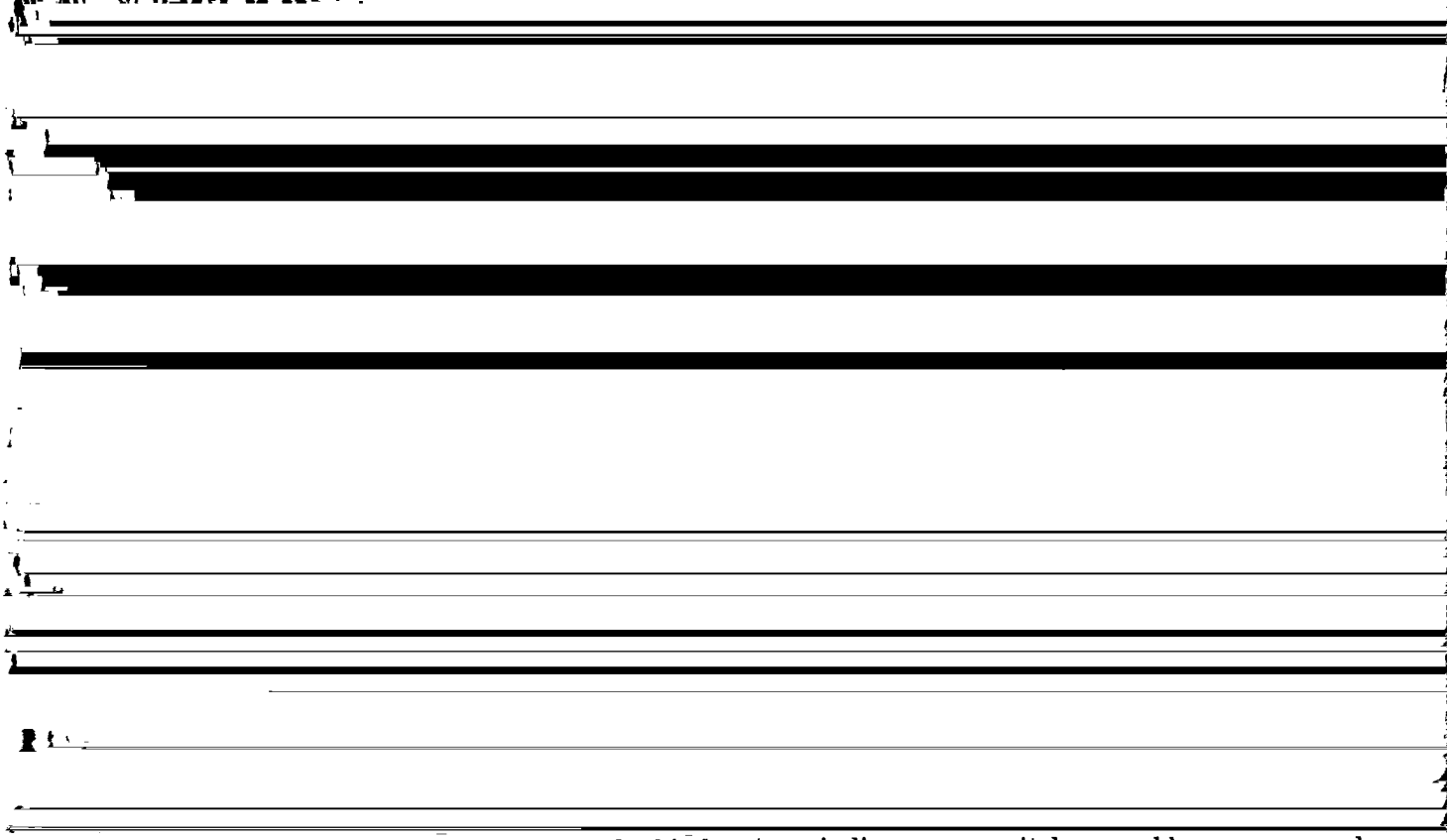
The effect of climate on the soils of this county varies according to the kind of parent material, the lay of the land, and the time the forces of soil formation have had to act. None of the soils has been excessively leached of plant nutrients. Few soils have been leached of lime to a depth of more than 30 inches. Except for those that formed in noncalcareous alluvium, most of the soils have an accumulation of calcium carbonate within 30 inches of the surface. The action exchange

where calcium carbonate has accumulated. Below a depth of 42 inches these soils have been little affected by the processes of soil formation, except for some accumulation of calcium carbonate.

Weather records in Smith County show that the winters are short and cold and the summers long and hot. About 75 percent of the precipitation falls during the long growing season and accounts for the mid and tall grass vegetation. The vegetation, in turn, reduces the hazard of erosion and removes bases and adds organic matter to the upper part of the soil profile.

Plants and animals

In Smith County the fluctuating, dry to moist subhumid climate favored the growth of mid and tall grasses. The original plant cover on the limy soils consisted mainly of sideoats grama and little bluestem grasses. On the loamy soils it consisted of big blue



capacity of the various soils depends more on the kind of parent material than on the amount of leaching that has occurred.

The climate fluctuates from dry to moist subhumid. This fluctuation may be from year to year or in cycles that cover several years. During dry periods, precipitation and humidity may be well below normal and temperature above normal. In wet periods, the precipitation and humidity are considerably above normal and the temperature is normal or below normal.

The soil profile is dried to varying depths during dry periods. During wet periods it is slowly moistened, and as it becomes saturated excess moisture generally penetrates the underlying material or substratum. The

stem, indiangrass, switchgrass, blue grama, and some buffalograss. Scattered trees grew along most of the larger streams. Some valleys had somewhat open stands of oak, ash, black walnut, hackberry, cottonwood, elm, and willow.

Grass has small, fibrous roots that filled nearly all of the spaces in the upper part of the soil. When these small roots died and decayed they left organic matter evenly distributed throughout the surface layer and caused it to be dark in color.

Decomposed organic matter darkened the soils of Smith County and influenced the development of soil structure. Plant growth and the accumulation of organic matter was greatest in nearly level areas where

As the vegetation decayed, plant nutrients were released and were carried into the soil by permeating moisture. Moderately leached, dark, fertile soils formed as a result of this growth-decay cycle operating in the fluctuating, subhumid, continental type climate.

Relief

Relief, or the lay of the land, affects runoff and drainage and modifies the effect of climate on the parent material. Other factors being equal, an increase in [illegible] accumulated. The weak horizonation in the moderately developed soils on terraces indicates that they have been developing for less time than some of the soils on uplands, but this general grouping is broad and is related to geologic time periods. In each group of soils the development of the soil profile is the result of the action of all of the closely interrelated soil-forming factors.

Differences among the soils in this county have been [illegible]

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a work of three or four syllables ending in *sol* (Moll-i-sol).

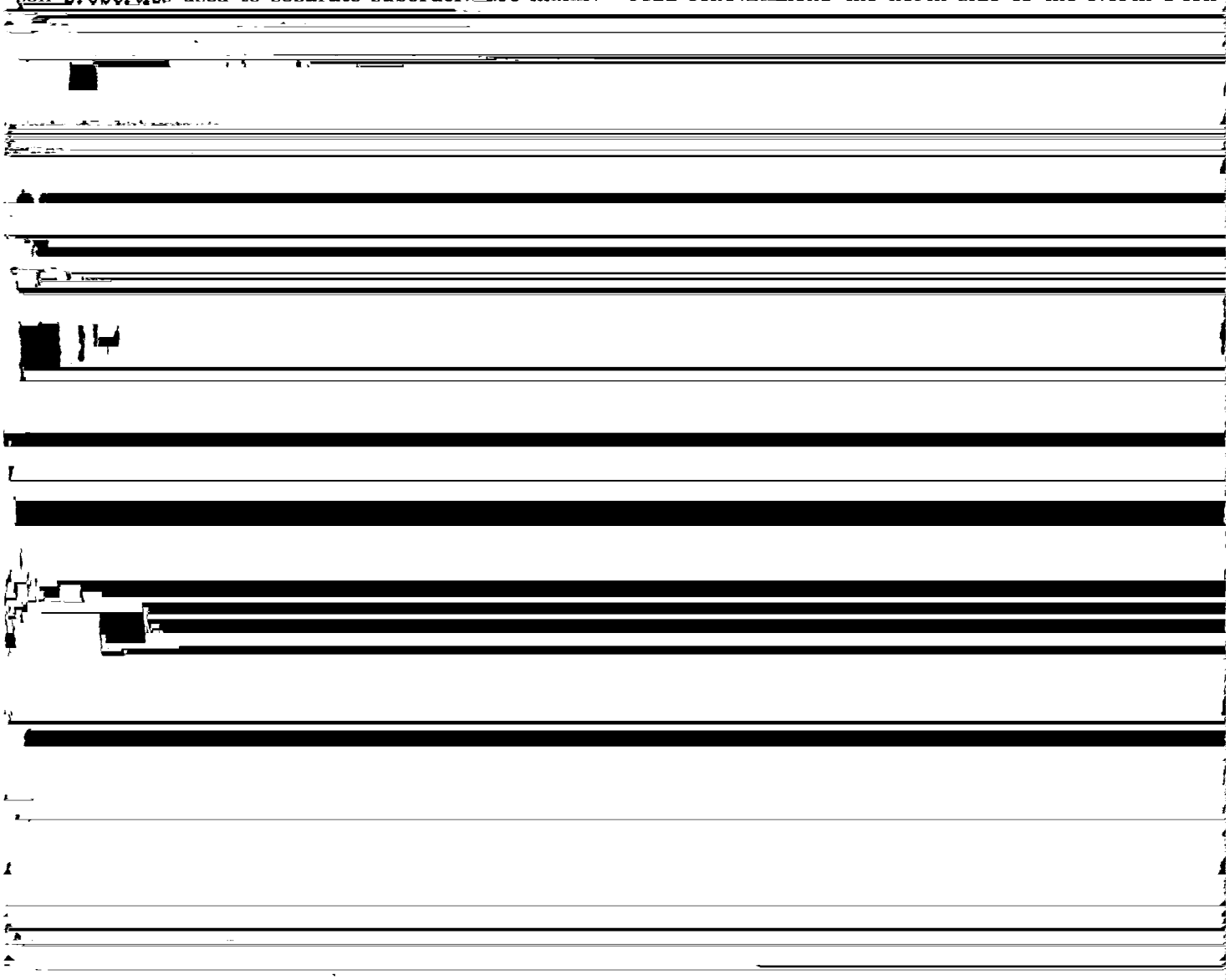
SUBORDER. Each order is subdivided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly

Smith, who was killed at the Battle of the Little Blue.

The pioneers were encouraged to settle in the county because of the availability of new land. In the spring of 1870, the territory that is now Smith County had 66 inhabitants. This number increased rapidly from 3,876 in 1872 to 13,904 in 1880 and 15,982 in 1900.

In recent years, there has been a decline in population. The population was 13,545 in 1930, 10,582 in 1940, 8,846 in 1950, 7,776 in 1960, and 6,757 in 1970.

The Rock Island Railroad crosses midway in the county—east to west—and the Missouri Pacific Railroad follows along the north side of the North Fork



water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper part of the solum, cracking of soils caused by a decrease in soil moisture, and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is *Ustoll; Ust* meaning dry, and *oll,* from mollisol.

GREAT GROUP. Soil suborders are separated into

Physiography, Relief, and Drainage

Smith County lies in the eastern part of the High Plains section of the Great Plains physiographic province (fig. 23).

The climate of the county is the continental subhumid type characterized by relatively cold winters

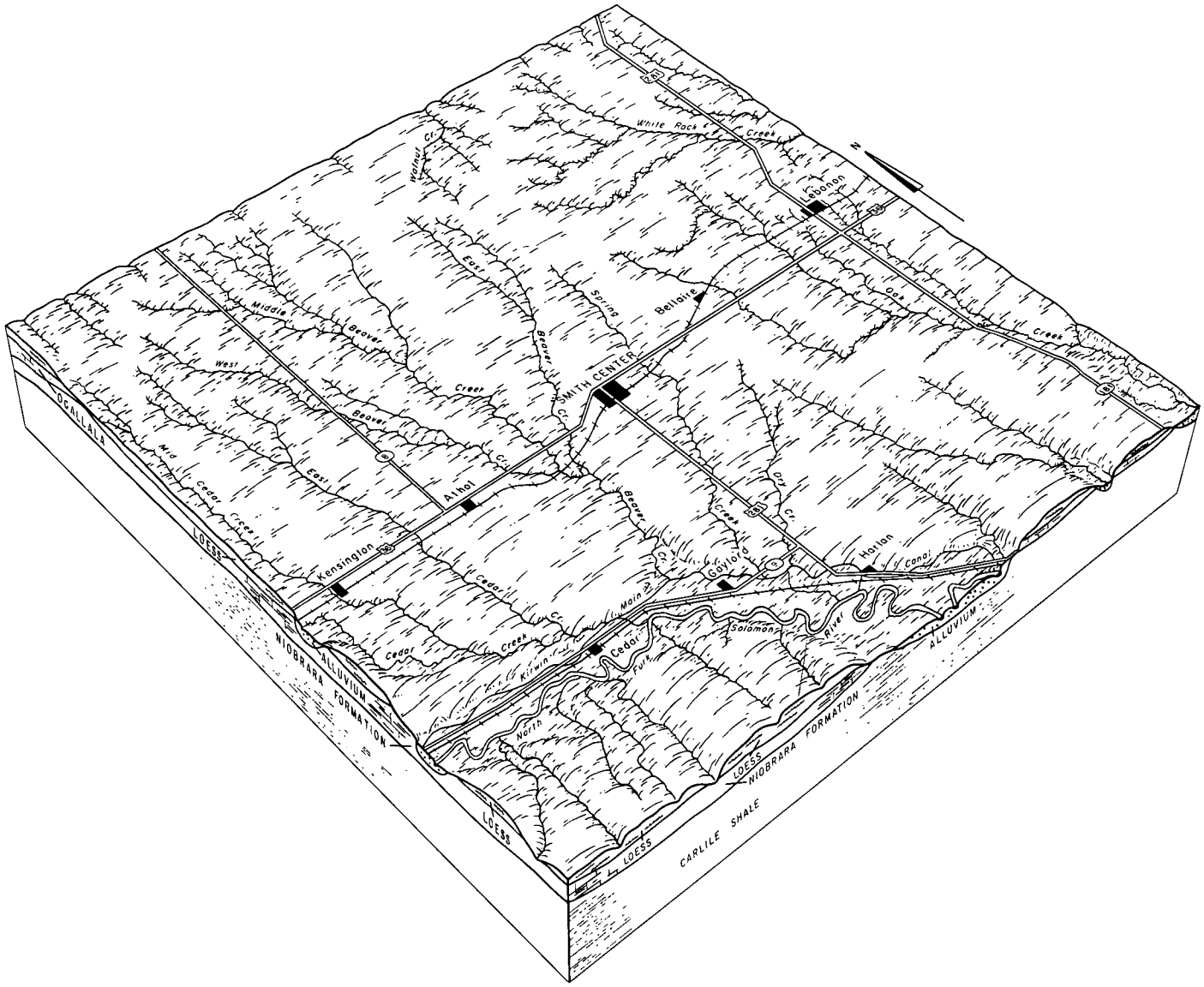


Figure 23.—**Relief and drainage of Smith County.**

These streams have narrow, low flood plains along the channels. Nearly level, dark, deep, and fertile soils are on the high flood plains between the uplands and the low flood plains.

Water Supply

Most domestic wells of the county are drilled or dug in alluvium in the drainageways and along streams; a few are in the uplands. A few irrigation water wells have been developed along the North Fork of the Solomon River. There are several wells used for irrigation in the uplands.

Most of the wells are for domestic use. Nearly all the land under irrigation in the North Fork of the Solomon River Valley is watered from the Kirwin Ditch.

Many dams have been built on the uplands to impound water for livestock. Several ponds are used for irrigation.

Climate[8]

The climate of Smith County is a typical continental type. This would be expected from its location in the interior of a large land mass in middle latitudes. Such climates are characterized by large diurnal and annual variations in temperature. This feature of the climate is similar to all of Kansas and, indeed, to much of the area between the Rockies to the west and the Appalachian Mountains to the east.

[8] By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan.

The climate of Smith County has been classified by Thornthwaite as dry subhumid (*9*). Precipitation in such a climate "does not exceed the losses by evapora-

months with the highest average number of rainy days are May, with 8, and June, with 9. These are also the months that have the highest average amounts of pre-

at times during the snow season, especially early in

ures are perhaps higher than average since the period

The range in temperature is large in a continental climate. Annual extremes in Smith County are generally from –5° and –10° to 105°. The lowest temperature ever recorded in the state of Kansas was –40° at Lebanon on February 13, 1905. Temperature records were not taken in the county during the 1930's, but Phillipsburg reported 120° and Alton 121° on July 24, 1936. Extremely cold periods are associated with snow-covered ground and clear nights. Fortunately, the snow acts as insulation for winter wheat, lawns, and dormant plants.

The average temperature data in table 12 indicate that the transition seasons of spring and fall in Kansas are rather short. The winter months are December through February, and the average daily temperatures are in the 30's or lower. The warm summer temperatures necessary for plant growth continue from late April into early October.

and 50's. Although a longer period of study might show a shorter time of severe and extreme drought, those farming in this section of Kansas need to be aware of the high potential for drought.

Smith County has occasional tornadoes and severe windstorms, which are associated with the passage of squall lines through the State. It is somewhat removed from the center of maximum tornadoes in east-central Oklahoma, however, and the threat of such storms is correspondingly low. When they do occur, these storms are local in extent and of short duration so that risk of damage is small. The county is nearer to the center of maximum occurrence of hail storms (northeastern Colorado, southeastern Wyoming, Nebraska panhandle). Hail is associated with heavy rains, and thus the months of May and June are the months of most frequent hail. Unfortunately this is also a critical period in the development and harvest of winter wheat. Crop

ghum for grain from 59,000 acres, sorghum for silage from 8,100 acres, corn for grain from 7,100 acres, corn for silage from 1,700 acres, alfalfa from 19,000 acres, and wild hay from 4,000 acres.

Livestock raising is an increasingly important enterprise. The cow herds are increasing in number in the county. The number of farm feedlots is also increasing. In 1972 there were 32,000 beef cows, 1,700 milk cows, 48,300 other cattle, 47,000 hogs, 2,000 sheep and lambs, and 16,000 chickens.

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(2) AMERICAN SOCIETY FOR TESTING AND MATERIALS.
1974. METHOD FOR CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES. ASTM Stand. D 2487-69. *In* 1974

between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

underlies a C horizon but may be immediately beneath an A or B horizon.

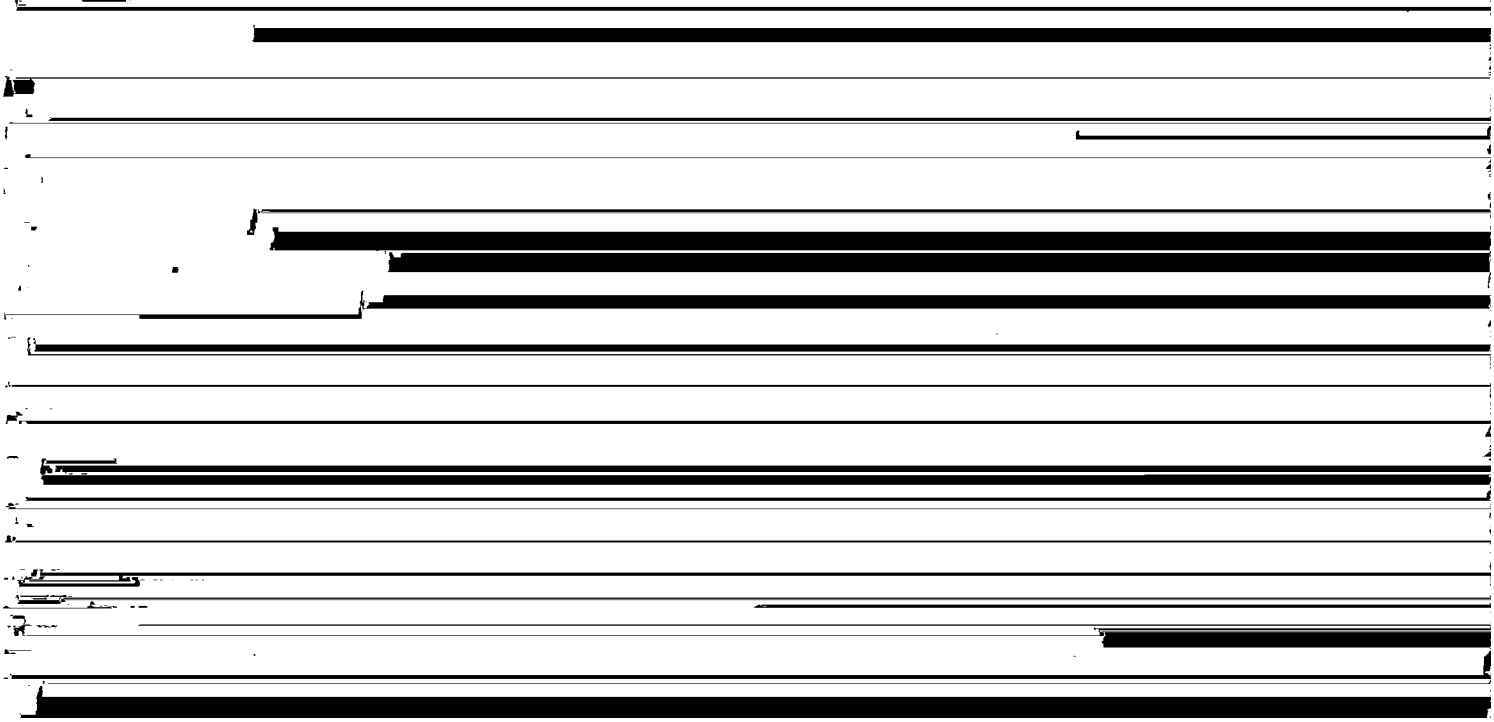
Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neautral-

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these hori-



GUIDE TO MAPPING UNITS

For a complete description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. Range sites are described beginning on page 38. Windbreak suitability groups are described on pages 41 and 42.

Map symbol	Mapping unit	Page	Capability unit		Range site	Windbreak suitability group
			Dryfarmed	Irrigated		
			Symbol	Symbol	Name	Number
Aa	Alluvial land, loamy	12	Vw-1	-------	Loamy Lowland	1
Ar	Armo loam, 2 to 7 percent slopes	14	IIIe-2	-------	Limy Upland	3
Bo	Bogue clay, 3 to 15 percent slopes	15	VIe-5	-------	Blue Shale	--
Br	Brownell gravelly loam, 3 to 15 percent slopes	16	VIe-4	-------	Limy Upland	3
Cc	Campus-Canlon complex, 5 to 30 percent slopes	17	VIe-2	-------	----------	--
	Campus soil	--	-------	-------	Limy Upland	3
	Canlon soil	--	-------	-------	Shallow Limy	--
Ha	Harney silt loam, 0 to 1 percent slopes	18	IIc-1	I-2	Loamy Upland	2
Hb	Harney silt loam, 1 to 3 percent slopes	19	IIe-3	IIe-3	Loamy Upland	2
Hc	Harney-Mento silt loams, 3 to 7 percent slopes	19	IVe-1	-------	Loamy Upland	2
Hd	Heizer-Brownell complex, 7 to 30 percent slopes	20	VIIs-1	-------	----------	--
	Heizer soil	--	-------	-------	Shallow Limy	--
	Brownell soil	--	-------	-------	Limy Upland	3
He	Holdrege silt loam, 1 to 3 percent slopes	21	IIe-1	IIe-1	Loamy Upland	2
Hf	Holdrege silt loam, 3 to 7 percent slopes	21	IIIe-1	-------	Loamy Upland	2
Hg	Holdrege silty clay loam, 3 to 7 percent slopes, eroded	22	IIIe-3	-------	Loamy Upland	2
Hh	Hord silt loam	23	I-1	I-1	Loamy Terrace	1
Im	Inavale-Munjor complex	24	IVe-4	-------	----------	--
	Inavale soil	--	-------	-------	Sands	--
	Munjor soil	--	-------	-------	Sandy	1
Ma	McCook silt loam	24	I-1	I-1	Loamy Terrace	1
Mm	McCook-Munjor complex	24	IIw-1	IIw-1	Loamy Lowland	1
Nc	New Cambria silty clay	26	IIs-1	IIs-1	Clay Terrace	1
Nd	Nuckolls silt loam, 7 to 12 percent slopes	27	IVe-3	-------	Loamy Upland	2
Nh	Nuckolls-Holdrege silt loams, 3 to 7 percent slopes	27	IIIe-1	-------	Loamy Upland	2
Pe	Penden loam, 3 to 7 percent slopes	28	IIIe-4	-------	Limy Upland	3
Ro	Roxbury silt loam	28	I-1	I-1	Loamy Terrace	1
Rp	Roxbury silt loam, frequently flooded	29	IIIw-1	-------	Loamy Lowland	1
Rr	Roxbury-Armo complex, 0 to 3 percent slopes	29	IIe-2	IIe-2	----------	--
	Roxbury soil	--	-------	-------	Loamy Lowland	1
	Armo soil	--	-------	-------	Limy Upland	3
Uh	Uly-Holdrege silt loams, 7 to 12 percent slopes	30	IVe-3	-------	Loamy Upland	2
Ur	Uly-Roxbury silt loams, 0 to 30 percent slopes	30	VIe-1	-------	----------	--
	Uly soil	--	-------	-------	Loamy Upland	2
	Roxbury soil	--	-------	-------	Loamy Lowland	1
Wc	Wakeen silt loam, 3 to 7 percent slopes	31	IVe-2	-------	Limy Upland	3
Wd	Wakeen complex, 5 to 20 percent slopes	32	VIe-3	-------	Limy Upland	3

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