

United States  
Department of  
Agriculture

Soil  
Conservation  
Service

In cooperation with  
University of Nebraska,  
Conservation and Survey  
Division

# Soil Survey of Brown County, Nebraska





# How To Use This Soil Survey

## General Soil Map

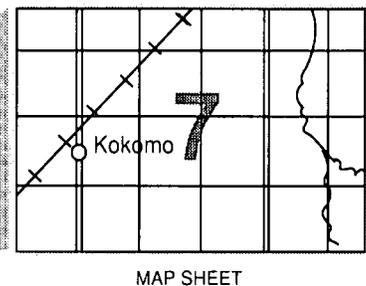
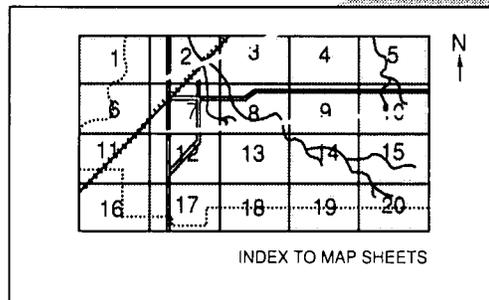
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

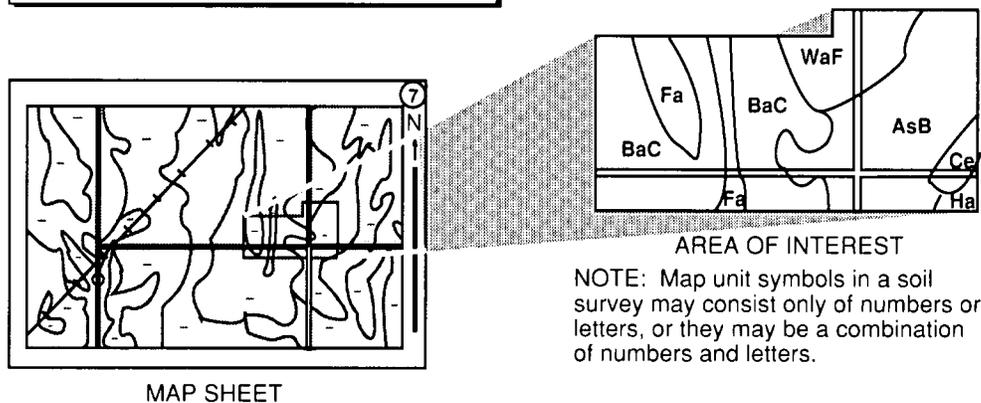
## Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

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This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Upper Loup and Middle Niobrara Natural Resources Districts. The State of Nebraska, the Upper Loup Natural Resources District, the Middle Niobrara Natural Resources District, and the Brown County Commissioners provided financial assistance to employ a soil scientist to accelerate completion of the soil survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

**Cover: Range In an area of Almeria-Histosols complex, channeled, along the Calamus River.**

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# Foreword

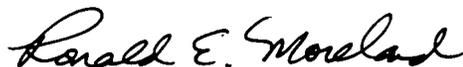
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This soil survey contains information that can be used in land-planning programs in Brown County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



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# Soil Survey of Brown County, Nebraska

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United States Department of Agriculture, Soil Conservation Service,  
in cooperation with  
University of Nebraska, Conservation and Survey Division

BROWN COUNTY is in the north-central part of Nebraska (fig. 1). It is 26 miles wide and about 52 miles long at its longest point. The irregular northern boundary is formed by the deeply entrenched Niobrara River. Brown County is bordered on the north by Keya Paha County, on the west by Cherry County, on the south by Blaine and Loup Counties, and on the east by Rock County. The total area of the county is 781,728 acres, or about 1,221 square miles. Ainsworth, the county seat and the largest town, has a population of about 2,300.

About 83 percent of the acreage in the county is rangeland or native hayland, 9 percent is cropland, and 3 percent is tame pasture or hayland. Corn and alfalfa are the most extensively grown crops. These crops, along with native hay, provide feed for the county's beef cattle. Most of the cropland and some of the tame pasture and hayland are irrigated because of inadequate rainfall during most years. Woodland and areas of tree windbreaks make up about 3 percent of the county. Water, urban areas, and other miscellaneous areas make up about 2 percent.

The areas of Brown County south of U.S. Highway 20 and the areas north of U.S. Highway 20 and west of Plum Creek are mostly rolling and hilly sandhills and nearly level valleys that have a seasonal high water table. The soils formed in sandy eolian or alluvial material and are mostly deep and sandy. Ranching and hay production are dominant in these areas. Center-pivot irrigation has been developed in some areas. If these soils are farmed, soil blowing is the main hazard

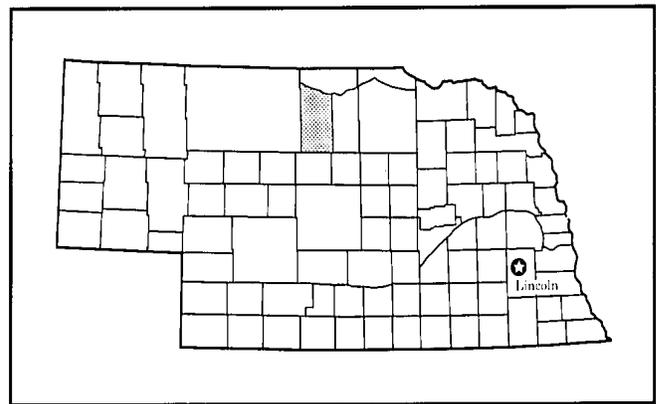


Figure 1.—Location of Brown County in Nebraska.

and wetness, low available water capacity, and low fertility are the main limitations.

The areas north of U.S. Highway 20 and east of Plum Creek generally are nearly level tableland and bottom land and very steep canyons. The soils formed in sandy and loamy eolian and alluvial material, loamy material weathered from sandstone, and clayey material weathered from shale. The majority of the irrigated crops in the county are grown on the tableland.

The soils in canyons and on bottom land along the major streams are used as rangeland or woodland. If these soils are farmed, soil blowing and water erosion are the main hazards and a shallow or moderately deep root zone is the main limitation. Flooding is a hazard on the bottom land.

This soil survey updates the survey of Brown County published in 1938 (13). It gives additional information and has larger maps, which show the soils in greater detail.

## General Nature of the County

This section provides general information about Brown County. It describes history and development; climate; physiography, relief, and drainage; geology; ground water; and trends in farming.

## History and Development

The Ogallala and Brule Tribes of the Sioux Indian Nation claimed the area now known as Brown County, according to the earliest historical records (6). These two tribes held all of what is now northwest and north-central Nebraska as far east as Long Pine Canyon. They and their allies, the Cheyenne and Arapahoe, fought other Nebraska Indians over this choice hunting area.

The first recorded European explorer in Brown County was James M. Mackey, a Scotsman. He explored and mapped the Nebraska Sandhills and the Niobrara River in 1795 and 1796. His map of the region was published in Paris in 1802. Other early explorers, hunters, gold seekers, troops, and missionaries left their mark. The Sawyers Trail was a freight route that crossed Brown County directly south of the Niobrara River. The Calamus Trail followed the Calamus River to Moon Lake and then headed west. It was used mainly by the military. The Gordon Trail, which was used by gold seekers, followed the present route of U.S. Highway 20 across the county. The first settlers were ranchers and farmers of European descent. They arrived as early as the 1870's, mainly from eastern and southeastern Nebraska.

On February 19, 1883, Brown County was formed from the unorganized territory attached to Holt County. It was named by the Nebraska Legislature, of which five members had the surname Brown. Later, Keya Paha and Rock Counties were formed, reducing Brown County to its present size.

The town of Long Pine was founded in 1881. It was incorporated into a village on January 9, 1884. Ainsworth was founded in 1882. It was named after Captain J.E. Ainsworth, who organized the construction of the first railroad station. Ainsworth was incorporated into a village on December 11, 1883, and later became the county seat. Johnstown was also founded in 1882. It probably was named after John Berry, who, along with George Berry, ran a government stagecoach line

across the county. In 1883, Meadville was established by Merritt I. Mead in an area where old Nebraska Highway 7 crosses the Niobrara River. It was later moved from the south to the north side of the river.

According to census figures, the population of Brown County was 4,377 in 1980. The population fluctuated between 1890 and 1930 because of some droughty years and has steadily declined since 1930. The number of ranchers in the county has declined, while the size of ranches has become larger. Most of the population is in the northern half of the county.

Railroads, highways, and county roads provide a means of transporting grain and livestock to Ainsworth and other markets. The first railroad to reach Brown County was the Fremont, Elkhorn, and Missouri Valley Railroad. This railroad was extended to Long Pine in 1881 and to Ainsworth and Johnstown in 1882.

U.S. Highway 20 provides an all-weather east-west route through the northern part of the county. It connects the towns of Long Pine, Ainsworth, and Johnstown. Nebraska Highway 7 provides an all-weather north-south route from the southern part of the county to Ainsworth. U.S. Highway 183 extends north through the northeastern part of the county. The rural roads in the northern part of the county are generally constructed along section lines. Few roads are developed on the breaks and in the Sandhills, and roads in the Sandhills generally follow valleys. Most of the rural roads are graveled, and a few have an asphalt surface. Primitive roads and trails lead to most ranch headquarters in the Sandhills.

The economy of the county is based mainly on farming and ranching and on small businesses that provide local services. These enterprises provide most of the employment opportunities in the county.

## Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

In Brown County winters are cold because of incursions of cold, continental air that bring fairly frequent spells of low temperatures. Summers are hot but are characterized by occasional interruptions of cooler air from the north. Snowfall is fairly frequent in winter, but the snow cover is usually not continuous. Rainfall is heaviest in late spring and early summer. The annual precipitation is normally adequate for wheat, sorghum, and range grasses.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Ainsworth in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 25 degrees F and the average daily minimum temperature is 14 degrees. The lowest temperature on record, which occurred at Ainsworth on January 29, 1966, is -28 degrees. In summer, the average temperature is 73 degrees and the average daily maximum temperature is 86 degrees. The highest recorded temperature, which occurred at Ainsworth on July 13, 1954, is 109 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 22 inches. Of this, about 17 inches, or nearly 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 13 inches. The heaviest 1-day rainfall during the period of record was 4.95 inches at Ainsworth on July 1, 1962. Thunderstorms occur on about 47 days each year.

The average seasonal snowfall is about 39 inches. The greatest snow depth at any one time during the period of record was 20 inches. On the average, 36 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 50 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

Severe duststorms occur occasionally in spring, when strong dry winds blow over unprotected soils. Tornadoes and severe thunderstorms, some of which are accompanied by hail, occur occasionally. These storms are local in extent and of short duration and cause damage in scattered small areas.

## Physiography, Relief, and Drainage

Brown County is in the Nebraska Sandhills and the Dakota-Nebraska Eroded Tableland of the Great Plains physiographic province (4). This county includes parts of the four general landform divisions known as the Niobrara Valley, the Ainsworth Table, the Long Pine Table, and the Sandhills.

The Niobrara Valley consists of remnants of stream terraces and escarpments or breaks to the Niobrara

River. This landform makes up about 5 percent of Brown County. The high Niobrara River terrace was formed before the river became deeply entrenched. It once occurred as a continuous strip of bottom land, ½ mile to 2 miles wide, that stretched across the county from the Niobrara River to the older, slightly higher Ainsworth Table. The terrace currently is dissected and occurs as remnants between the deeply entrenched tributaries of Plum Creek and Long Pine Creek that flow northward into the Niobrara River. Relief on the terrace is generally less than 10 feet. In most places sandy material has covered the original loamy material of the terrace. Many areas are rolling or undulating, but nearly level areas remain where the former terrace surface persists.

After the formation of the high Niobrara River terrace, a lowering of the base level caused the river to deepen its valley and to produce a rugged, steeply eroded landscape. This landscape has the strongest relief in the county. The maximum relief between ridgetops and the bottom of the river valley is about 200 to 250 feet. The upper part of these eroded breaks consists of a mantle of windblown sandy material and outcrops of weathered sandstone. The lower part consists of clayey material weathered from Pierre Shale.

The Ainsworth Table makes up approximately 9 percent of the northern part of Brown County. It is directly south of the high Niobrara River terrace and north of the Sandhills. It is a strip of land about 10 to 12 miles wide that extends from east to west across the county. The relief of this landform varies because tributaries of the Niobrara River have dissected and eroded many areas. Areas of this landform consist of nearly level to very gently sloping tableland interrupted by drainageways that have gently sloping to strongly sloping side slopes. On the tableland, sand or gravel material lies directly below a loamy or sandy surface layer. In some areas on the upper parts of the side slopes along drainageways, the sandy and gravelly material is exposed or is very near the surface. On the lower parts of the side slopes, weathered sandstone crops out or is very near the surface.

The Long Pine Table covers only about 10 square miles east of Long Pine Creek. The surface features are similar to those of the Ainsworth Table, but the Long Pine Table is slightly sandier.

The Sandhills make up about 86 percent of the county. The relief generally ranges from 30 to 70 feet. In most areas windblown sand has been formed into a gently sloping to hilly landscape. Lower valleys or small depressional pockets are around the margins of the higher hills. These areas, some of which are quite large, have smoother slopes. Most valleys have areas of very poorly to somewhat poorly drained soils,

marshes, and small shallow lakes. Goose Creek and the Calamus River permanently flow southeast from the Sandhills and are tributaries of the North Loup River. Tributaries of the Niobrara River that flow north and east from the Sandhills are Fairfield Creek; Plum Creek and its tributaries, including Evergreen, Cedar, Little Minnie, Dry, and Brush Creeks; and Long Pine Creek and its tributaries, including Willow, Bone, and Sand Draw Creeks.

Brown County is drained by the Niobrara and North Loup Rivers and their tributaries. Drainage conditions vary throughout the county. In the southern two-thirds of the county, most drainage occurs as subsurface drainage through porous sandy material. Drainage channels in this part of the county generally are poorly defined or do not occur. Permanently flowing streams, such as the Calamus River and Goose Creek, are slow and are not deeply entrenched. The Niobrara River is a deeply entrenched, swift-flowing river that carries large amounts of sediment. Long Pine, Bone, Sand Draw, Dutch, Plum, and Fairfield Creeks are swift-flowing streams. Their channels are deepening.

The lowest elevation in Brown County, in an area at the base of the Niobrara River Valley at the Rock County line, is about 1,900 feet above sea level. The highest point, in an area in the southwest part of the county, is about 2,900 feet. Ainsworth is at an elevation of about 2,525 feet.

## Geology

Pierre Shale is the oldest exposed rock formation in Brown County. It consists of light gray and black to bluish gray clay shale of the Late Cretaceous System. It crops out along the lower slopes of the Niobrara River Valley. These slopes tend to develop gravity faults or landslides along the banks of the river.

The Rosebud Formation, a member of the Arikaree Group of late Oligocene to early Miocene age in the Tertiary System, overlies the Pierre Shale. This formation consists of fine grained, horizontally bedded, pinkish tan to gray siltstone that crops out primarily on the valley slopes along the Niobrara River.

The Ogallala Group, which is of Pliocene age in the Tertiary System, overlies the Rosebud Formation along the upper slopes of the Niobrara River Valley. It is primarily alluvial in origin. In Brown County the Ogallala Group consists of two geologic formations—the Valentine Formation and the Ash Hollow Formation. The Valentine Formation can be subdivided into a lower Crookston Bridge Member, which is characterized by gray to yellowish, fine or medium grained sand with some clayey sand, and into a Devil's Gulch Member,

which is characterized by fine grained, yellowish, clay-filled sand. The Ash Hollow Formation overlies the Valentine Formation. It consists of gray to brown, silty sandstone that is commonly cemented by calcium carbonate.

The Keim Formation, which is of Pliocene age, overlies the Ogallala Group (8). It is a sedimentary rock unit made up of fine sand, silt, clay, and limy sandstone. It was deposited in old valleys that cut into Ogallala rocks prior to deposition of the coarser textured sediments of the Long Pine and Pettijohn Formations. In the northern part of the county, Keim sediments crop out in the canyons along Plum and Deep Creeks and along the lower reaches of Sand Draw, Long Pine, and Bone Creeks.

Alluvial sand and gravel and glaciofluvial fine sand, silt, and clay of early Pleistocene age and possibly of Pliocene age lie above the Keim Formation. These have been divided into the Long Pine, Duffy, and Pettijohn Formations (8).

The Long Pine Formation overlies either the Keim Formation or the Ash Hollow Formation. It is in most areas in the northern part of the county. It is made up of unconsolidated or crossbedded, coarse sand and gravel. The pebbles are as much as 3 inches in diameter.

The Duffy Formation overlies the Long Pine Formation and is made up of buff to brown, rust-stained fine sand, silt, and clay. It is buried below most of the Ainsworth Table and is in areas southeast of the Long Pine Formation. The Duffy Formation is overlain by either the Pettijohn Formation or the Sandhills.

The Pettijohn Formation is made up of well sorted, fine gravel and sand. It is in areas directly north of the sand dunes in Brown County. It extends southward under the Sandhills and westward to areas where it appears to converge with Long Pine Gravel and become one gravel sheet. The Pettijohn Formation is intermittently exposed on the Ainsworth Table north of the Sandhills.

The Sandhills and the loamy soils of the Ainsworth Table and Buffalo Flats overlie the Duffy and Pettijohn Formations (8). The southern two-thirds of the county and the northwestern part are covered by sand dunes that constitute the northeast part of the Nebraska Sandhills. Outlying areas of sandhills also occur as isolated hills and ridges in other parts of the county and as dune areas between intersecting drainageways. The dunes are as high as 200 feet and consist primarily of well sorted, fine grained sand. Silty material is in some of the interdune valleys. The present dune topography formed about 7,000 to 1,500 years ago, probably during arid intervals within the Holocene age (1).

## Ground Water

Wells in Brown County provide water for irrigation, for livestock, and for municipal, industrial, and domestic uses. The ground water, however, is not uniformly distributed throughout the county. In areas bordering the Niobrara River Valley and Long Pine Creek in the northeastern part of the county, Pierre Shale is either a few feet below the surface or is exposed. This rock unit does not yield water to wells. Throughout the remainder of the county, however, ground water is available from rock units of the Ogallala Group and the overlying younger unconsolidated deposits (5).

The Ogallala Group yields adequate amounts of ground water for irrigation. In most places the Long Pine and Pettijohn Formations can yield large amounts of water. In the Sandhills, most of the producing wells are shallow, low-yielding wells used for watering livestock.

The chemical quality of most of the water in the county is suitable for all uses. Generally, the water is the calcium carbonate type and is low in content of dissolved solids. The ground water in rocks that directly overlie Pierre Shale, however, tends to be alkaline and high in content of dissolved solids. The depth to water ranges from a few feet to more than 200 feet. The water level at many well sites is less than 25 feet.

## Trends in Farming

Ranching, hay production, and farming have been the basis of the economy in Brown County since its settlement. Cattle producers have used the native prairie as rangeland or hayland. Some sandy areas, especially in the northern part of the county, were cultivated at one time but were later converted back to range. In the 1970's and early 1980's, the development of sprinkler irrigation systems encouraged the use of sandy soils for irrigated crops. The latest trend, however, is to return areas that are marginal for use as cropland to use as range. The tablelands have been farmed since settlement and were developed in the 1960's for gravity irrigation.

Irrigation has been the most important factor affecting the growth of agriculture in the county. In 1954, plans were developed for the Ainsworth Irrigation Project. This project created a system of irrigation canals, laterals, and drains that brings water from the Snake River in eastern Cherry County to the tablelands near Johnstown, Ainsworth, and Long Pine. Construction of the Merritt Dam on the Snake River was completed in 1964. The construction of canals and laterals was completed in 1967. The first water from the Ainsworth Irrigation District was brought to Brown County through

the Ainsworth canal in 1966. About 33,800 acres in the county currently is irrigated by water from this source.

Large cattle ranches dominate the southern two-thirds of the county, and smaller livestock and grain units generally are in the northern one-third. The Federal census reported that the county had 797 farms and ranches in 1935. This number decreased to 390 by 1966 and to 350 by 1984 (7). This decrease is primarily the result of increases in the size of the remaining farms and ranches.

Farm and ranch production has grown with the increased use of irrigation and commercial fertilizers. According to the Nebraska Department of Agriculture, the county had 105 registered irrigation wells and 30,000 acres of irrigated land in 1967. Most of this land was irrigated by water from the Ainsworth Canal. By 1985, the number of registered wells had increased to 442 and the acreage of irrigated land had increased to about 74,000 acres. The extent of irrigation has increased in the last 15 years mainly because of the introduction of center-pivot irrigation systems.

Corn is the main cultivated crop in the county. The acreage of irrigated corn increased from 11,380 acres in 1966 to 53,700 acres in 1985. The acreage of irrigated alfalfa hay has increased over the past 15 years.

In recent years, the acreage planted to dryland oats, wheat, grain, or forage sorghum has decreased. Irrigated soybeans, potatoes, popcorn, and pinto beans are grown on small acreages in the county.

Ranches that raise cattle and sell calves in the fall as feeders are the most important agricultural enterprises in the county. A few ranches raise purebred cattle. The total number of cattle raised on the farms and ranches in the county increased from 64,200 head in 1966 to 94,000 head in 1984. The number of cattle in feedlots increased in the past 15 years. The number of dairy cattle, however, decreased from 1,460 head in 1966 to 700 head in 1984.

The number of hogs raised on farms increased from 4,830 head in 1966 to 14,500 head in 1984. Some farms and ranches also have chickens, sheep, goats, and horses.

## How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of

crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and

tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

## Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and

management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough

observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.



# General Soil Map Units

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The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some soil boundaries and soil names in this survey do not fully match those in the surveys of adjoining counties that were published at an earlier date. Differences are the result of changes and refinements in series concepts, variations in slope groupings, and application of the latest soil classification system.

## Soil Descriptions

### 1. Valentine Association

*Deep, nearly level to hilly, excessively drained, sandy soils; on uplands*

This association consists mainly of soils on dunes in the Sandhills. Many of the dunes rise as much as 200 feet above the valleys. Slopes range from 0 to 60 percent.

The total area of this association is 449,614 acres, which is about 58 percent of the county. The association is about 93 percent Valentine soils and 7 percent minor soils (fig. 2).

The Valentine soils are on hummocks and on rolling and hilly sand dunes that in places have a catstep surface. They are excessively drained. They formed in sandy eolian material. Typically, the surface layer is

grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown fine sand.

Of minor extent in this association are Dunday, Els, Ipage, and Simeon soils. Dunday soils are on side slopes in the uplands and in enclosed sandhill valleys. They have a dark surface layer that is more than 10 inches thick. Els and Ipage soils are in sandhill valleys. Els soils are somewhat poorly drained, and Ipage soils are moderately well drained. Simeon soils are in the lower positions in swales, on breaks, and on side slopes. More than 35 percent of their subsurface layer is medium and coarse sand, and as much as 15 percent is gravel.

Ranches in areas of this association are mainly cow-calf livestock enterprises. Most of the acreage supports native grasses and is used for grazing. Only a few areas are used for hayland because the valleys are too narrow for more than scattered small meadows. Most areas are unsuited to cultivated crops because of droughtiness, the slope, and the hazard of soil blowing. A few areas of the more gently sloping soils are irrigated and used for corn and alfalfa. Wells provide sufficient water for livestock and irrigation.

Using the soils in this association as rangeland effectively controls soil blowing and water erosion. Proper grazing use, timely deferment of grazing or haying, and rotation grazing and haying systems in which the order of use and rest is changed each year help to maintain or improve the condition of the native grasses.

### 2. Simeon-Valentine Association

*Deep, nearly level to very steep, excessively drained, sandy soils; on uplands*

The association is in sandhills and on breaks to the Niobrara River Valley and its tributaries. Slopes range from 0 to 40 percent.

The total area of this association is 40,782 acres, which is about 5 percent of the county. The association

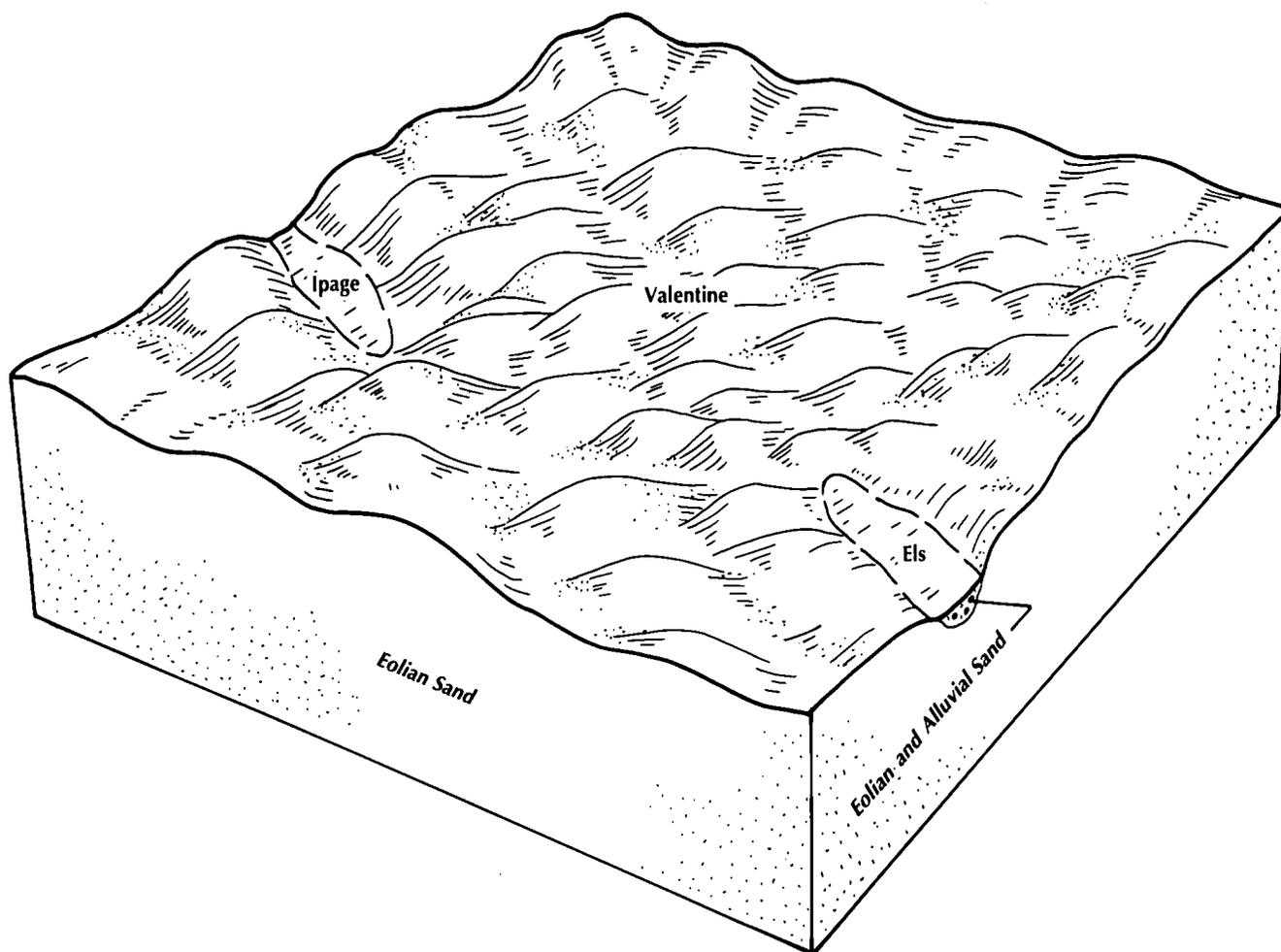


Figure 2.—Typical pattern of soils and parent material in the Valentine association.

is about 42 percent Simeon soils, 40 percent Valentine soils, and 18 percent minor soils.

The Simeon soils are nearly level to steep, are on upper side slopes and in areas between hummocks, and are excessively drained. They formed in sandy alluvium that in some areas has been reworked by the wind. Typically, the surface layer is dark grayish brown, very friable loamy sand about 5 inches thick. Below this is a transition layer of brown, loose sand about 5 inches thick. The underlying material to a depth of more than 60 inches is very pale brown coarse sand and contains as much as 10 percent gravel.

The Valentine soils are nearly level to very steep, are on the lower side slopes and hummocky areas, and are excessively drained. They formed in sandy eolian material. Typically, the Valentine soil has a surface layer of grayish brown, very friable fine sand about 6 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying

material to a depth of more than 60 inches is very pale brown fine sand.

Of minor extent in this association are Meadin, O'Neill, and Pivot soils. These soils have a thicker, dark surface layer. Meadin and O'Neill soils are on side slopes and ridgetops. Pivot soils are on uplands and in sandhill valleys. Meadin soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. O'Neill soils have sand, coarse sand, or gravelly coarse sand at a depth of 20 to 40 inches. Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches.

Ranches in areas of this association are mainly cow-calf livestock enterprises. Nearly all of the acreage supports native grasses and is used for grazing. Only a few areas are used for hayland because the valleys are too narrow for more than scattered small meadows. Most areas are unsuited to cultivated crops because of the slope and the hazards of soil blowing and water

erosion. A few areas of the more gently sloping soils are irrigated and used for corn and alfalfa. Wells provide sufficient water for livestock and irrigation.

Using the soils in this association as rangeland effectively controls soil blowing and water erosion. Proper grazing use, timely deferment of grazing or haying, and rotation grazing and haying systems in which the order of use and rest is changed each year help to maintain or improve the condition of the native grasses.

### 3. Valentine-Els-Tryon Association

*Deep, nearly level to hilly, excessively drained, somewhat poorly drained, and poorly drained or very poorly drained, sandy soils; on uplands and in valleys*

This association consists of soils on dunes and in valleys in the Sandhills. Slopes range from 0 to 60 percent.

The total area of this association is 39,353 acres, which is about 5 percent of the county. The association is about 64 percent Valentine soils, 9 percent Els soils, 6 percent Tryon soils, and 21 percent minor soils.

The Valentine soils are on hummocks, on moderately steep dunes, and on rolling and hilly sand dunes. They formed in sandy eolian material. They are excessively drained. Typically, the surface layer is grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown fine sand.

The Els soils are nearly level and very gently sloping and are in swales or depressed areas of sandhill valleys. They formed in sandy eolian and alluvial material. They are somewhat poorly drained. Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. Below this is a transition layer of brown, loose loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is fine sand. It is pale brown in the upper part, light gray in the next part, and white in the lower part. It is mottled below a depth of 19 inches.

The Tryon soils are nearly level and are in narrow valleys between dunes and in low areas of sandhill valleys. They formed in eolian and alluvial sediments. They are poorly drained or very poorly drained. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is mottled fine sand. It is light brownish gray in the upper part, light gray in the next part, and light brownish gray in the lower part.

Of minor extent in the association are Dunday, Loup,

and Marlake soils and areas of water. Dunday soils are on side slopes in the uplands and in enclosed sandhill valleys. They have a dark surface layer that is more than 10 inches thick. Loup soils are on bottom land and valley floors of the Sandhills and are poorly drained and very poorly drained. Marlake soils are on low depressional areas in sandhill valleys and are covered with water much of the time. Also of minor extent, in the lowest areas, are intermittent lakes that have water above the surface for long periods.

Ranches in areas of this association are mainly cow-calf livestock enterprises. Most of the acreage supports native grasses and is used for hay or grazing. Most areas are unsuited to cultivated crops because of the slope, the hazard of soil blowing, and wetness.

The soils in the uplands generally are too droughty for dryland farming and require irrigation. The soils in the sandhill valleys generally are too wet for farming. Some of the nearly level to strongly sloping sandhill soils are used as cropland. Corn and alfalfa are the main crops under irrigation. Wells produce sufficient water for livestock and for center-pivot irrigation systems.

Proper grazing use, timely deferment of grazing or haying, rotation grazing and haying systems in which the order of use and rest is changed each year, and restricted use during very wet periods help to maintain or improve the range condition. Proper distribution of livestock can be achieved by proper placement of fences and salting and watering facilities. Soil blowing and water erosion are hazards if the protective grass cover is destroyed. Overgrazing, improper timing of mowing, and improper mowing heights reduce the protective plant cover and cause deterioration of the native plants. Wetness, caused by the high water table, and soil blowing and water erosion are the main management problems if these areas are cultivated. The seasonal high water table benefits grasses and cultivated crops during dry seasons, but it interferes with haying and tillage operations during wet seasons. Managing irrigation water is an additional management concern.

### 4. Valentine-Els-Ipage Association

*Deep, nearly level to strongly sloping, excessively drained, somewhat poorly drained, and moderately well drained, sandy soils; on uplands and in valleys*

This association consists of hummocky sandhills and the intervening valleys and swales. Slopes range from 0 to 9 percent.

The total area of this association is 93,857 acres, which is about 12 percent of the county. The association is about 36 percent Valentine soils, 28

percent Els soils, 12 percent lpage soils, and 24 percent minor soils.

The Valentine soils are nearly level to strongly sloping and are on hummocky areas. They formed in sandy eolian material. They are excessively drained. Typically, the Valentine soil has a surface layer that is dark grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of grayish brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is pale brown and light yellowish brown fine sand.

The Els soils are nearly level and very gently sloping and are in swales between hummocky areas and in low areas in sandhill valleys. They formed in sandy eolian and alluvial material. They are somewhat poorly drained. Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. Below this is a transition layer of brown, loose loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is fine sand. It is pale brown in the upper part, light gray in the next part, and white in the lower part. It is mottled below a depth of 19 inches.

The lpage soils are nearly level to very gently sloping and are on low hummocky slopes or low ridges in sandhill valleys. They formed in sandy eolian and alluvial material. They are moderately well drained. Typically, the surface layer is dark grayish brown, very friable fine sand about 7 inches thick. Below this is a transition layer of brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light gray fine sand. It is mottled below a depth of 31 inches.

Of minor extent in this association are Libory, Loup, and Tryon soils. Libory soils are in positions in swales slightly higher than the Els soils. They have loamy or silty underlying material. Loup and Tryon soils are in the lower areas of bottom land in sandhill valleys and are poorly drained or very poorly drained. Also included in this association are a few areas of rolling to hilly sandhills.

Ranches in areas of this association are mainly cow-calf livestock enterprises. Most of the acreage supports native grasses and is used for hay or grazing. Most areas are unsuited to cultivation because of droughtiness and the hazard of soil blowing. Some of the nearly level to strongly sloping sandhill soils are used as cropland. These soils generally are too droughty for dryland farming and require irrigation. Corn and alfalfa are the main crops under irrigation. Wells produce sufficient water for livestock and for center-pivot irrigation systems.

Proper grazing use, timely deferment of grazing or haying, and rotation grazing and haying systems in which the order of use and rest is changed each year

help to maintain or improve the range condition. Proper distribution of livestock can be achieved by proper placement of fences and salting and watering facilities. Soil blowing is a hazard if the protective grass cover is destroyed. Wetness can be a problem in cultivated areas of the Els soils and in areas of the included soils. The high water table benefits grasses and cultivated crops during dry periods, but it can cause severe wetness problems in periods of above normal rainfall. Increasing the organic matter content is a management concern. Maintaining crop residue on the surface, stripcropping, and minimum tillage help to control soil blowing and conserve soil moisture. Irrigation water management also is a management concern.

## 5. Loup-Els-Tryon Association

*Deep, nearly level and very gently sloping, somewhat poorly drained to very poorly drained, loamy and sandy soils; in valleys*

The association is in valleys in the Sandhills. Slopes range from 0 to 3 percent.

The total area of this association is 24,408 acres, which is about 3 percent of the county. The association is about 38 percent Loup soils, 26 percent Els soils, 17 percent Tryon soils, and 19 percent minor soils.

The Loup soils are nearly level and are on bottom land and valley floors of the Sandhills. They formed in loamy and sandy alluvium. They are poorly drained or very poorly drained. Typically, the surface layer is dark gray, very friable fine sandy loam about 10 inches thick. Below this is a transition layer of gray, very friable fine sand about 5 inches thick. It has grayish brown mottles. The underlying material to a depth of 48 inches is light gray, mottled fine sand and sand.

The Els soils are nearly level to very gently sloping and are on bottom land in the Sandhills. They formed in sandy eolian and alluvial material. They are somewhat poorly drained. Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. Below this is a transition layer of brown, loose loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is fine sand. It is pale brown in the upper part, light gray in the next part, and white in the lower part. It is mottled below a depth of 19 inches.

The Tryon soils are nearly level and are in low areas of sandhill valleys. They are poorly drained or very poorly drained. They formed in eolian and alluvial sediments. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is mottled fine sand. It is light brownish gray in the upper part, light gray in the next part, and light

brownish gray in the lower part.

Of minor extent in the association are Elsmere, lpage, Libory, Marlake, and Valentine soils. Elsmere soils are somewhat poorly drained. They have a dark surface layer that is more than 10 inches thick. They are on bottom land and depressed areas similar to those of the Els soils. lpage soils are in the slightly higher positions on low ridges and low hummocky areas and are moderately well drained. Libory soils are in upland swales. They have a loamy or silty underlying layer. Marlake soils are in low depressional areas and are covered with water much of the time. Valentine soils are excessively drained and are in the higher hummocky positions.

Ranches in areas of this association are mainly cow-calf livestock enterprises. A large part of the acreage supports native grasses and is used for hay or grazing. Most areas are unsuited to cultivation because of wetness. Some of the Els soils are cultivated. The Els soils are generally too sandy for dryland farming and require irrigation. Corn and alfalfa are the main crops under irrigation. Wells supply sufficient water for livestock and for center-pivot irrigation systems.

Proper grazing use, timely deferment of grazing or haying, and restricted use during very wet periods help to maintain or improve the range condition. Overgrazing, improper timing of mowing, and improper mowing heights reduce the protective plant cover and cause deterioration of the native plants. Wetness, caused by the high water table, and soil blowing are the main management problems if these areas are cultivated. The seasonal high water table benefits grasses and cultivated crops during dry seasons, but it interferes with haying and tillage operations during wet seasons. Loup and Tryon soils are generally too wet for use as cropland. Soil blowing can be controlled in areas of Els soils by keeping the soil covered with crops or crop residue. Managing irrigation water is an additional concern.

## 6. Johnstown-Jansen Association

*Deep, nearly level to gently sloping, well drained, loamy soils underlain by coarse sand; on uplands*

This association consists mainly of soils on tablelands. Slopes range from 0 to 6 percent.

The total area of this association is 39,758 acres, which is about 5 percent of the county. The association is about 62 percent Johnstown soils, 11 percent Jansen soils, and 27 percent minor soils (fig. 3).

The Johnstown soils are deep, are well drained, and are on the nearly level to gently sloping tablelands and side slopes that are dissected by drainageways. They formed in loamy and silty sediment or loess. Typically,

the surface layer is dark gray, very friable loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable loam about 13 inches thick. The subsoil is grayish brown, very friable clay loam about 6 inches thick. A buried subsoil about 23 inches thick occurs at a depth of about 27 inches. It is very dark grayish brown, firm clay loam in the upper part; light yellowish brown, firm clay loam in the next part; and light yellowish brown, friable, calcareous clay loam in the lower part. The underlying material to a depth of more than 60 inches is light yellowish brown coarse sand.

The Jansen soils are well drained and are on the nearly level to gently sloping tablelands, ridges or divides, and side slopes that are dissected by drainageways. They formed in 20 to 36 inches of loamy sediment or loess over coarse sand, gravelly coarse sand, or sand. Typically, the surface layer is dark grayish brown, very friable loam about 8 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown, friable loam in the upper part; brown, firm clay loam in the next part; and pale brown, firm loam in the lower part. The underlying material extends to a depth of 60 inches or more. It is pale brown coarse sand in the upper part and light gray sand in the lower part.

Of minor extent in this association are Anselmo, Dunday, Sandose, and Valentine soils. These soils have a sandier surface layer. They are on the slightly higher side slopes and divides on uplands.

Farms in areas of this association are mainly cash-grain enterprises. There are a few livestock feeding operations. Nearly all of the acreage is used for irrigated cropland. Corn is the main crop. A few areas are used for alfalfa. Generally, water is applied with gravity systems using gated pipe. The Ainsworth Irrigation District supplies this water through a system of canals, laterals, and drains. Some of the cropland is irrigated by center-pivot irrigation systems.

Soil blowing is a hazard if the soils are not protected by plant cover or crop residue. Water erosion is slight or moderate on the nearly level to gently sloping soils. Irrigation water management can be improved by the use of tailwater recovery pits.

## 7. Jansen-O'Neill-Meadin Association

*Deep, nearly level to strongly sloping, well drained and excessively drained, loamy and sandy soils underlain by coarse sand and gravelly coarse sand; on uplands*

This association consists of soils on tablelands, upland divides, and side slopes that are dissected by drainageways. These soils formed in loamy material over alluvial coarse sand and gravelly coarse sand. Slopes range from 0 to 11 percent.

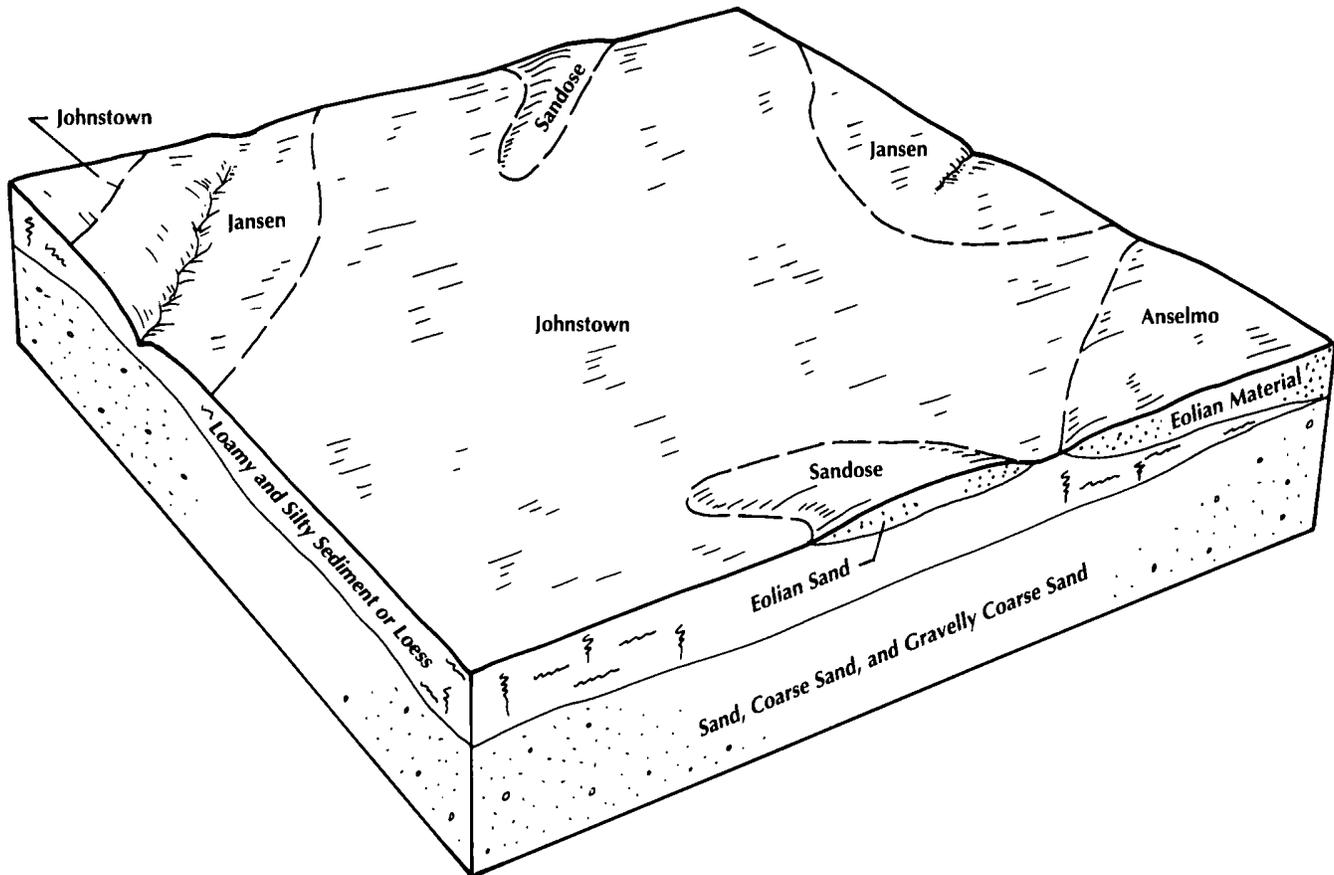


Figure 3.—Typical pattern of soils and parent material in the Johnstown-Jansen association.

The total area of this association is 26,761 acres, which is about 3 percent of the county. The association is about 36 percent Jansen soils, 11 percent O'Neill soils, 9 percent Meadin soils, and 44 percent minor soils (fig. 4).

The Jansen soils are nearly level to gently sloping and well drained. They formed in 20 to 36 inches of loamy sediment or loess overlying coarse sand, gravelly coarse sand, and sand. Typically, the surface layer is dark grayish brown, very friable loam about 8 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown, friable loam in the upper part; brown, firm clay loam in the next part; and pale brown, firm loam in the lower part. The underlying material extends to a depth of 60 inches or more. It is pale brown coarse sand in the upper part and light gray sand in the lower part.

The O'Neill soils are nearly level to strongly sloping and are well drained. They formed in 20 to 40 inches of loamy material over sand, coarse sand, or gravelly coarse sand. Typically, the surface layer is grayish brown, friable fine sandy loam about 5 inches thick. The

surface layer also is grayish brown, friable fine sandy loam. It is about 3 inches thick. The subsoil is brown, friable fine sandy loam about 18 inches thick. The upper part is friable, and the lower part is very friable. The underlying material extends to a depth of 60 inches or more. It is gravelly coarse sand. It is pale brown in the upper part and light yellowish brown in the lower part.

The Meadin soils are nearly level to strongly sloping and excessively drained. They formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. Typically, the surface layer is dark grayish brown, very friable sandy loam about 7 inches thick. Below this is a transition layer of brown, very friable sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is gravelly coarse sand. It is pale brown in the upper part and light gray in the lower part.

Of minor extent in this association are Anselmo, Dunday, Johnstown, Pivot, Sandose, and Valentine soils. Anselmo soils formed in loamy and sandy eolian material. They are on side slopes and divides similar to or slightly higher than those of the major soils. Dunday

soils formed in sandy eolian material. They are on side slopes similar to or higher than those of the major soils. Johnstown soils formed in loamy and silty sediments or loess. They are on tablelands and side slopes similar to those of the Jansen soils. Pivot soils are sandier than the major soils. They are in upland positions similar to those of the O'Neill soils. Sandose soils have loamy underlying material. They are on the slightly higher side slopes and divides. Valentine soils are sandy. They are on the higher side slopes.

Farms and ranches in areas of this association are diversified and mainly combine cash-grain and livestock enterprises. Most of the acreage is used for irrigated cropland. The rest supports native grasses and is used for grazing. Wheat and the first cutting of alfalfa are the most dependable crops under dryland farming because they grow and mature in spring when rainfall is highest. Corn and alfalfa are the main irrigated crops. Gravity and sprinkler irrigation systems are generally suited to the Jansen and O'Neill soils. Gravity irrigation should be limited to areas where the slope does not exceed 6 percent. Some land grading may be needed to smooth areas for gravity irrigation. Meadin soils are generally

unsuitable for use as cropland.

Inadequate seasonal rainfall is the main concern if these soils are dryland farmed. The soils have a low or moderate available water capacity and are droughty. Stubble mulch tillage and other management practices that keep crop residue on the surface help to control soil blowing and water erosion and conserve soil moisture. Managing irrigation water is a concern in irrigated areas. Proper grazing use, timely deferment of grazing, and a grazing system in which the order of use and rest is changed each year help to maintain or improve the range condition.

#### 8. Valentine-O'Neill-Pivot Association

*Deep, nearly level to strongly sloping, well drained to excessively drained, sandy soils and loamy and sandy soils underlain by coarse sand and gravelly coarse sand; on uplands*

This association consists of soils on tablelands, on uplands, and in sandhills. Slopes range from 0 to 11 percent.

The total area of this association is 10,961 acres,

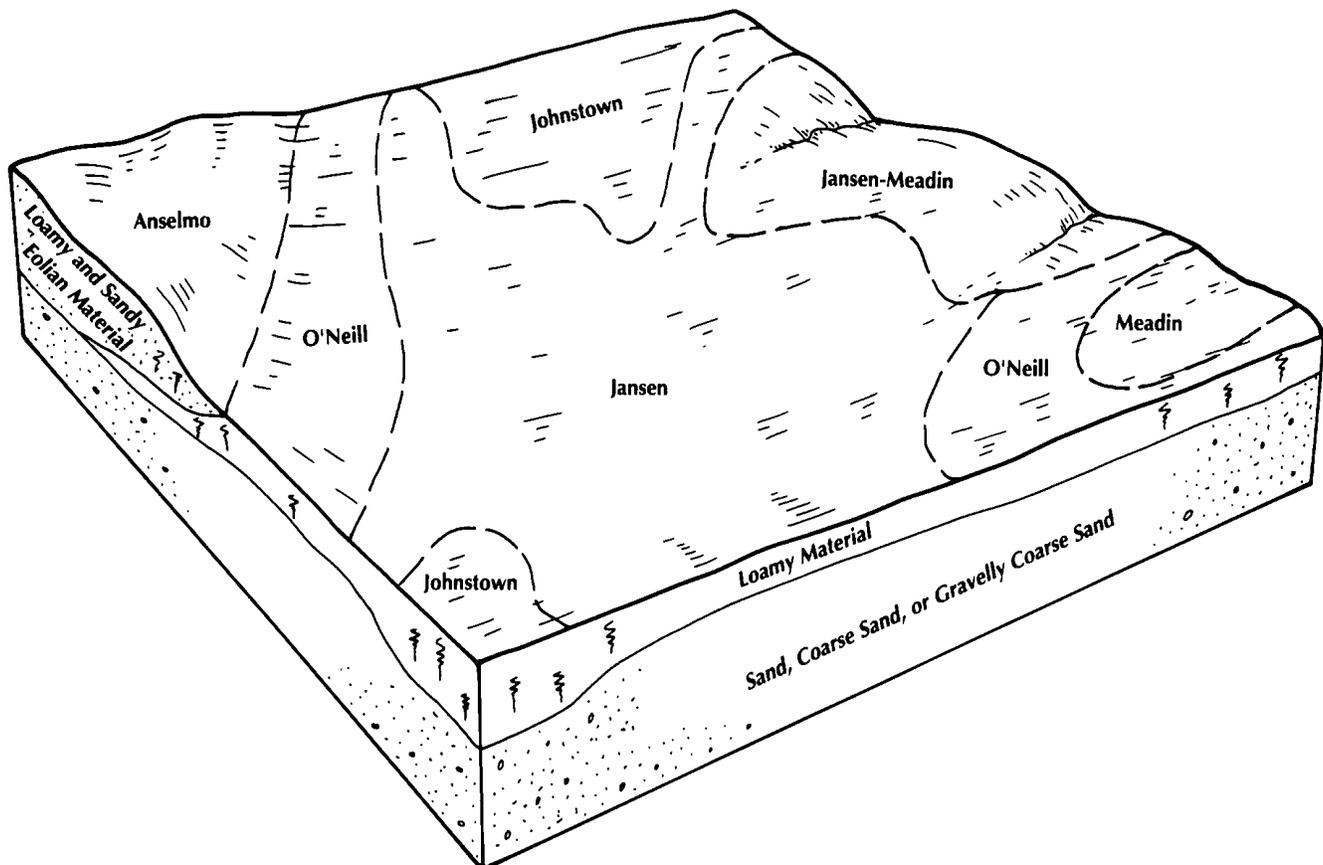


Figure 4.—Typical pattern of soils and parent material in the Jansen-O'Neill-Meadin association.

which is about 1 percent of the county. The association is about 28 percent Valentine soils, 25 percent O'Neill soils, 12 percent Pivot soils, and 35 percent minor soils.

The Valentine soils are deep, nearly level to strongly sloping, and excessively drained. They formed in sandy eolian material. Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand.

The O'Neill soils are nearly level to strongly sloping and are well drained. They formed in 20 to 40 inches of loamy material overlying sand, coarse sand, or gravelly coarse sand. Typically, the surface layer is grayish brown, friable fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, friable fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam about 18 inches thick. The upper part is friable, and the lower part is very friable. The underlying material extends to a depth of 60 inches or more. It is pale brown gravelly coarse sand in the upper part and light yellowish brown gravelly coarse sand in the lower part.

The Pivot soils are nearly level and very gently sloping and are somewhat excessively drained. They formed in 20 to 40 inches of sandy eolian material and sandy alluvium overlying coarse sand or gravelly coarse sand. Typically, the surface layer is dark grayish brown, very friable loamy sand about 9 inches thick. The subsurface layer also is dark grayish brown, very friable loamy sand about 7 inches thick. Below this is a transition layer of grayish brown, very friable loamy sand about 6 inches thick. The underlying material is pale brown sand in the upper part, very pale brown coarse sand in the next part, and very pale brown gravelly coarse sand in the lower part. It extends to a depth of more than 60 inches.

Of minor extent in this association are Anselmo, Dunday, Jansen, Meadin, and Simeon soils. Anselmo soils formed in loamy and sandy eolian material. They are on upland divides and side slopes similar to those of the O'Neill soils. Dunday soils formed in sandy eolian material and are sandy throughout. They are in upland positions similar to those of the O'Neill and Pivot soils. Jansen soils have more clay in the subsoil. They are on upland divides similar to those of the O'Neill soils. Meadin and Simeon soils are in upland positions similar to those of the Pivot soils. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Simeon soils are sandy and have a thin, light colored surface layer. They formed in sandy alluvium that in some areas has been reworked by the wind.

Farms and ranches in areas of this association are diversified and mainly combine cash-grain and livestock

enterprises. About one-half of the acreage is used for irrigated cropland. The rest supports native grasses, some of which is used for grazing and some of which is harvested for hay. These soils generally are too sandy for gravity irrigation systems. They are better suited to sprinkler irrigation systems. Carefully selected application rates and timely application of irrigation water are needed. Corn and alfalfa are the main irrigated crops.

Soil blowing, water erosion, and droughtiness are the main management concerns in cultivated areas and in areas of native grass. A low or moderate available water capacity is a limitation in some areas. Soil blowing and water erosion can be controlled by maintaining a cover of grass, crops, or crop residue. Irrigation water management is a major concern. Increasing the organic matter content is another important management concern. Proper grazing use, timely deferment of grazing or haying, and a rotation grazing system in which the order of use and rest is changed each year help to maintain or improve the condition of the native grasses.

## 9. Valentine-Ronson-Tassel Association

*Deep to shallow, nearly level to steep, excessively drained and well drained, sandy and loamy soils; on uplands*

This association consists of nearly level to steep soils on uplands. Slopes range from 0 to 24 percent.

The total area of this association is 12,218 acres, which is about 2 percent of the county. The association is about 25 percent Valentine soils, 17 percent Ronson soils, 17 percent Tassel soils, and 41 percent minor soils.

The Valentine soils are deep, are excessively drained, and are nearly level to steep. They are on hummocks, dunes, and rolling hills. Valentine soils formed in sandy eolian material. Typically, the surface layer is grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown fine sand.

The Ronson soils are moderately deep, well drained, and nearly level to strongly sloping. They formed in material weathered from sandstone. They are on ridges and side slopes. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. Below this is a transition layer of brown, very friable fine sandy loam about 5 inches thick. The underlying material is pale brown and light gray sandy

loam about 19 inches thick. It has many fine fragments of sandstone. Pale yellow, calcareous, soft sandstone is at a depth of about 37 inches.

The Tassel soils are on upper ridges and side slopes. They formed in material weathered from sandstone. They are shallow, well drained, and nearly level to moderately steep. Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam about 4 inches thick. White, calcareous, soft sandstone is at a depth of about 10 inches.

Of minor extent in this association are Anselmo, Dunday, and O'Neill soils. Anselmo soils are deep and loamy. They are on divides and side slopes. Dunday soils are deep and sandy. They have a dark surface soil. Dunday soils are in positions on side slopes similar to those of the Valentine soils. O'Neill soils formed in 20 to 40 inches of loamy material over sand, coarse sand, or gravelly coarse sand. They are on divides and side slopes.

Farms and ranches in areas of this association are mainly cow-calf livestock enterprises. Most of the acreage supports native grasses and is used for grazing or hay. A few areas are cultivated. The Tassel soils are generally unsuitable for use as cropland because of the shallow root zone. The deeper soils in this association are best suited to sprinkler irrigation systems because of the low available water capacity. Wheat and the first cutting of alfalfa are the most dependable crops under dryland farming because they grow and mature in spring when the rainfall is highest.

Proper grazing use, timely deferment of grazing or haying, and a rotation grazing system in which the order of use and rest is changed each year help to maintain or improve the condition of the native grasses. In cultivated areas, the main concerns of management are controlling soil blowing and water erosion and conserving soil moisture. Stubble mulch tillage and other management practices that keep crop residue on the surface help to control soil blowing and water erosion and conserve soil moisture. Inadequate seasonal rainfall is a major concern if these soils are dryland farmed.

#### **10. McKelvie-Tassel-Ronson Association**

*Deep to shallow, moderately steep to very steep, excessively drained to well drained, sandy and loamy soils; on upland breaks to the Niobrara River and its tributaries*

This association consists of soils on breaks to the Niobrara River and its tributaries. Most areas are

dissected by deep drainageways. Slopes range from 15 to 70 percent.

The total area of this association is 42,816 acres, which is about 5 percent of the county. The association is about 31 percent McKelvie soils, 20 percent Tassel soils, 14 percent Ronson soils, and 35 percent minor soils.

The McKelvie soils are deep, moderately steep to very steep, and excessively drained. They formed in sandy eolian material and in sandy material weathered from sandstone. They are on the mid and lower side slopes of the breaks. Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. Below this is a transition layer of light brownish gray, very friable loamy fine sand about 7 inches thick. The underlying material to a depth of more than 60 inches is light gray fine sand.

The Tassel soils are shallow, moderately steep to very steep, and somewhat excessively drained. They formed in dominantly loamy material weathered from sandstone. They are on ridgetops and the upper side slopes of the breaks. Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam about 4 inches thick. White, calcareous, soft sandstone is at a depth of about 10 inches.

The Ronson soils are moderately deep, moderately steep to steep, and well drained. They formed in loamy material weathered from sandstone. They are on the smooth, concave side slopes of the breaks. Typically, the surface layer is dark gray, very friable fine sandy loam about 8 inches thick. Below this is a transition layer of mixed grayish brown and brown, very friable fine sandy loam about 6 inches thick. The underlying material is about 13 inches thick. It is fine sandy loam. It is pale brown in the upper part and very pale brown in the lower part. White, noncalcareous, soft sandstone is at a depth of about 27 inches.

Of minor extent in this association are Almeria, Anselmo, Brunswick, Inavale, Meadin, and Valentine soils. Almeria soils are on bottom land along the Niobrara River and are poorly drained. Anselmo soils are on side slopes. They are deep and loamy. Brunswick soils are on the lower side slopes. They are moderately deep over sandstone bedrock and are loamy. Inavale soils are on narrow bottom land along major drainageways and the Niobrara River. They are deep and sandy. Meadin and Valentine soils are on the upper side slopes. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are excessively drained. Valentine soils are deep, excessively drained, and sandy.

Ranches in areas of this association are mainly cow-calf livestock enterprises. All of the soils support native vegetation of grass and trees. The trees are mainly ponderosa pine and eastern red cedar. The stands of trees generally are thin, but in some areas they are thick enough to shade out the grass. Broad-leaved trees are on the lower parts of most side slopes and on the bottom land along drainageways. These soils are not suitable for use as cropland because of the slope and the severe erosion hazard. The ranches in this association generally include soils of other associations that are suited to grazing or cultivation. The soils in this association are mainly used for summer grazing.

The production of grass on these soils is limited by the low rainfall, the shallowness of the soils, the slope, and the density of the tree canopy. Water for livestock is limited to precipitation that is caught and stored in stockwater ponds and water from the small streams. Water erosion is a severe hazard if the vegetative cover is destroyed or has deteriorated by overgrazing. Grazing needs to be carefully controlled to maintain the vegetative cover and control erosion.

### 11. Labu-Sansarc-Almeria Association

*Deep to shallow, nearly level to very steep, well drained and poorly drained, clayey and loamy soils; on upland breaks to the Niobrara River Valley and on bottom land along the Niobrara River*

This association consists of soils on side slopes and ridgetops along the breaks to the Niobrara River and on bottom land along the Niobrara River. Slopes range from 0 to 40 percent.

The total area of this association is 1,200 acres, which is less than 1 percent of the county. The association is about 25 percent Labu soils, 23 percent Sansarc soils, 21 percent Almeria soils, and 31 percent minor soils.

The Labu soils are moderately deep and well drained. They are on the lower side slopes of the breaks to the Niobrara River. They formed in clayey material weathered from shale. Typically, the surface layer is dark grayish brown, firm silty clay about 5 inches thick. The subsoil is silty clay about 13 inches thick. The upper part is very firm and light olive brown; the next part is very firm and light olive brown and has grayish brown tongues; and the lower part is firm, calcareous, and grayish brown. The underlying material is light brownish gray, calcareous clay about 5 inches thick. Light brownish gray, calcareous, bedded shale is

at a depth of about 23 inches.

The Sansarc soils are shallow and well drained. They are on the upper side slopes and narrow ridgetops of the breaks to the Niobrara River. They formed in clayey material weathered from shale. Typically, the surface layer is dark grayish brown, friable silty clay about 3 inches thick. The underlying material is grayish brown and light brownish gray, calcareous clay about 9 inches thick. Light brownish gray, calcareous, bedded shale is at a depth of about 12 inches.

The Almeria soils are deep, nearly level, and poorly drained. They are on bottom land. They formed in loamy and sandy alluvium. Typically, the surface layer is light gray, mottled, friable loamy fine sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is light gray and mottled. It is fine sand in the upper part and sand in the lower part.

Of minor extent in this association are Bolent, Inavale, Ronson, and Tassel soils. Bolent soils are somewhat poorly drained and are higher on the landscape than the Almeria soils. Inavale soils are sandy. They are on the higher bottom land that is subject to rare flooding. Ronson and Tassel soils are on the higher ridges and side slopes. Ronson soils are moderately deep over sandstone bedrock. Tassel soils are shallow over sandstone bedrock.

Ranches in areas of this association and in the adjoining associations are mainly cow-calf livestock enterprises. The Labu and Sansarc soils are generally too steep or too clayey for use as cropland under either dryland or irrigation management. The Almeria soils are generally too wet for use as cropland. Nearly all of the acreage in this association supports native grasses and is used for grazing. Ground-water supplies are not reliable in areas of the Labu and Sansarc soils. Wells dug in these soils generally yield water of poor quality.

Maintaining or improving the range condition is the main concern in managing the native rangeland on the Labu and Sansarc soils. Proper grazing use, timely deferment of grazing, and a rotation grazing system in which the order of use and rest is changed each year are needed. Water erosion and droughtiness are additional management concerns on the clayey soils. Maintaining an adequate vegetative cover helps to prevent excessive erosion and increases the moisture supply by reducing the runoff rate.

Wetness and flooding are management concerns on the Almeria soils. Proper grazing use, timely deferment of grazing, and restricted use during very wet periods help to maintain or improve the range condition.

## Detailed Soil Map Units

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The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Johnstown loam, 0 to 1 percent slopes, is a phase in the Johnstown series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Valentine-Els fine sands, 0 to 9 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ

substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the soil boundaries and soil names on the detailed maps of this county do not fully match those on the maps of adjacent counties published at an earlier date. Differences result from changes and refinements in series concepts, variations in slope groupings, and application of the latest soil classification system.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

### Soil Descriptions

**Aa—Almeria loamy fine sand, 0 to 2 percent slopes.** This deep, nearly level, poorly drained soil is on low bottom land along the Niobrara River. It is frequently flooded. It formed in stratified, loamy and sandy alluvium. Areas generally are long and narrow and range from 20 to more than 150 acres in size.

Typically, the surface layer is light gray, mottled, friable loamy fine sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is light gray and mottled. It is dominantly fine sand in the upper part and sand in the lower part. At a depth of 15 to 18 inches, however, it has a layer of light gray, stratified very fine sandy loam. In some places the surface layer is fine sandy loam, loamy sand, fine sand, or sand. In other places it is dark and is more than 10 inches thick. In a few places the underlying material is coarse sand or gravelly coarse sand. In some areas it

has no sandstone fragments. In other areas the water table is above the surface for brief periods.

Included with this soil in mapping are small areas of Bolent and Inavale soils and Fluvaquents, sandy. Bolent and Inavale soils are better drained than the Almeria soil and are on the higher parts of the bottom land. Fluvaquents are very poorly drained and are in the lowest positions on the bottom land. They are covered by water during most of the growing season. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Almeria soil. Available water capacity is low. Organic matter content also is low. Runoff is very slow. The seasonal high water table is at the surface in wet years and at a depth of 1.5 feet in dry years.

Most of the acreage supports native grasses and is used mainly for grazing or hay. Some areas are covered with trees and shrubs. This soil generally is too wet for use as cropland.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, switchgrass, big bluestem, and reedgrass. These species make up 80 percent or more of the total annual forage. Various sedges, perennial grasses, and forbs make up the remaining 20 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, switchgrass, big bluestem, and reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clovers also increase in abundance if they are overseeded. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse.

If this soil is used as hayland, mowing should be

regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying operations generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a high water table. Wetness is the main limitation. Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Weeds and undesirable grasses that compete with the trees can be controlled by timely cultivation and by applications of approved herbicide.

This soil is not suitable as a site for sanitary facilities or dwellings because of the flooding and the wetness. A suitable alternative site is needed. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness.

The capability unit is Vw-7, dryland; Wet Subirrigated range site; windbreak suitability group 2D.

**Ae—Almeria fine sandy loam, 0 to 2 percent slopes.** This deep, nearly level, poorly drained soil is on low bottom land along the major streams and tributaries. It is frequently flooded. It formed in stratified, loamy and sandy alluvium. Areas generally are long and narrow and range from 20 to 300 acres in size.

Typically, the surface layer is very dark gray, very friable fine sandy loam about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is mottled. It is light brownish gray fine sand in the upper part; grayish brown, stratified loamy fine

sand and fine sandy loam in the next part; and light gray sand and light brownish gray fine sand in the lower part. In some places the surface layer is loamy fine sand, fine sand, or loamy sand. In other places it is dark and is more than 10 inches thick. In some areas the water table is above the surface for brief periods.

Included with this soil in mapping are small areas of Bolent soils and Histosols. Bolent soils are somewhat poorly drained and are on the higher parts of the bottom land. Histosols are very poorly drained and are in the lowest positions on the bottom land in old oxbows and stream channels. They are covered by water during most of the growing season. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Almeria soil. Available water capacity is low. Organic matter content is moderately low. Runoff is very slow. The seasonal high water table is at the surface in wet years and at a depth of 1.5 feet in dry years.

Most of the acreage supports native grasses and is used mainly for grazing or hay. This soil generally is too wet for use as cropland.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, switchgrass, big bluestem, and reedgrass. These species make up 80 percent or more of the total annual forage. Various sedges, perennial grasses, and forbs make up the remaining 20 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, switchgrass, big bluestem, and reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clovers also increase in abundance if they are overseeded. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating

them each time that salt is provided help to prevent excessive trampling and local overuse.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying operations generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a high water table. Wetness is the main limitation. Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Weeds and undesirable grasses that compete with the trees can be controlled by timely cultivation and by applications of approved herbicide.

This soil is not suitable as a site for sanitary facilities or dwellings because of the flooding and the wetness. A suitable alternative site is needed. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness.

The capability unit is Vw-7, dryland; Wet Subirrigated range site; windbreak suitability group 2D.

**Af—Almeria-Histosols complex, channeled.** These deep, nearly level, very poorly drained soils are on low bottom land along the Calamus River. They are frequently flooded. Slopes range from 0 to 2 percent. The Almeria soil formed in stratified, loamy and sandy alluvium. The Histosols formed in organic material overlying stratified, sandy alluvium. The Almeria soil is on slight rises adjacent to the stream channels. The

Histosols are in oxbows and old stream channels in the lowest positions on the bottom land. Areas generally are long and narrow and range from 10 to more than 600 acres in size. They are 40 to 60 percent Almeria soil and 30 to 50 percent Histosols. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Almeria soil has a surface layer of dark gray, very friable fine sandy loam about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is light gray. It is dominantly mottled fine sand in the upper part and white sand in the lower part. At a depth of 12 to 28 inches, however, it has a layer of grayish brown very fine sandy loam. In some places the surface layer is dark and is more than 10 inches thick. In other places it is loamy fine sand or fine sand.

Typically, the Histosols have a surface layer of very dark grayish brown, partially decomposed organic material about 26 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray, mottled fine sand in the upper part; light gray fine sand in the next part; and light gray sand in the lower part. The underlying material has thin strata of loamy material. In places the organic surface layer may be as thin as 6 inches or as thick as 42 inches.

Included with these soils in mapping are small areas of Bolent soils and small areas of open water more than 2 feet deep. Bolent soils are on the higher parts of the bottom land and are better drained than the Almeria soil and Histosols. The areas of open water are in former stream channels or oxbows. Included areas make up 5 to 10 percent of the unit.

Permeability is rapid in the Almeria soil and Histosols. Available water capacity is low in the Almeria soil and high in the Histosols. Organic matter content is moderately low in the Almeria soil and high in the Histosols. Runoff is ponded on both soils. The seasonal high water table is 0.5 foot above to 1.0 foot below the surface of the Almeria soil and 2.0 feet above to 1.0 foot below the surface of the Histosols.

These soils support wetland grasses, woody vegetation, and marsh vegetation and are used as range. A few very small areas are harvested for hay. The Histosols generally are too wet and marshy for forage production and are used mostly as habitat for wetland wildlife. The vegetation of these marshy areas generally is cattails, rushes, and sedges. The soils are too wet for cultivation.

In areas of the Almeria soil used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and sedges. These species make up 75 percent or more of the total annual forage. Slender wheatgrass and other perennial grasses, rushes, and forbs make up the rest.

If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.1 animal unit months per acre. The Almeria soil produces high yields of low-quality forage. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. When the surface is wet, grazing or using heavy machinery causes surface compaction and the formation of mounds and ruts, which make grazing or harvesting hay difficult.

If the Almeria soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. In wet years some areas of the soil cannot be harvested. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring.

These soils generally are not suited to the trees and shrubs grown as windbreaks because of the wetness and the flooding. A few areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied. Onsite investigation is needed to identify the areas best suited to windbreaks.

These soils generally are not suitable as sites for sanitary facilities or dwellings because of the ponding and the flooding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by ponding and flooding.

The capability unit is Vllw-7, dryland; windbreak suitability group 10. The Almeria soil is in the Wetland range site, and the Histosols are not assigned a range site.

**An—Anselmo fine sandy loam, 0 to 2 percent slopes.** This deep, nearly level, well drained soil is on upland divides. It formed in loamy and sandy eolian material. Areas range from 5 to 150 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable fine

sandy loam about 11 inches thick. The subsoil is brown, very friable fine sandy loam about 15 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and pale brown loamy fine sand and very pale brown fine sand. In some areas the dark upper layers are more than 20 inches thick. In other areas the surface layer is loam, very fine sandy loam, or loamy fine sand. In places the subsoil is silty.

Included with this soil in mapping are small areas of Dunday, O'Neill, and Ronson soils. Dunday soils are sandy throughout. They are in upland positions similar to those of the Anselmo soil or are in the slightly higher areas. O'Neill soils formed in 20 to 40 inches of loamy material overlying sand, coarse sand, or gravelly coarse sand. They are on upland divides. Ronson soils are moderately deep over soft sandstone. They are in swales and on side slopes in the uplands. Included soils make up less than 15 percent of the unit.

Permeability is moderately rapid in the Anselmo soil. Available water capacity is moderate. Organic matter content is moderately low. The rate of water intake is moderately high. Runoff is slow.

Most of the acreage is cultivated. The rest supports native grasses and is used for grazing. About half of the cropland is irrigated.

If used for dryland farming, this soil is suited to wheat and alfalfa. Soil blowing is the main hazard in areas where the surface is not protected by crops or crop residue. The soil is somewhat droughty because of the moderate available water capacity. A system of conservation tillage, such as no-till planting or chisel-plant, leaves all or part of the crop residue on the surface and thus helps to control soil blowing, conserves moisture, and increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suitable. Some land leveling generally is needed if gravity systems are used. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard. Stubble mulch tillage and a cropping system that keeps crops or crop residue on the surface most of the time help to control soil blowing and conserve moisture. Applications of feedlot manure increase the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The climax vegetation is dominantly little bluestem, sand bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, western wheatgrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. If the range is in

excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

This soil is suited to the trees and shrubs grown as windbreaks. If trees are planted, insufficient seasonal rainfall is a hazard. An irrigation system may be needed. Soil blowing can be controlled by growing cover crops between the tree rows. Grasses and weeds that compete for moisture can be controlled by timely cultivation and by applications of approved herbicide.

This soil generally is suitable as a site for septic tank absorption fields and dwellings. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The road damage caused by frost action can be minimized by establishing good surface drainage. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are 11e-3, dryland, and 11e-8, irrigated; Sandy range site; windbreak suitability group 5.

**AnC—Anselmo fine sandy loam, 2 to 6 percent slopes.** This deep, gently sloping, well drained soil is on upland divides and side slopes dissected by drainageways. It formed in loamy and sandy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 14 inches thick. The subsoil is about 24 inches thick. It is very friable. It is dark brown fine sandy loam in the upper part and brown sandy loam in the lower part. The underlying material to a depth of more than 60 inches is pale brown loamy fine sand. In some places the dark upper layers are more than 20 inches thick. In other places the surface layer is loam or loamy fine sand.

Included with this soil in mapping are small areas of Dunday, O'Neill, Ronson, and Valentine soils. Dunday and Valentine soils are sandy throughout. Valentine soils have a surface layer that is thinner and lighter colored than that of the Anselmo soil. O'Neill soils formed in 20 to 40 inches of loamy material overlying sand, coarse sand, or gravelly coarse sand. Ronson soils are moderately deep over soft sandstone. Dunday, O'Neill, and Ronson soils are in positions on upland divides and side slopes similar to those of the Anselmo

soil. Valentine soils are on the higher hummocky uplands. Included soils make up less than 15 percent of the unit.

Permeability is moderately rapid in the Anselmo soil. Available water capacity is moderate. Organic matter content is moderately low. The rate of water intake is moderately high. Runoff is slow.

About half of the acreage is used for dryland or irrigated crops. The rest supports native grasses and is used for grazing or hay.

If used for dryland farming, this soil is suited to wheat and alfalfa. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch tillage, and stripcropping conserve moisture and help to prevent excessive soil loss. Contour farming and cover crops also help to control erosion. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Contour farming, stripcropping, and conservation tillage help to control water erosion. Disking and other tillage practices that keep crop residue on the surface help to control water erosion and soil blowing, conserve moisture, and increase the rate of water intake. Applying feedlot manure increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, western wheatgrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the

watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. If trees are planted, insufficient seasonal rainfall is a hazard. An irrigation system may be needed. Growing cover crops between the tree rows helps to control soil blowing and water erosion. Grasses and weeds that compete for moisture can be controlled by timely cultivation and by applications of approved herbicide.

This soil generally is suitable as a site for septic tank absorption fields and dwellings. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. The road damage caused by frost action can be minimized by establishing good surface drainage. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are Ille-3, dryland, and Ille-8, irrigated; Sandy range site; windbreak suitability group 5.

**AnD—Anselmo fine sandy loam, 6 to 11 percent slopes.** This deep, strongly sloping, well drained soil is on breaks below silty uplands and on ridges and side slopes in the uplands. It formed in loamy and sandy eolian material. Areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 10 inches thick. The subsoil is brown, very friable fine sandy loam about 23 inches thick. The underlying material to a depth of more than 60 inches is pale brown loamy fine sand and fine sand. In some places the surface layer is loam or loamy fine sand. In other places the dark upper layers are more than 20 inches thick.

Included with this soil in mapping are small areas of Dunday and Valentine soils. These soils are sandy throughout. Valentine soils have a surface layer that is thinner and lighter colored than that of the Anselmo soil. Dunday soils are in positions on side slopes similar to those of the Anselmo soil. Valentine soils are in the higher positions on hummocky or rolling sandhills. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Anselmo soil. Available water capacity is moderate. Organic matter content is moderately low. The rate of water intake is moderately high. Runoff is medium.

About half of the acreage supports native grasses and is used for grazing or hay. The rest is cultivated. Most of the cropland is irrigated.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Soil blowing is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. Water erosion also is a hazard in these areas. A system of conservation tillage, such as stubble mulch tillage, and stripcropping help to control soil blowing and water erosion and conserve moisture. Conserving available moisture is important because of the moderate available water capacity. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation because of the slope. Wheel-track erosion can be a problem if a center-pivot system is used. Soil blowing and water erosion are hazards if the surface is not protected. Contour farming, conservation tillage, and a cropping system that keeps crops, grass, or crop residue on the surface help to control runoff and erosion. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, western wheatgrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass

decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Insufficient moisture, soil blowing, and water erosion are the principal hazards. Soil blowing can be controlled by strips of sod or a cover crop between the tree rows. Planting the trees on the contour and terracing help to control runoff and water erosion. Competing weeds and grasses in the tree rows can be controlled by careful applications of approved herbicide and by rototilling or hand hoeing. Cultivating between the tree rows with conventional equipment can control the undesirable grasses and weeds in areas where sod strips and cover crops are not used. Irrigation is needed during dry periods.

This soil generally is suitable as a site for septic tank absorption fields and dwellings. Land shaping and

installing septic tank absorption fields on the contour help to ensure that absorption systems function properly. On sites for sewage lagoons, grading is required to modify the slope and shape the lagoon. Lining or sealing the lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads. The road damage caused by frost action can be minimized by establishing good surface drainage. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IVe-3, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 5.

**AtF—Anselmo-Brunswick fine sandy loams, 11 to 30 percent slopes.** These moderately steep and steep, well drained soils are on upland side slopes dissected by drainageways and on the lower parts of side slopes in canyons. The deep Anselmo soil generally is on the upper part of the side slopes. It formed in loamy and sandy eolian material. The moderately deep Brunswick soil generally is on the lower part of the side slopes. It formed in material weathered from soft sandstone. Areas range from 5 to 640 acres in size. They are 40 to 60 percent Anselmo soil and 20 to 40 percent Brunswick soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Anselmo soil has a surface layer of dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 5 inches thick. The subsoil is very friable fine sandy loam about 17 inches thick. It is brown in the upper part and light yellowish brown in the lower part. The underlying material to a depth of more than 60 inches is very pale brown fine sandy loam, loamy fine sand, and fine sand. In some places the dark upper layers are more than 20 inches thick. In other places the surface layer is loam or loamy fine sand.

Typically, the Brunswick soil has a surface layer of grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is very friable fine sandy loam about 22 inches thick. It is brown in the upper part, grayish brown in the next part, and very pale brown in the lower part. The underlying material is very pale brown fine sandy loam about 7 inches thick. White and pale yellow, soft sandstone is at a depth of about 33 inches. In some places the surface layer is dark and is

more than 7 inches thick. In other places it is loam or loamy fine sand.

Included with these soils in mapping are small areas of Inavale, Meadin, Tassel, and Valentine soils. Inavale soils are stratified and are sandier than the Anselmo and Brunswick soils. They are in narrow areas on the bottom land. Meadin soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. They are on narrow ridges and the upper part of the side slopes. Tassel soils are shallow over soft sandstone. They are on the steeper breaks. Valentine soils are sandy throughout. They are on hummocky uplands. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Anselmo and Brunswick soils. Available water capacity is moderate in the Anselmo soil and low in the Brunswick soil. Organic matter content is moderately low in the Anselmo soil and low in the Brunswick soil. Runoff is medium on the Anselmo soil and rapid on the Brunswick soil.

All of the acreage supports native grasses and is used for grazing or hay. These soils generally are unsuitable for cultivation because of the slope.

If these soils are used as range, the climax vegetation is dominantly little bluestem, sand bluestem, needleandthread, prairie sandreed, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, western wheatgrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities and the steeper slopes may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing

use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils generally are not suited to the trees and shrubs grown as windbreaks because of the slope. Onsite investigation is needed to determine if trees and shrubs can be planted after special site preparation.

In areas where slopes are more than 15 percent, these soils generally are not suitable as sites for sanitary facilities. A suitable alternative site is needed. In areas where slopes are 11 to 15 percent, installing septic tank absorption fields on the contour and land shaping help to ensure that absorption systems function properly. The Brunswick soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. Building up or mounding the site with suitable fill material improves the filtering capacity of the field. On the Anselmo soil, the sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads.

The capability unit is Vle-3, dryland; Sandy range site; windbreak suitability group 10.

**Ba—Barney fine sandy loam, channeled.** This deep, nearly level, poorly drained soil is on low bottom land. It is frequently flooded. It formed in loamy alluvium over sandy alluvium. Slopes range from 0 to 2 percent. Areas generally are long and narrow and range from 40 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is stratified grayish brown and dark grayish brown, very friable fine sandy loam about 3 inches thick. Below this is a transition layer of grayish brown, mottled, very friable loamy sand about 3 inches thick. The underlying material extends to a depth of more than 60 inches. It is dominantly light gray,

mottled sand in the upper part and light brownish gray coarse sand in the lower part, but it has thin strata of loamy material throughout. In some places the surface layer is dark and is less than 7 inches thick. In other places it is loam or loamy fine sand. In a few areas gravelly coarse sand is in the underlying material.

Included with this soil in mapping are a few small areas of Bolent and Inavale soils. Also included are marshy areas. These either are on the lower parts of the bottom land or are near foot slopes in areas bordering drainageways. They result from seepage of underground water from the uplands. Bolent and Inavale soils are in the higher positions on the bottom land. Bolent soils are somewhat poorly drained, and Inavale soils are somewhat excessively drained. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the surface layer of the Barney soil and rapid in the underlying material. Available water capacity is low. Organic matter content is moderate. Runoff is very slow. The seasonal high water table is at the surface in wet years and at a depth of about 2 feet in dry years.

Most of the acreage supports native grasses and is used mainly for grazing or hay. Some areas are covered with trees and shrubs. This soil generally is too wet for use as cropland.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, various sedges, and rushes. These species make up 80 percent or more of the total annual forage. Plains bluegrass and other perennial grasses, forbs, and sedges make up the remaining 20 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially these species are replaced by slender wheatgrass, plains bluegrass, green muhly, various sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is about 2.1 animal unit months per acre. This soil generally is not grazed during the growing season but is used for grazing in fall and winter. It can produce high yields, but the forage is of low quality. Proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous and the

yields of hay remain high. The native plants produce rather coarse hay. Interseeding of adapted, early maturing, cool-season grasses can improve the quality of the hay where soil conditions allow early cutting. The optimum time for mowing is prior to the emergence of seedheads. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. In some years forage cannot be harvested because of the wetness. A proper mowing sequence should be followed. Mowing should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil generally is not suited to the trees and shrubs grown as windbreaks because of the high water table. A few areas can be used for water-tolerant trees and shrubs that enhance recreational areas or wildlife habitat if they are hand planted or other special management is applied.

This soil generally is not suitable as a site for sanitary facilities or dwellings because of the flooding and the wetness. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness.

The capability unit is Vlw-7, dryland; Wetland range site; windbreak suitability group 10.

**Bd—Bolent fine sandy loam, 0 to 2 percent slopes.**

This deep, nearly level, somewhat poorly drained soil is on bottom land along the major streams and tributaries. It is occasionally flooded. It formed in sandy alluvium. Areas generally are long and narrow and range from 5 to more than 150 acres in size.

Typically, the surface layer is light brownish gray, friable fine sandy loam about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is light gray loamy fine sand in the upper part; white, mottled fine sand stratified with fine sandy loam in the next part; and white, mottled fine sand in the lower part. In some places the underlying material is sand, coarse sand, or gravelly coarse sand. In other places the surface layer is loamy sand, loamy fine sand, or very fine sandy loam.

Included with this soil in mapping are small areas of Almeria, Barney, and Inavale soils. Almeria and Barney soils are in the lower positions on the bottom land. Almeria soils are poorly drained or very poorly drained.

Barney soils are poorly drained. Inavale soils are somewhat excessively drained and are on the higher parts of the bottom land. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Bolent soil. Available water capacity is low. Organic matter content is moderately low. Runoff is very slow. The rate of water intake is very high. Depth to the seasonal high water table ranges from 1.5 feet in wet years to about 3.5 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. If cultivated, this soil generally is used for alfalfa.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Flooding may delay planting in spring and limit the production of wheat. It is of short duration, however, and seldom causes severe crop damage. Alfalfa can be grown in areas where the water table is not too high. The high water table may delay cultivation in spring. Planting alfalfa and other close-growing crops eliminates the need for working the soil in spring and helps to control soil blowing when the surface is dry. A system of conservation tillage, such as stubble mulch tillage, and a cropping system that keeps crop residue on the surface most of the time reduce the hazard of soil blowing. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If irrigated, this soil is poorly suited to alfalfa and introduced grasses. If flooding is controlled, alfalfa is a suitable crop in irrigated areas. The soil is too sandy for gravity irrigation. A sprinkler system is the best method of irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Open drains or tile drains can reduce the wetness if suitable outlets are available. Stubble mulch tillage and winter cover crops are needed to control soil blowing.

If this soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass. These species make up 80 percent or more of the total annual forage. Various sedges, perennial grasses, and forbs make up the remaining 20 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clovers, and other

forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.7 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. The quality of hay is higher when grasses are cut earlier. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring.

This soil is suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a high water table. Establishing seedlings and cultivating between the tree rows can be difficult during wet years. Tillage and tree planting should be delayed until the soil begins to dry. Competing weeds and undesirable grasses in the tree rows can be removed by timely cultivation and by applications of approved herbicide. Soil blowing can be controlled by growing a cover crop between the tree rows.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative site is needed. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough

or cave in unless they are temporarily shored. The excavations should be made during dry periods. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness.

The capability units are IVw-6, dryland, and IVw-11, irrigated; Subirrigated range site; windbreak suitability group 2S.

**Bo—Brocksburg loam, 0 to 1 percent slopes.** This deep, nearly level, well drained soil is on broad upland divides. It formed in 20 to 40 inches of loamy sediment or loess overlying alluvial sand and coarse sand. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 6 inches thick. The subsurface layer is very dark grayish brown, very friable loam about 10 inches thick. The subsoil is firm clay loam about 20 inches thick. The upper part is dark grayish brown, the next part is light olive brown, and the lower part is light yellowish brown. The underlying material extends to a depth of 60 inches or more. It is light yellowish brown sand in the upper part and light gray coarse sand in the lower part. In some places the underlying material is gravelly coarse sand. In other places the surface layer is fine sandy loam. In a few areas it is dark and is less than 20 inches thick.

Included with this soil in mapping are small areas of Johnstown soils. These soils contain more clay in the subsoil than the Brocksburg soil and are more than 40 inches deep to gravelly or sandy material. They are in positions on upland divides similar to those of the Brocksburg soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Brocksburg soil and very rapid in the underlying material. Available water capacity and organic matter content are moderate. The rate of water intake also is moderate. Runoff is slow.

Nearly all of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa grow and mature in the spring, when the amount of rainfall is highest. The principal hazards are soil blowing and drought. A system of conservation tillage and a cropping system that keeps crops or crop residue on the surface most of the year conserve moisture and reduce the hazard of soil blowing. Applications of feedlot manure increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and

introduced grasses. It is suited to both gravity and sprinkler irrigation. Some land leveling may be needed if a gravity system is used, but deep cuts should be avoided because the coarse textured underlying material should not be exposed. Because of a very low available water capacity in the underlying material, drought is a hazard unless irrigation is timely. Carefully managing the application of water helps to prevent the leaching of plant nutrients below the root zone. Leaving crop residue on the surface as a mulch and keeping tillage to a minimum help to control soil blowing and prevent excessive loss of moisture through evaporation. Returning crop residue or green manure crops to the soil and applying feedlot manure increase the content of organic matter and improve tilth.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly big bluestem, little bluestem, sideoats grama, and western wheatgrass. These species make up 65 percent or more of the total annual forage. Indiangrass, switchgrass, blue grama, leadplant, sedges, and annual or perennial grasses and forbs make up the remaining 35 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. Seedling establishment is restricted mainly by droughtiness, competition for moisture from grasses and weeds, and soil blowing. Irrigation can be helpful in establishing the seedlings. Growing a cover crop between the tree rows helps to control soil blowing. Weeds and undesirable grasses can be removed by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings with basements. The foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to

prevent the structural damage caused by the shrinking and swelling of the soil. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarser grained base material helps to ensure better performance.

The capability units are IIs-5, dryland, and IIs-7, irrigated; Silty range site; windbreak suitability group 6G.

**BrD—Brunswick fine sandy loam, 3 to 9 percent slopes.** This moderately deep, gently sloping and strongly sloping, well drained soil is on side slopes in the uplands. It formed in material weathered from soft sandstone bedrock. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is very friable fine sandy loam about 13 inches thick. The upper part is brown, and the lower part is light olive brown and pale olive. The underlying material is pale yellow fine sand about 19 inches thick. White, soft sandstone is at a depth of about 36 inches. In a few areas the soft sandstone is below a depth of 40 inches.

Included with this soil in mapping are small areas of Anselmo, O'Neill, and Tassel soils. Anselmo soils are not underlain by soft sandstone. They are on the upper part of the side slopes. O'Neill soils are underlain by gravelly coarse sand, coarse sand, or sand. They are in the higher positions on upland side slopes. Tassel soils have sandstone within a depth of 20 inches. They are in the lower positions on upland side slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Brunswick soil. Available water capacity is low. Organic matter content also is low. Runoff is medium. The rate of water intake is moderate.

About half of the acreage is used as irrigated cropland. The rest generally supports native grasses and is used for grazing or hay. A small acreage is used for dryland crops.

If used for dryland farming, this soil is poorly suited to cultivated crops. It is better suited to legumes and introduced grasses for hay or pasture because of the low available water capacity and the moderately deep root zone. Water erosion and soil blowing are hazards. These hazards can be reduced and moisture conserved by a system of conservation tillage that leaves crop residue on the surface most of the time. Contour farming also helps to control water erosion. Returning crop residue or green manure crops to the soil increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and

introduced grasses. A sprinkler system is the best method of irrigation. Because of the moderately deep root zone and the low available water capacity, timely applications of water and carefully selected application rates are needed. Soil blowing and water erosion are hazards. Contour farming and a system of conservation tillage, such as no-till planting, that keeps crop residue on the surface help to control soil blowing and water erosion and conserve moisture. Returning crop residue or green manure crops to the soil increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, needleandthread, and prairie sandreed. These species make up 65 percent or more of the total annual forage. Blue grama, sideoats grama, sedges, and annual and perennial grasses, forbs, and shrubs make up the remaining 35 percent. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases

the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing and water erosion are hazards. They can be controlled by maintaining sod between the tree rows. Drought is a hazard, and competition for moisture from grasses and weeds is a management concern. The trees and shrubs should be watered during periods of low rainfall. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

The depth to bedrock is a limitation if this soil is used as a site for septic tank absorption fields. The layer of suitable filtering material is thin, and seepage is a hazard. Mounding with several feet of suitable fill material improves the filtering capacity of the field. Lining or sealing sewage lagoons helps to prevent seepage. The soil generally is suitable as a site for dwellings. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. The road damage caused by frost action can be minimized by establishing good surface drainage. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IVe-3, dryland, and IVe-7, irrigated; Sandy range site; windbreak suitability group 7.

**DuB—Dunday loamy fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, somewhat excessively drained soil is on uplands and in enclosed sandhill valleys. It formed in sandy eolian material. Areas range from 10 to 320 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. Below this is a transition layer of brown, very friable loamy fine sand about 11 inches thick. The underlying material to a depth of more than 60 inches is pale brown and very pale brown fine sand. In some places the surface layer is fine sandy loam or loamy sand. In other places the dark surface soil is more than 20 inches thick.

Included with this soil in mapping are small areas of Anselmo, Pivot, Ronson, Sandose, and Valentine soils. Anselmo soils have less sand than the Dunday soil. They are in positions on side slopes similar to or slightly lower than those of the Dunday soil. Pivot soils are underlain by coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. They are on the slightly lower side slopes. Ronson soils have less sand than the Dunday soil and are moderately deep over soft

sandstone. They are in swales and in positions on side slopes similar to those of the Dunday soil. Sandose soils have loamy underlying material. They are on the slightly lower side slopes. Valentine soils have a surface layer that is thinner and lighter colored than that of the Dunday soil. They are in positions on uplands similar to those of the Dunday soil or are in the higher hummocky areas. Included soils make up less than 15 percent of the unit.

Permeability is rapid in the Dunday soil. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is very high. Runoff is very slow.

About half of the acreage supports native grasses and is used for grazing or hay. The rest is cultivated. Most of the cropland is irrigated.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the better suited crops because they grow and mature in the spring, when the amount of rainfall is highest. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Soil blowing can be controlled and moisture conserved by a cropping system that keeps crops, grass, or crop residue on the surface. The cropping sequence should include a limited proportion of row crops and the maximum proportion of close-growing crops that protect the surface and conserve moisture. Stripcropping and stubble mulch tillage help to control soil blowing. Returning crop residue to the soil increases the organic matter content.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Stubble mulch tillage and winter cover crops help to control soil blowing. Returning crop residue to the soil increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue

grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Irrigation is needed during droughty periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The soil generally is suitable as a site for dwellings and roads.

The capability units are IVe-5, dryland, and IIIe-11, irrigated; Sandy range site; windbreak suitability group 5.

**DuD—Dunday loamy fine sand, 3 to 9 percent slopes.** This deep, gently sloping and strongly sloping, somewhat excessively drained soil is on side slopes in the uplands. It formed in sandy eolian material. Areas range from 10 to 320 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 14 inches thick. Below this is a transition layer of grayish brown, very friable loamy fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand. In some places the surface layer is loamy sand or fine sandy loam. In other places the dark surface soil is more than 20 inches thick. In a few areas buried loamy layers are in the underlying material.

Included with this soil in mapping are small areas of Anselmo, Ronson, and Valentine soils. Anselmo and Ronson soils have less sand than the Dunday soil. They are in positions on side slopes similar to or slightly lower than those of the Dunday soil. Also, Ronson soils are in upland swales. They are moderately deep over soft sandstone. Valentine soils have a surface layer that is thinner and lighter colored than that of the Dunday soil. They are in upland positions similar to those of the Dunday soil or are in the higher positions on dunes. Included soils make up less than 15 percent of the unit.

Permeability is rapid in the Dunday soil. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is very high. Runoff is very slow.

About two-thirds of the acreage supports native grasses and is used for grazing or hay. The rest is cultivated. Most of the cropland is irrigated.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the better suited crops because they grow and mature in the spring, when the amount of rainfall is highest. Soil blowing and water erosion are hazards if the surface is not adequately protected by crops or crop residue. Soil blowing and water erosion can be controlled and moisture conserved by a cropping system that keeps crops, grass, or crop residue on the surface. The cropping sequence should include a limited proportion of row crops and the maximum proportion of close-growing crops that protect the surface and conserve moisture. Stripcropping and stubble mulch tillage help to control soil blowing and water erosion. Returning crop residue to the soil increases the organic matter content.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed.

Excessive irrigation leaches plant nutrients below the root zone. Soil blowing and water erosion are hazards if the surface is not adequately protected by crops or crop residue. Stubble mulch tillage and winter cover crops help to control soil blowing and water erosion. Returning crop residue to the soil increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 80 percent or more of the total annual forage. Switchgrass, sedges, and annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs.

If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the water facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Irrigation is needed during droughty periods. Soil blowing and water erosion can be controlled by strips of sod or other vegetation between the tree rows. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded.

The capability units are IVe-5, dryland, and IVe-11, irrigated; Sandy range site; windbreak suitability group 5.

**Eo—EIs loamy sand, 0 to 2 percent slopes.** This deep, nearly level, somewhat poorly drained soil is on bottom land in sandhill valleys. It is subject to rare flooding. It formed in mixed eolian and alluvial sandy material. Areas range from 10 to 600 acres in size.

Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. Below this is a transition layer of brown, loose loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is fine sand. It is pale brown in the upper part, light gray and mottled in the next part, and white and mottled in the lower part. In some places the surface layer is dark and is more than 10 inches or less than 5 inches thick. In other places it is fine sand. In some areas loamy strata are below a depth of 40 inches.

Included with this soil in mapping are small areas of lpage, Tryon, and Valentine soils. lpage soils are on low hummocks and are moderately well drained. Tryon soils are on the lower bottom land on sandhill valley floors. They are poorly drained or very poorly drained. Valentine soils are in the highest positions on dunes and are excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the EIs soil. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is very high. Runoff is slow. Depth to the seasonal high water table ranges from about 1.5 feet in wet years to 3.0 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. A small acreage is used as cropland, most of which is irrigated.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wetness delays planting in spring and may prevent cultivation during the wettest periods. During dry periods the water table can be beneficial to grasses and growing crops, but it may drown out wheat and alfalfa in places. Soil blowing is a hazard in cultivated areas. It can be controlled by applying a conservation tillage system, returning crop residue to the soil, and planting winter cover crops or close-growing crops. Applying feedlot manure increases the organic matter content.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is too sandy for gravity irrigation. A sprinkler system is the best method of irrigation. Timely applications of water and carefully selected application rates are needed to prevent waterlogging of the soil and deep leaching of plant nutrients. Tiling normally is not required in irrigated areas, but wetness may be a problem during some periods. Soil blowing can be controlled by applying a conservation tillage system that keeps crops or crop residue on the surface or by planting winter cover crops and growing close-growing crops. Applying feedlot manure increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, indiagrass, and switchgrass. These species make up 85 percent or more of the total annual forage. Prairie cordgrass, sedges, and other perennial grasses make up the remaining 15 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clovers, and other forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.7 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils.

Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. The maximum storage of these food reserves is completed by the first frost. The quality of hay is higher when grasses are cut earlier. A proper mowing height helps to maintain the stand of grasses and high forage production. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring.

This soil is suited to the trees and shrubs grown as windbreaks. The species selected for planting should be those that can tolerate occasional wetness. In some years establishing seedlings and cultivating between the tree rows are difficult because of the wetness. Planting should be delayed until the soil begins to dry. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Soil blowing can be controlled by growing a cover crop between the tree rows.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Fill material can elevate the absorption field a sufficient distance above the seasonal high water table. Lining or sealing sewage lagoons helps to prevent seepage. Fill material can raise the bottom of the lagoon above the seasonal high water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods.

Constructing dwellings and other buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent flood damage. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness. The road damage caused by frost action can be minimized by establishing a good surface drainage system and by a gravel

moisture barrier in the subgrade. Crowning the road by grading and establishing adequate roadside ditches help to provide needed surface drainage.

The capability units are IVw-5, dryland, and IVw-12, irrigated; Subirrigated range site; windbreak suitability group 2S.

#### **EpB—Els-lpage fine sands, 0 to 3 percent slopes.**

These deep, nearly level and very gently sloping soils are on bottom land in sandhill valleys. The somewhat poorly drained Els soil is in swales that are subject to rare flooding. The moderately well drained lpage soil is on low sandy ridges that are not flooded. Both soils formed in sandy eolian and alluvial material. Areas range from 10 to 1,000 acres in size. They are 50 to 65 percent Els soil and 20 to 35 percent lpage soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Els soil has a surface layer of grayish brown, very friable fine sand about 6 inches thick. Below this is a transition layer of brown, very friable fine sand about 6 inches thick. The underlying material to a depth of 60 inches or more is mottled fine sand. It is pale brown in the upper part and light gray in the lower part. In some places the dark surface layer is 10 or more inches thick. In other places loamy material or gravelly coarse sand is below a depth of 40 inches.

Typically, the lpage soil has a surface layer of grayish brown, very friable fine sand about 7 inches thick. Below this is a transition layer of brown, very friable fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is fine sand. It is pale brown in the upper part, light gray in the next part, and pale brown in the lower part. Mottles are below a depth of 35 inches. In places gravelly coarse sand is at a depth of 20 to 40 inches.

Included with these soils in mapping are small areas of Loup, Tryon, and Valentine soils. Loup and Tryon soils are on the slightly lower parts of the bottom land. They are poorly drained or very poorly drained. Loup soils have a dark surface layer that is thicker than that of the Els and lpage soils. Valentine soils are on the higher hummocky uplands and sandhills. They are better drained than the Els and lpage soils. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Els and lpage soils. Available water capacity is low. Organic matter content is moderately low in the Els soil and low in the lpage soil. The rate of water intake is very high in both soils. Runoff is slow. Depth to the seasonal high water table in the Els soil ranges from about 1.5 feet in wet years to 3.0 feet in dry years. Depth to the seasonal high water table in the lpage soil ranges from about 3 feet in wet years to 6 feet in dry years.



Figure 5.—Hay meadow in an area of Els-lpage fine sands, 0 to 3 percent slopes.

Most of the acreage supports native grasses and is used for grazing or hay (fig. 5). The remaining acreage is mostly irrigated cropland.

These soils are unsuited to dryland farming because of droughtiness and the hazard of soil blowing. If irrigated, they are suited to corn, alfalfa, and introduced grasses. They are too sandy for gravity irrigation but can be irrigated by sprinklers. Soil blowing is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. Wetness is a management concern in some of the low areas. Soil blowing can be controlled by planting cover crops and close-growing crops and by applying tillage methods that leave crop residue on the surface. Carefully selected water application rates are needed because overirrigating can inundate low areas and leach plant nutrients below the root zone. Timely applications are needed because of the low available water capacity.

If these soils are used as range or native hayland, the climax vegetation on the Els soil is dominantly big bluestem, little bluestem, indiagrass, and switchgrass. These species make up 85 percent or more of the total annual forage on this soil. Prairie cordgrass, sedges, and other annual and perennial grasses make up the remaining 15 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are

replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clovers, and other forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

The climax vegetation on the lpage soil is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage on this soil. Blue grama, switchgrass, indiagrass, sedges, and other annual and perennial grasses and forbs make up the remaining 30 percent. Under continuous heavy grazing, sand bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is

1.7 on the Els soil and 1.0 on the lpage soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs grown as windbreaks. The species selected for planting on the Els soil should be those that can tolerate occasional wetness. Establishing seedlings can be difficult on this soil during wet years. Tillage and tree planting should be delayed until the soil dries out. The lpage soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Irrigation may be needed during dry periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Young seedlings may be damaged by sand blasting or covered by drifting sand during periods of high winds. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Fill material can elevate the absorption field a sufficient distance above the seasonal high water table. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoon on fill material raises the bottom of the lagoon a sufficient height above the water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored. In areas of the Els soil, digging

should be limited to dry periods, when machinery can be operated more easily.

The lpage soil generally is suitable as a site for dwellings without basements. If dwellings or other buildings are constructed on the Els soil or dwellings with basements are constructed on the lpage soil, well compacted fill material is needed to raise the site above the seasonal high water table. Raising the site also provides protection against floodwater on the Els soil. The road damage caused by frost action can be minimized by establishing a good surface drainage system and by a gravel moisture barrier in the subgrade. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness in areas of the Els soil.

The capability units are V1e-5, dryland, and IVe-12, irrigated. The Els soil is in the Subirrigated range site and windbreak suitability group 2S. The lpage soil is in the Sandy Lowland range site and windbreak suitability group 7.

**Es—Elsmere loamy fine sand, 0 to 2 percent slopes.** This deep, nearly level, somewhat poorly drained soil is on bottom land and in depressed areas in sandhill valleys. It is subject to rare flooding. It formed in mixed eolian and alluvial sandy material. Areas range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is very dark gray, very friable loamy fine sand about 8 inches thick. Below this is a transition layer of light brownish gray, loose fine sand about 9 inches thick. The underlying material to a depth of more than 60 inches is light gray, mottled fine sand. In a few places the dark surface layer is less than 10 inches thick. In some areas thin layers of loamy material are at a depth of 20 to 60 inches. In a few areas coarse sand or gravelly coarse sand is below a depth of 30 inches.

Included with this soil in mapping are small areas of lpage, Loup, and Tryon soils. lpage soils are in the higher positions on small hummocks or low ridges. They are better drained than the Elsmere soil. Loup and Tryon soils are on the slightly lower parts of the bottom land. They are poorly drained or very poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Elsmere soil. Available water capacity is low. Organic matter content is moderate. The rate of water intake is very high. Runoff is slow. Depth to the seasonal high water table ranges from 1.5 feet in wet years to about 3.0 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. The rest is used as cropland.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. During dry periods the water table subirrigates the soil. Cultivating the soil is difficult early in the spring because of the high water table. Planting close-growing crops eliminates the need for tilling the soil in spring and helps to control soil blowing when the surface is dry. The water table may drown out wheat and alfalfa in places. Keeping crop residue on the surface helps to control soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is too sandy for gravity irrigation. A sprinkler system is the best method of irrigation. Timely applications of water and carefully selected application rates are needed to prevent waterlogging of the soil and deep leaching of plant nutrients. Tilling normally is not required in irrigated areas, but wetness may be a problem during some periods. Soil blowing can be controlled by applying a conservation tillage system that keeps crops or crop residue on the surface or by planting winter cover crops and close-growing crops. Applying feedlot manure increases the organic matter content.

If this soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, switchgrass, indiagrass, and prairie cordgrass. These species make up 75 percent or more of the total annual forage. Plains bluegrass, slender wheatgrass, sedges, perennial grasses, and forbs make up the remaining 25 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clovers, and other forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.7 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils.

Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. The maximum storage of these food reserves is completed by the first frost. The quality of hay is higher when grasses are cut earlier. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring.

This soil is suited to the trees and shrubs grown as windbreaks. The species selected for planting should be those that can tolerate occasional wetness. In some years establishing seedlings and cultivating between the tree rows are difficult because of the wetness. Planting should be delayed until the soil begins to dry. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Soil blowing can be controlled by growing a cover crop between the tree rows. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Fill material can elevate the absorption field a sufficient distance above the seasonal high water table. Lining or sealing sewage lagoons helps to prevent seepage. Fill material can raise the bottom of the lagoon above the seasonal high water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods.

Constructing dwellings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent flood damage. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness. The road damage caused by frost action can be minimized by establishing

a good surface drainage system and by a gravel moisture barrier in the subgrade. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IVw-5, dryland, and IVw-11, irrigated; Subirrigated range site; windbreak suitability group 2S.

**Fe—Fluvaquents, sandy.** These deep, nearly level, very poorly drained soils are in oxbows and low bottom land bordering the larger streams. They are frequently flooded. They formed in recently deposited sandy alluvium. Slopes range from 0 to 2 percent. Areas range from 5 to 25 acres in size.

Typically, the surface layer is grayish brown and light brownish gray, stratified, very friable loamy fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light gray sand that has thin strata of coarse sand and loamy material. In a few areas the soils have a thin or thick surface layer of partially decomposed plant material. The texture and color of the soils vary widely from one area to another.

Included with these soils in mapping are small areas of Almeria soils, small areas of open water more than 2 feet deep, and areas of riverwash. Almeria soils are on the slightly higher parts of the bottom land. They are poorly drained or very poorly drained. The areas of open water are in former stream channels and oxbows. The areas of riverwash support no vegetation. They are in bottom land positions slightly lower than those of the Fluvaquents. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Fluvaquents. Available water capacity is low. Organic matter content ranges from low to high. The seasonal high water table is as much as 2 feet above the surface in wet years to a depth of about 1 foot in dry years. The soils have water on the surface for long periods during most years. Runoff is ponded.

These soils provide good habitat for wetland wildlife. They are too wet for cultivated crops, hay, and range. The vegetation on these soils is not palatable to livestock. It is dominantly indigobush, willows, cattails, ferns, rushes, arrowhead, and other water-tolerant plants. Because of the vegetation, the soils provide good nesting sites and cover for wildlife.

These soils are not suited to the trees and shrubs grown as windbreaks because of the wetness and the flooding. A few marginal areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat. Hand planting or other special management is needed.

These soils generally are not suitable as sites for sanitary facilities or dwellings because of the ponding

and the flooding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of ponding and flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by ponding, flooding, and wetness.

The capability unit is VIIIw-7, dryland; windbreak suitability group 10. No range site is assigned.

**Gn—Gannett fine sandy loam, 0 to 2 percent slopes.** This deep, nearly level, poorly drained soil is in depressions in sandhill valleys. It is subject to rare flooding. It formed in eolian or water-worked sandy and silty material. Areas range from 10 to 200 acres in size.

Typically, the surface layer is very dark gray, friable fine sandy loam about 6 inches thick. The subsurface layer is very dark gray, friable loam about 13 inches thick. Below this is a transition layer of dark gray, friable fine sandy loam about 4 inches thick. The underlying material extends to a depth of 60 inches or more. It is light gray loamy sand in the upper part and light gray fine sand in the lower part. In places the surface layer is loamy fine sand or loam.

Included with this soil in mapping are small areas of Elsmere, Loup, and Marlake soils. Elsmere soils are better drained than the Gannett soil. They are in the slightly higher depressed areas and on bottom land. They contain more sand throughout than the Gannett soil. Loup soils are on the slightly lower bottom land. They contain more sand in the solum than the Gannett soil. Marlake soils are in the lowest depressional areas and have water on the surface for most of the growing season. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Gannett soil and rapid in the underlying material. Available water capacity is moderate. Organic matter content is high. Runoff is very slow. The seasonal high water table is at the surface in wet years and at a depth of 1.5 feet in dry years. The water table normally recedes to a depth of 2 to 3 feet by late summer.

Nearly all of the acreage supports native grasses and is used for grazing or hay. This soil generally is too wet for cultivation.

If this soil is used as range, either for grazing or haying, the climax vegetation is dominantly switchgrass, indiagrass, prairie cordgrass, and big bluestem. These species make up 65 percent or more of the total annual forage. Northern reedgrass, slender wheatgrass, plains bluegrass, and other perennial grasses, forbs, and sedges make up the remaining 35 percent. Under continuous heavy grazing or improper haying, big bluestem, northern reedgrass, prairie cordgrass, switchgrass, and indiagrass decrease in abundance.

Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, plains bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying activities generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is suited to water-tolerant trees and shrubs grown as windbreaks. Wetness is the main limitation. Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Competing weeds and undesirable

grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil generally is not suitable as a site for sanitary facilities because of the wetness. A suitable alternative site is needed. Constructing dwellings and other buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater and helps to overcome the wetness caused by the high water table. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by wetness and flooding. The road damage caused by frost action can be minimized by establishing a good surface drainage system and a good moisture barrier in the subgrade. Crowning the road by grading also helps to protect the roads from frost action.

The capability unit is Vw-5, dryland; Wet Subirrigated range site; windbreak suitability group 2D.

**IdB—Inavale loamy fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, somewhat excessively drained soil is on the highest part of flood plains. It is subject to rare flooding. It formed in sandy alluvium. Areas range from 5 to 200 acres in size.

Typically, the surface layer is gray, very friable loamy fine sand about 8 inches thick. Below this is a transition layer of light brownish gray, loose fine sand that has thin strata of darker very fine sandy loam. This layer is about 12 inches thick. The underlying material to a depth of 60 inches is light gray fine sand that has thin strata of darker fine sandy loam. In some areas coarse sand or gravelly coarse sand is below a depth of 20 inches. In a few places the surface layer is very fine sandy loam, fine sandy loam, or sand.

Included with this soil in mapping are small areas of Bolent soils. Also included are areas where the slope is more than 3 percent. Bolent soils are in the lower positions on the bottom land and are somewhat poorly drained. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow. The water table is normally below a depth of 6 feet but may be higher in spring, when nearby streams are at full flow because of runoff and snowmelt.

Most of the acreage supports native grasses and is used for grazing or hay. A few small areas are used as cropland.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the most dependable crops

because they mature in the spring, when the amount of rainfall is higher. Soil blowing is a hazard. Soil blowing can be controlled, moisture conserved, and the organic matter content increased by a cropping system that keeps crops, grass, or crop residue on the surface.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation because of the very high rate of water intake. It is too sandy for gravity irrigation. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing. Returning crop residue or green manure crops to the soil and applying feedlot manure increase the organic matter content. Efficient management of irrigation water is needed. Excessive amounts of water can leach plant nutrients below the root zone. Frequent applications of water are needed because of the low available water capacity.

If this soil is used as range or native hayland, the climax vegetation is dominantly sand bluestem, prairie sandreed, little bluestem, and needleandthread. These species make up 80 percent or more of the total annual forage. Switchgrass, porcupinegrass, sedges, and other annual and perennial grasses and forbs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.0 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter

range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing is a hazard. Young seedlings can be damaged by sand blasting or covered by drifting sand during periods of high winds. Seedlings should be planted in shallow furrows with as little disturbance of the surface as possible. Strips of sod or other vegetation between the tree rows help to control soil blowing and the growth of weeds. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of excavations can slough or cave in unless they are temporarily shored. Constructing dwellings and other buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding.

The capability units are IVE-5, dryland, and IIIe-11, irrigated; Sandy Lowland range site; windbreak suitability group 7.

**IkB—Inavale sand, channeled.** This deep, nearly level and very gently sloping, somewhat excessively drained soil is on narrow flood plains along streams. It is occasionally flooded. It formed in sandy alluvium. Slopes range from 0 to 3 percent. Areas are long and narrow and are dissected by old dry creekbeds and channels that meander through the flood plains. They range from 10 to 400 acres in size.

Typically, the surface layer is pale brown, loose sand about 6 inches thick. Below this is a transition layer of very pale brown sand about 11 inches thick. The underlying material extends to a depth of more than 60 inches. It is light gray coarse sand in the upper part and light gray and light brownish gray loamy sand in the lower part. Thin strata of loamy material are throughout the profile. In some places the surface layer is loamy



Figure 6.—An area of Inavale sand, channeled, along Bone Creek in Keller Park.

sand. In other places the underlying material is gravelly coarse sand.

Included with this soil in mapping are small areas of Almeria and Bolent soils; soils that have short, steep slopes; and Fluvaquents, sandy. The poorly drained and very poorly drained Almeria soils and somewhat poorly drained Bolent soils are in the lower positions on the flood plains. The very poorly drained Fluvaquents are in oxbows and on low bottom land. The soils that have short, steep slopes are on escarpments along drainageways. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. Available water capacity is low. Organic matter content also is low. Runoff is slow. The water table is typically below a depth of 6 feet.

Nearly all of the acreage supports native grasses and is used for grazing. Some areas are used for recreational purposes or wildlife habitat (fig. 6). This soil

is unsuitable for cultivation because of inaccessibility and the hazards of flooding and erosion. The narrowness and inaccessibility of the flood plains limit the suitability for hay.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, porcupinegrass, little bluestem, and prairie sandreed. These species make up 80 percent or more of the total annual forage. Switchgrass, needleandthread, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.0 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying help to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

This soil generally is not suited to the trees and shrubs grown as windbreaks because of the hazard of flooding. Some areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied. Wooded or brushy areas that are not used for grazing can provide habitat for wildlife.

This soil is not suitable as a site for septic tank absorption fields, sewage lagoons, or dwellings because of the flooding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding.

The capability unit is VIw-5, dryland; Sandy Lowland range site; windbreak suitability group 10.

**In—Inavale-Barney complex, channeled.** These deep soils are on bottom land along major drainageways. They are dissected by stream channels that meander across the flood plains. The Inavale soil is somewhat excessively drained, is occasionally flooded, and is on the highest part of the bottom land. The Barney soil is poorly drained, is frequently flooded, and is on the lowest part of the bottom land. The Inavale soil formed in sandy alluvium. The Barney soil formed in loamy alluvium over sandy alluvium. Slopes range from 0 to 2 percent. Areas are long and narrow and range from 10 to more than 300 acres in size. They are 35 to 60 percent Inavale soil and 25 to 50 percent Barney soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Inavale soil has a surface layer of pale brown, very friable, stratified fine sandy loam and loamy fine sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 4

inches thick. The underlying material to a depth of more than 60 inches is very pale brown sand. Thin strata of loamy material are in the subsurface layer and underlying material. In some places the surface layer is fine sand or sand. In other places the underlying material has layers of coarse sand or gravelly coarse sand.

Typically, the Barney soil has a surface layer of grayish brown, mottled, very friable, stratified fine sandy loam about 3 inches thick. The underlying material extends to a depth of more than 60 inches. It is stratified grayish brown and light gray, mottled loamy fine sand and sand in the upper 4 inches and light gray gravelly sand in the lower part. In some places the surface layer is loam or loamy sand. In other places the underlying material is coarse sand or gravelly coarse sand.

Included with these soils in mapping are small areas of Bolent soils; soils that have short, steep slopes; and Fluvaquents, sandy. Bolent soils are somewhat poorly drained and are in the slightly higher positions on the flood plains. The Fluvaquents are very poorly drained. They are in the lower positions in old oxbows and along stream channels. The soils that have short, steep slopes are on streambanks. They are being eroded by the channels. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. It is moderately rapid in the surface layer of the Barney soil and rapid in the underlying material. Available water capacity is low in both soils. Organic matter content is moderate in the Barney soil and low in the Inavale soil. In most years the seasonal high water table in the Barney soil is within a depth of about 2 feet. The water table in the Inavale soil is typically below a depth of 6 feet. Runoff is slow on the Inavale soil and very slow on the Barney soil.

Nearly all of the acreage supports native grasses and is used for grazing. Some areas are covered with trees and shrubs. These soils are unsuitable for dryland and irrigated crops because of inaccessibility and the hazard of flooding.

If these soils are used as range, the climax vegetation on the Inavale soil is dominantly sand bluestem, porcupinegrass, little bluestem, and prairie sandreed. These species make up 80 percent or more of the total annual forage on this soil. Switchgrass, needleandthread, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and

forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Barney soil is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and various sedges and rushes. These species make up 80 percent or more of the total annual forage on this soil. Plains bluegrass and other annual and perennial grasses and forbs make up the remaining 20 percent. Under continuous heavy grazing, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, plains bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing continues for many years, bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing causes surface compaction and the formation of small mounds and ruts, which make grazing difficult.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 2.1 on the Barney soil and 1.0 on the Inavale soil. The Barney soil produces high yields, but the forage is of low quality. The forage on the Barney soil is of higher quality early in the growing season. Frequent flooding causes sedimentation, channeling, and the deposition of debris and weed seeds. A planned grazing system that includes proper grazing use, timely deferment of grazing, and restricted use during very wet periods or periods of flooding help to maintain or improve the range condition. Proper grazing use is very effective in controlling soil blowing. The included short, steep slopes can hinder the movement of range animals from one area to another.

These soils generally are not suited to the trees and shrubs grown as windbreaks. Some areas can be used for water-tolerant trees or shrubs that enhance recreational areas or wildlife habitat if they are hand planted or other special management is applied.

These soils are not suitable as sites for sanitary facilities or dwellings because of the flooding and the wetness. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of flooding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness.

The capability unit is Vlw-5, dryland; windbreak suitability group 10. The Inavale soil is in the Sandy Lowland range site, and the Barney soil is in the Wetland range site.

**lpB—lpage fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, moderately well drained soil is in sandhill valleys on low hummocky slopes or low ridges. It formed in sandy eolian and alluvial material. Areas range from 10 to 500 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sand about 7 inches thick. Below this is a transition layer of brown, loose fine sand about 6 inches thick. The underlying material to a depth of 60 inches or more is light gray fine sand. It is mottled below a depth of 31 inches. In some places the surface layer is loamy fine sand, sand, or loamy sand. In other places the underlying material is sand or coarse sand.

Included with this soil in mapping are small areas of Els, Tryon, and Valentine soils. Els and Tryon soils are in the lower positions in the valleys. Els soils are somewhat poorly drained, and Tryon soils are poorly drained. Valentine soils are in the higher positions on ridges and dunes. They are excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the lpage soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow. Depth to the seasonal high water table ranges from about 3 feet in wet years to 6 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. A few areas are used as irrigated cropland. This soil is unsuitable for dryland crops because of droughtiness and the hazard of soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation because of the very high rate of water intake. It is too sandy for gravity irrigation. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing. Returning crop residue or green manure crops to the soil and applying feedlot manure increase the organic matter content. Efficient management of irrigation water is needed. Excessive amounts of water can leach plant nutrients below the root zone. Frequent applications of water are needed because of the low available water capacity.

If this soil is used as range or native hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage. Blue grama, switchgrass, indiagrass, sedges, and other perennial grasses and forbs make up

the remaining 30 percent. Under continuous heavy grazing, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.0 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing is a severe hazard. Seedlings should be planted in shallow furrows with as little disturbance of the surface as possible. Young seedlings can be damaged by sand blasting or covered by drifting sand during periods of high winds. Strips of sod or other vegetation between the tree rows help to control soil blowing and the growth of weeds. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The absorption fields should be

constructed on fill material, so that they are a sufficient distance above the seasonal high water table. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoon on fill material raises the bottom of the lagoon a sufficient height above the seasonal high water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings without basements. Dwellings with basements should be constructed on raised, well compacted fill material. This measure helps to overcome the wetness caused by the high water table. Providing a good surface drainage system and a gravel moisture barrier in the subgrade minimizes the road damage caused by frost action. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are VIe-5, dryland, and IVe-12, irrigated; Sandy Lowland range site; windbreak suitability group 7.

**IsB—lpage loamy sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, moderately well drained soil is on low hummocky slopes in sandhill valleys. It formed in sandy eolian and alluvial material. Areas range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 8 inches thick. Below this is a transition layer of brown, loose fine sand about 6 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown fine sand in the upper part, light gray sand in the next part, and pale brown sand in the lower part. It is mottled below a depth of 35 inches. In some areas the dark surface layer is more than 10 inches thick. In a few places coarse sand or gravelly coarse sand is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Els, Elsmere, and Valentine soils. Els and Elsmere soils are on the lower parts of the bottom land in sandhill valleys. They are somewhat poorly drained. Valentine soils are in the higher positions on ridges, hummocks, and dunes. They are excessively drained. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the lpage soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow. Depth to the seasonal high water table ranges from about 3 feet in wet years to 6 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. A small acreage is used as cropland.

If used for dryland farming, this soil is poorly suited

to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the better suited crops because they grow and mature in the spring, when the amount of rainfall is higher. Soil blowing is a hazard. Establishing crops is sometimes difficult because windblown sand can damage young plants. Soil blowing can be controlled, moisture conserved, and the organic matter content maintained by a cropping system that keeps crops, grass, or crop residue on the surface.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation because of the very high rate of water intake. It is too sandy for gravity irrigation. Efficient management of irrigation water is needed. Excessive amounts of water can leach plant nutrients below the root zone. Frequent applications of water are needed because of the low available water capacity. Returning crop residue to the soil and applying feedlot manure increase the organic matter content. Leaving crop residue on the surface helps to control soil blowing.

If this soil is used as range or native hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage. Blue grama, switchgrass, indiangrass, sedges, and other perennial grasses and forbs make up the remaining 30 percent. Under continuous heavy grazing, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.0 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following

year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Irrigation is needed during droughty periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The absorption fields should be constructed on fill material, so that they are a sufficient distance above the seasonal high water table. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoon on fill material raises the bottom of the lagoon a sufficient height above the seasonal high water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings without basements. Dwellings with basements should be constructed on raised, well compacted fill material. This measure helps to overcome the wetness caused by the high water table. Providing a good surface drainage system and a gravel moisture barrier in the subgrade minimizes the road damage caused by frost action. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IVe-5, dryland, and IVe-11, irrigated; Sandy Lowland range site; windbreak suitability group 5.

**Jn—Jansen fine sandy loam, 0 to 2 percent slopes.** This nearly level, well drained soil is on tableland. It formed in 36 inches of loamy sediment or loess overlying coarse sand and gravelly coarse sand. Areas range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, very friable loam about 6 inches thick. The subsoil is about 24 inches thick. It is brown, friable clay loam in the upper

part; light olive brown, friable loam in the next part; and light yellowish brown, very friable loamy coarse sand in the lower part. The underlying material extends to a depth of 60 inches or more. It is light yellowish brown coarse sand in the upper part and light gray gravelly coarse sand in the lower part. In some places the surface layer is loam or sandy loam. In other places the surface soil is dark and is more than 20 inches thick.

Included with this soil in mapping are small areas of Johnstown, Meadin, O'Neill, and Sandose soils. Also included are small cut areas. All of the included soils are in positions on tableland similar to those of the Jansen soil or are on upland divides. Johnstown soils have sandy or gravelly material at a depth of 40 to 60 inches, have dark upper layers more than 20 inches thick, and contain less sand in the subsoil than the Jansen soil. Meadin soils are less than 20 inches deep to gravelly coarse sand. O'Neill soils have more sand in the subsoil than the Jansen soil. Sandose soils are sandy in the upper part and loamy in the lower part. The small cut areas have a light colored, clayey subsoil or coarse textured underlying material that has been exposed by land leveling. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the underlying material. Available water capacity is moderate. Organic matter content is moderately low. The rate of water intake is moderate. Runoff is slow.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. A system of conservation tillage and a cropping system that keeps crops or crop residue on the surface most of the year conserve moisture and reduce the hazard of soil blowing. Applications of feedlot manure increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Furrow and border irrigation systems are effective in leveled areas. A sprinkler system also is suitable. Avoiding deep cuts when irrigation ditches are established or the landscape is leveled helps to keep irrigation water from seeping through the coarse textured underlying material. Because of a very low available water capacity in the underlying material, drought is a hazard unless irrigation is timely. Carefully managing the application of water helps to prevent leaching plant nutrients below the root zone. Leaving crop residue on the surface helps to control soil blowing. Returning crop residue to the soil increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The climax vegetation is dominantly little bluestem, sand bluestem, blue grama, sand dropseed, needleandthread, and prairie sandreed. These species make up 80 percent or more of the total annual forage. Sedges, purple lovegrass, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 20 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

This soil is suited to the trees and shrubs grown as windbreaks. A cover crop between the tree rows helps to control soil blowing. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Irrigation can be helpful in establishing the seedlings. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings with basements. The foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by the shrinking and swelling of the soil. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material for subgrade or base helps to ensure better performance.

The capability units are 11e-3, dryland, and 11e-7, irrigated; Sandy range site; windbreak suitability group 6G.

**JnC—Jansen fine sandy loam, 2 to 6 percent slopes.** This deep, gently sloping, well drained soil is on side slopes dissected by drainageways and on ridges on upland divides. It formed in 30 inches of loamy sediment or loess overlying coarse sand and gravelly coarse sand. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 8 inches thick. The subsoil is brown, firm clay loam about 15 inches thick. The underlying material extends to a depth of 60 inches or more. It is very pale brown gravelly coarse sand in the upper part, light gray coarse sand in the next part, and white coarse sand in the lower part. In places the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of Johnstown, Meadin, and O'Neill soils. Also included are small cut areas. All of the included soils are in positions on side slopes and upland divides similar to those of the Jansen soil. Johnstown soils have sandy or gravelly material at a depth of 40 to 60 inches, have dark upper layers more than 20 inches thick, and contain less sand in the subsoil than the Jansen soil. Meadin soils are less than 20 inches deep to gravelly coarse sand. O'Neill soils have more sand in the subsoil than the Jansen soil. The small cut areas have a light colored, clayey subsoil or coarse textured underlying material that has been exposed by land leveling. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the underlying material. Available water capacity is moderate. Organic matter content is moderately low. The rate of water intake is moderate. Runoff is medium.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. A system of conservation tillage and a cropping system that keeps crops or crop residue on the surface most of the year conserve moisture and reduce the hazards of water erosion and soil blowing. Applications of feedlot manure increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Contour bench leveling is suitable in some of the less sloping areas irrigated by a gravity system. Because of the slope, controlling the runoff and erosion caused by rainfall and the additional irrigation water is difficult. In areas irrigated by center-pivot sprinkler systems, terraces help to intercept runoff and thus prevent excessive water erosion, especially along wheel tracks. A cover of grasses on the terraces minimizes the depth of the wheel tracks. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control water

erosion and soil blowing and conserves moisture. The rate of water application should be adjusted to the moderate rate of water intake. Returning crop residue or green manure crops to the soil increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing and water erosion. The climax vegetation is dominantly little bluestem, sand bluestem, blue grama, sand dropseed, needleandthread, and prairie sandreed. These species make up 80 percent or more of the total annual forage. Sedges, purple lovegrass, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 20 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

This soil is suited to the trees and shrubs grown as windbreaks. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Growing a cover crop between the tree rows helps to control soil blowing. Planting the trees on the contour and terracing help to control water erosion. Irrigation can be helpful in establishing the seedlings and during periods of low rainfall. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings with basements. The foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Roads should be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance.

The capability units are Ille-3, dryland, and Ille-7, irrigated; Sandy range site; windbreak suitability group 6G.

**Jo—Jansen loam, 0 to 2 percent slopes.** This deep, nearly level, well drained soil is on tableland. It formed in 30 inches of loamy sediment or loess overlying sand and coarse sand. Areas range from 5 to 320 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 8 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown, friable loam in the upper part; brown, firm clay loam in the next part; and pale brown, firm loam in the lower part. The underlying material extends to a depth of 60 inches or more. It is pale brown coarse sand in the upper part and light gray sand in the lower part. In some places the surface layer is fine sandy loam. In other places the surface soil is dark and is more than 20 inches thick. In some areas the subsoil is silty clay loam or silt loam.

Included with this soil in mapping are small areas of Johnstown, Meadin, O'Neill, and Sandose soils. Also included are small cut areas. All of the included soils are in positions on tableland similar to those of the Jansen soil or are on upland divides. Johnstown soils have sandy or gravelly material at a depth of 40 to 60 inches, have dark upper layers more than 20 inches thick, and contain less sand in the subsoil than the Jansen soil. Meadin soils are less than 20 inches deep to gravelly coarse sand. O'Neill soils have more sand in the subsoil than the Jansen soil. Sandose soils are sandy in the upper part and loamy in the underlying material. The small cut areas have a light colored, clayey subsoil or coarse textured underlying material that has been exposed by land leveling. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the underlying material. Available water capacity and organic matter content are moderate. The rate of water intake also is moderate. Runoff is slow.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. A system of conservation tillage and a cropping system that keeps crops or crop residue on the surface most of the year conserve moisture and reduce the hazard of soil blowing. Applications of feedlot manure increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Furrow and border irrigation

systems are effective in leveled areas. A sprinkler system also is suitable. Avoiding deep cuts when ditches are established or the landscape is leveled helps to keep irrigation water from seeping through the coarse textured underlying material. Because of a very low available water capacity in the underlying material, drought is a hazard unless irrigation is timely. Leaving crop residue on the surface helps to control soil blowing. Carefully managing the application of water helps to prevent leaching plant nutrients below the root zone. Returning crop residue to the soil increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Buffalograss, sand dropseed, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 30 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem and little bluestem decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. Growing a cover crop between the tree rows helps to control soil blowing. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Irrigation can be helpful in establishing the seedlings and during periods of low rainfall. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings with basements. The foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and subbase are thick enough to compensate

for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance.

The capability units are IIs-5, dryland, and IIs-7, irrigated; Silty range site; windbreak suitability group 6G.

**JoC—Jansen loam, 2 to 6 percent slopes.** This deep, gently sloping, well drained soil is on side slopes dissected by drainageways and on ridges on upland divides. It formed in 31 inches of loamy sediment or loess overlying coarse sand and gravelly coarse sand. Areas range from 5 to about 300 acres in size.

Typically, the surface layer is dark gray, very friable loam about 7 inches thick. The subsoil is about 24 inches thick. It is dark grayish brown, firm clay loam in the upper part; brown, firm silty clay loam in the next part; and light yellowish brown, friable silt loam in the lower part. The underlying material extends to a depth of more than 60 inches. It is light olive brown and light yellowish brown gravelly coarse sand in the upper part and light yellowish brown coarse sand in the lower part. In places the surface layer is sandy loam or fine sandy loam.

Included with this soil in mapping are small areas of Johnstown, Meadin, and O'Neill soils. Also included are small cut areas. All of the included soils are in positions on side slopes and upland divides similar to those of the Jansen soil. Johnstown soils have sandy or gravelly material at a depth of 40 to 60 inches and have dark upper layers more than 20 inches thick. They contain less sand in the subsoil than the Jansen soil. Meadin soils are less than 20 inches deep to gravelly coarse sand. O'Neill soils have more sand in the subsoil than the Jansen soil. The small cut areas have a light colored, clayey subsoil or coarse textured underlying material that has been exposed by land leveling. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the underlying material. Available water capacity and organic matter content are moderate. The rate of water intake also is moderate. Runoff is medium.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. Water erosion is the main hazard. Soil blowing also is a hazard. Terraces, contour farming, and grassed waterways help to control water erosion and runoff. A system of conservation tillage that leaves crop residue on the surface reduces the hazards of water erosion and soil

blowing and conserves moisture. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. A cropping system that includes close-growing crops, such as wheat, alfalfa, and introduced grasses, helps to control erosion. Returning crop residue or green manure crops to the soil increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Contour bench leveling is suitable in some of the less sloping areas irrigated by a gravity system. Because of the slope, controlling the runoff and erosion caused by rainfall and the additional irrigation water is difficult. In areas irrigated by center-pivot sprinkler systems, terraces help to intercept runoff and thus prevent excessive water erosion, especially along wheel tracks. A cover of grasses on the terraces minimizes the depth of the wheel tracks. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. The rate of water application should be adjusted to the moderate rate of water intake. Returning crop residue or green manure crops to the soil increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing and water erosion. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Buffalograss, sand dropseed, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 30 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem and little bluestem decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Planting the trees on the contour and leaving strips of sod or growing a cover crop between the tree rows reduce the hazard of erosion. Seedlings may require supplemental water during dry periods. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings with basements. The foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance.

The capability units are IIIe-1, dryland, and IIIe-7, irrigated; Silty range site; windbreak suitability group 6G.

**Jr—Jansen-Meadin complex, 0 to 2 percent slopes.** These deep, nearly level soils are on the edges of tableland near breaks to major streams. The Jansen soil is well drained and the Meadin soil is excessively drained. The Jansen soil formed in 22 inches of loamy sediment overlying sand and coarse sand. The Meadin soil formed in 10 inches of sandy and loamy material overlying coarse sand and gravelly coarse sand. It is slightly lower on side slopes than the Jansen soil. Areas range from 5 to 400 acres in size. They are 35 to 50 percent Jansen soil and 35 to 50 percent Meadin soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Jansen soil has a surface layer of dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsoil is brown, firm clay loam about 15 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown sand in the upper part and light gray gravelly coarse sand in the lower part. In places the surface layer is loam or sandy loam.

Typically, the Meadin soil has a surface layer of dark grayish brown, very friable sandy loam about 5 inches thick. Below this is a transition layer of brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown gravelly coarse sand in the upper part, light yellowish brown gravelly coarse sand in the next part, and light gray coarse sand in the lower part. In some places the surface layer is fine sandy loam or loam. In other places a clayey layer 2 to 4 inches thick is above

the gravelly coarse sand. In a few areas the gravelly coarse sand is at the surface.

Included with these soils in mapping are small areas of O'Neill, Pivot, Sandose, and Simeon soils. O'Neill soils contain less clay and more sand in the subsoil than the Jansen and Meadin soils. They are in positions on tableland similar to or slightly higher than those of the Jansen and Meadin soils. Pivot soils are sandy throughout. They are in upland positions similar to those of the Jansen and Meadin soils. Sandose soils have a sandy surface layer overlying loamy layers. They are on the slightly higher divides. Simeon soils do not have a dark surface layer and are sandy throughout. They are in positions on upland breaks similar to those of the Jansen and Meadin soils. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the subsoil of the Jansen soil and very rapid in the underlying material. It is rapid in the Meadin soil. Available water capacity is low in both soils. Organic matter content is moderately low. The rate of water intake is moderate in the Jansen soil and high in the Meadin soil. Runoff is slow on both soils.

Most of the acreage supports native grasses and is used for grazing or hay. Some of the acreage is used as irrigated cropland. A few small areas are used for dryland crops.

If used for dryland farming, these soils are poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa are normally the most dependable crops because they grow and mature in the spring, when the amount of rainfall is highest. Crop response is poor on the Meadin soil, and crop growth is spotty. Keeping the soil covered with crops or crop residue helps to control soil blowing and conserves moisture. Applying feedlot manure increases the organic matter content.

If irrigated, these soils are suited to introduced grasses. Corn and alfalfa can be grown, but crop growth may be spotty if irrigation is not timely. A sprinkler system is the best method of irrigation. Applying the water in small quantities helps to prevent the leaching of plant nutrients below the root zone. Soil blowing is a hazard. It can be controlled by a cropping system that keeps crops or crop residue on the surface. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If these soils are used as range, the climax vegetation on the Jansen soil is dominantly little bluestem, sand bluestem, blue grama, sand dropseed, needleandthread, and prairie sandreed. These species make up 80 percent or more of the total annual forage on this soil. Sedges, purple lovegrass, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 20 percent. Under

continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Meadin soil is dominantly blue grama, clubmoss, needleandthread, prairie sandreed, and fringed sagewort. These species make up 75 percent or more of the total annual forage on this soil. Sand bluestem, hairy grama, sand dropseed, and other annual and perennial grasses and forbs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Jansen soil and 0.6 on the Meadin soil. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain sand bluestem and prairie sandreed in areas of the Meadin soil. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Both soils are droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage

allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The Jansen soil is suited to the trees and shrubs grown as windbreaks, but the Meadin soil generally is unsuited. Onsite investigation is needed when suitable sites for trees and shrubs are selected. Because of the low available water capacity, the only suitable species are those that are tolerant of drought. Growing a cover crop between the tree rows helps to control soil blowing. Inadequate rainfall can hinder seedling establishment. Competition for moisture from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

The Meadin soil generally is suitable as a site for dwellings, buildings, and roads. In areas of the Jansen soil, the foundations of buildings without basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads in areas of the Jansen soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance.

The capability units are IVs-4, dryland, and IVs-14, irrigated. The Jansen soil is in the Sandy range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

**JtB—Jansen-Sandose complex, 0 to 3 percent slopes.** These deep, nearly level and very gently sloping, well drained soils are on uplands. The Jansen soil formed in 32 inches of loamy sediment or loess overlying coarse sand and gravelly coarse sand. It is in the lower, nearly level swales. The Sandose soil is on the higher, very gently sloping ridgetops. It formed in sandy eolian material over loamy sediment. Areas range from 10 to about 200 acres in size. They are 35 to 50 percent Jansen soil and 35 to 50 percent Sandose soil. The two soils occur as areas so

intricately mixed or so small that separating them in mapping is not practical.

Typically, the Jansen soil has a surface layer of dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer also is dark grayish brown, very friable fine sandy loam. It is about 4 inches thick. The subsoil is about 21 inches thick. It is brown and yellowish brown, firm clay loam in the upper part and light yellowish brown, friable loam in the lower part. The underlying material extends to a depth of more than 60 inches. It is pale yellow coarse sand in the upper part and light gray gravelly coarse sand in the lower part. In some places the surface layer is loamy fine sand or loam. In other places the underlying material is sand or fine sand.

Typically, the Sandose soil has a surface layer of dark grayish brown, very friable loamy fine sand about 10 inches thick. The subsoil is about 48 inches thick. It is brown, very friable loamy fine sand in the upper part; light yellowish brown, firm sandy clay loam in the next part; and very pale brown, firm clay loam in the lower part. The underlying material to a depth of 60 inches or more is very pale brown loam. In some places the surface layer is loamy sand or fine sand. In other places the sandy material is less than 20 inches or more than 40 inches deep over the loamy material. In some areas the dark surface layer is less than 10 inches thick. In other areas the underlying material is gravelly sand.

Included with these soils in mapping are small areas of Johnstown, Meadin, and Valentine soils. Johnstown soils have dark upper layers more than 20 inches thick. They are more than 40 inches deep to sandy or gravelly material. Meadin soils are less than 20 inches deep to gravelly coarse sand. Johnstown and Meadin soils are in upland positions similar to those of the Jansen and Sandose soils. Valentine soils are sandy throughout. They are on the higher side slopes and hummocks. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the underlying material. It is rapid in the upper part of the Sandose soil and moderate in the lower part. Available water capacity is moderate in both soils. Organic matter content is moderately low. The rate of water intake is moderate in the Jansen soil and high in the Sandose soil. Runoff is slow on both soils.

Most of the acreage is used as irrigated cropland. Some areas are used for dryland farming. The rest supports native grasses and is used for grazing or hay.

If used for dryland farming, these soils are suited to wheat and alfalfa. Wheat and the first cuttings of alfalfa mature before the weather becomes hot and dry. Soil blowing is a hazard, especially on the Sandose soil. A system of conservation tillage that leaves crop residue

on the surface, such as stubble mulch tillage and no-till planting, helps to control soil blowing and conserves moisture. Stripcropping also helps to control soil blowing. Returning crop residue or green manure crops to the soils and applying feedlot manure increase the organic matter content.

If irrigated, these soils are suited to corn, alfalfa, and introduced grasses. Because of the hummocky nature of the soils, land leveling is required for gravity irrigation. Deep cuts can expose the coarse textured underlying material. A sprinkler system is a better method of irrigation because it does not require deep cuts and because the Sandose soil requires timely applications of water and carefully selected application rates. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue or green manure crops to the soil increases the organic matter content.

If these soils are used as range, the climax vegetation on the Jansen soil is dominantly little bluestem, sand bluestem, blue grama, sand dropseed, needleandthread, and prairie sandreed. These species make up 80 percent or more of the total annual forage on this soil. Sedges, purple lovegrass, western wheatgrass, and other annual and perennial grasses and forbs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Sandose soil is dominantly little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 65 percent or more of the total annual forage on this soil. Sand bluestem, sedges, and other annual and perennial grasses and forbs make up the remaining 35 percent. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing

use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs grown as windbreaks. Insufficient moisture and severe soil blowing are the principal hazards in establishing trees. Irrigation is needed during dry periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Weeds and undesirable grasses in the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

The Jansen soil is suitable as a site for dwellings with basements. The Sandose soil is suitable as a site for dwellings without basements and for other buildings. The foundations of dwellings without basements and of other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. The Sandose soil is suitable as a site for roads. Roads in areas of the Jansen soil should be designed so that the surface pavement and base

material are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance.

The capability units are IIIe-3, dryland, and IIIe-8, irrigated; Sandy range site. The Jansen soil is in windbreak suitability group 6G, and the Sandose soil is in windbreak suitability group 5.

**Jw—Johnstown fine sandy loam, 0 to 1 percent slopes.** This deep, nearly level, well drained soil is on tableland. It formed in loamy and silty sediment or loess. Areas range from 5 to 400 acres in size.

Typically, the surface layer is brown, very friable fine sandy loam about 8 inches thick. The subsoil is grayish brown, friable clay loam about 9 inches thick. Below this is a buried subsoil about 27 inches thick. This subsoil is dark grayish brown, firm clay loam in the upper part; light yellowish brown, firm silty clay loam in the next part; and pale yellow, friable silty clay loam in the lower part. The underlying material extends to a depth of 60 inches or more. It is light gray, calcareous silt loam in the upper part and pale yellow gravelly coarse sand in the lower part. In some places the surface layer is loam. In other places land leveling and tillage have mixed the surface layer with the upper part of the more clayey subsoil. In some areas the dark upper layers are less than 20 inches thick. In a few areas the depth to gravelly coarse sand is more than 60 inches.

Included with this soil in mapping are small areas of Anselmo, Brocksburg, Jansen, and Sandose soils. Also included are small cut areas and soils in old depressions. All of the included soils, except for Brocksburg soils, have dark upper layers less than 20 inches thick. Anselmo soils contain more sand in the subsoil than the Johnstown soil. They are on the slightly higher side slopes. Brocksburg and Jansen soils formed in 20 to 40 inches of loamy material overlying sand, coarse sand, or gravelly coarse sand. They are on upland divides. Sandose soils have a sandy surface layer and loamy underlying material. They are on ridgetops, on divides, and in upland swales. The small cut areas have a light colored subsoil or underlying material that has been exposed by land leveling. The soils in the old depressions are more clayey in the subsoil than the Johnstown soil. Nearly all of the depressions have been filled by land leveling. Included areas make up 15 percent or less of the unit.

Permeability is moderate in the upper part of the Johnstown soil and very rapid in the underlying material. Available water capacity is high. Organic matter content is moderately low. The rate of water intake is moderate. Runoff is slow. In areas where deep cuts have been made during land leveling, the organic

matter content is low, tilth is poor, and available phosphorus and zinc are deficient.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Conservation of moisture is a management concern, and soil blowing is a hazard in areas where the soil is cultivated. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface conserves moisture and helps to control soil blowing. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. Returning crop residue or green manure crops to the soil increases the organic matter content. Rotation of crops interrupts the cycles of weeds, insects, and plant diseases.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is suited to both gravity and sprinkler systems. Land leveling improves surface drainage and helps to achieve a uniform distribution of water in areas irrigated by a gravity system. Leveled areas where the subsoil has been exposed require applications of feedlot manure, phosphorus, and zinc to improve tilth and fertility. An application rate that is suited to the moderate rate of water intake aids in conserving irrigation water. A tailwater recovery system also conserves irrigation water. Lining or sealing tailwater recovery pits helps to prevent seepage. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to prevent excessive soil blowing and conserves moisture.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. These species make up 70 percent or more of the total annual forage. Indiangrass, blue grama, and other annual and perennial grasses, forbs, and sedges make up the remaining 30 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. If competing vegetation is removed by good site preparation and timely weed control, the

seedlings generally can survive. They may require supplemental water during dry periods. Soil blowing can be controlled by maintaining strips of sod between the tree rows.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The foundations of dwellings and other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained base material helps to ensure better performance.

The capability units are 1Ie-3, dryland, and 1-5, irrigated; Silty range site; windbreak suitability group 3.

**JwB—Johnstown fine sandy loam, 1 to 3 percent slopes.** This deep, very gently sloping, well drained soil is on upland divides. It formed in loamy and silty sediment or loess. Areas range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsoil is dark brown, friable silty clay loam about 9 inches thick. Below this is a buried subsoil about 30 inches thick. This subsoil is dark grayish brown, firm clay loam in the upper part; grayish brown and pale brown, firm silty clay loam in the next part; and light gray, firm silty clay loam in the lower part. The underlying material extends to a depth of 60 inches or more. It is light gray loamy fine sand in the upper part and white sand in the lower part. In some places the surface layer is loam. In other places the dark upper layers are less than 20 inches thick. In some areas depth to the coarse textured underlying material is more than 60 inches.

Included with this soil in mapping are small areas of Anselmo, Jansen, and Sandose soils. Also included are small cut areas. Anselmo soils are sandier throughout than the Johnstown soil. They are in positions on divides similar to or slightly higher than the those of Johnstown soil. Jansen soils formed in 20 to 40 inches of loamy sediment or loess over sand, coarse sand, or gravelly coarse sand. Jansen soils are in positions on divides similar to those of the Johnstown soil. Sandose soils have a sandy surface layer and loamy underlying material. They are on ridgetops and upland divides. The small cut areas have a light colored subsoil or

underlying material that has been exposed by land leveling. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Johnstown soil and rapid in the underlying material. Available water capacity is high. Organic matter content is moderately low. The rate of water intake is moderate. Runoff is medium. In areas where deep cuts have been made during land leveling, the organic matter content is low, tilth is poor, and available phosphorus and zinc are deficient.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Conservation of moisture is a management concern, and soil blowing is a hazard in areas where the soil is cultivated. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface conserves moisture and helps to control soil blowing. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. Returning crop residue or green manure crops to the soil increases the organic matter content. Rotation of crops interrupts the cycles of weeds, insects, and plant diseases.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is suited to both gravity and sprinkler systems. Land leveling improves surface drainage and helps to achieve a uniform distribution of water in areas irrigated by a gravity system. Leveled areas where the subsoil has been exposed require applications of feedlot manure, phosphorus, and zinc to improve tilth and fertility. An application rate that is suited to the moderate rate of water intake aids in conserving irrigation water. A tailwater recovery system also conserves irrigation water. Lining or sealing tailwater recovery pits helps to prevent seepage. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to prevent excessive soil blowing and conserves moisture.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. These species make up 70 percent or more of the total annual forage. Indiangrass, blue grama, and other annual and perennial grasses, forbs, and sedges make up the remaining 30 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance. Initially, these

species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. If competing vegetation is removed by good site preparation and timely weed control, the seedlings generally can survive. They may require supplemental water during dry periods. Soil blowing can be controlled by maintaining strips of sod between the tree rows.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The foundations of dwellings and other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained base material helps to ensure better performance.

The capability units are 11e-3, dryland, and 11e-5, irrigated; Silty range site; windbreak suitability group 3.

**Jy—Johnstown loam, 0 to 1 percent slopes.** This deep, nearly level, well drained soil is on tableland. It formed in loamy and silty sediment or loess. Areas range from 5 to more than 1,000 acres in size.

Typically, the surface layer is dark gray, very friable loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable loam about 13 inches thick. The subsoil is grayish brown, firm clay loam about 6 inches thick. Below this is a buried subsoil of clay loam about 23 inches thick. This subsoil is very dark grayish brown and firm in the upper part; light yellowish brown and firm in the next part; and light yellowish brown, friable, and calcareous in the lower part. The underlying material to a depth of more than 60 inches is light yellowish brown coarse sand. In some areas the surface layer is fine sandy loam or silt loam. In other areas land leveling and tillage have mixed the surface layer with the upper part of the more clayey subsoil. In places the dark upper layers are less than 20 inches thick. In a few places the depth to gravelly coarse sand is more than 60 inches.

Included with this soil in mapping are small areas of Brocksburg and Jansen soils. Also included are small

cut areas and soils in old depressions. Brocksburg and Jansen soils formed in 20 to 40 inches of loamy sediment over sand, coarse sand, or gravelly coarse sand. They are in upland positions similar to those of the Johnstown soil. Jansen soils have a dark surface layer less than 20 inches thick. The small cut areas have a light colored subsoil or underlying material that has been exposed by land leveling. The soils in old depressions are more clayey in the subsoil than the Johnstown soil. Nearly all of the depressions have been filled by land leveling. Included areas make up 15 percent or less of the unit.

Permeability is moderate in the upper part of the Johnstown soil and very rapid in the underlying material. Available water capacity is high. Organic matter content is moderate. The rate of water intake also is moderate. Runoff is slow. In areas where deep cuts have been made during land leveling, the organic matter content is low, tilth is poor, and available phosphorus and zinc are deficient.

Nearly all of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Conservation of moisture and soil blowing are management concerns in areas where the soil is cultivated. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface conserves moisture and helps to control soil blowing. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. Returning crop residue or green manure crops to the soil increases the organic matter content. Rotation of crops interrupts the cycles of weeds, insects, and plant diseases.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is suited to both gravity and sprinkler systems. Land leveling improves surface drainage and helps to achieve a uniform distribution of water in areas irrigated by a gravity system. Leveled areas where the subsoil has been exposed require applications of feedlot manure, phosphorus, and zinc to improve tilth and fertility. An application rate that is suited to the moderate rate of water intake conserves irrigation water. A tailwater recovery system also conserves irrigation water. Lining or sealing tailwater recovery pits helps to prevent seepage. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface conserves moisture and helps to prevent excessive soil blowing.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly big bluestem, little

bluestem, blue grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Switchgrass, indiagrass, sideoats grama, and other annual and perennial grasses, forbs, sedges, and shrubs make up the remaining 40 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem, little bluestem, indiagrass, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. If competing vegetation is removed by good site preparation and timely weed control, the seedlings generally can survive. They may require supplemental water during dry periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The foundations of dwellings and other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained base material helps to ensure better performance.

The capability units are 11c-1, dryland, and 1-6, irrigated; Silty range site; windbreak suitability group 3.

**JyB—Johnstown loam, 1 to 3 percent slopes.** This deep, very gently sloping, well drained soil is on tableland. It formed in loamy and silty sediment or loess. Areas range from 5 to about 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 8 inches thick. The subsoil is grayish brown, friable clay loam about 6 inches thick. Below this is a buried subsoil of silty clay loam about 24 inches thick. This subsoil is dark grayish brown and firm in the upper part, light olive brown and firm in the next part, and light yellowish brown and friable in the lower part. The underlying material extends to a depth of more than 60 inches. It is pale yellow, calcareous silt loam in the upper part and light gray sand and loamy

sand in the lower part. In some areas the surface layer is fine sandy loam. In other areas the dark upper layers are less than 20 inches thick. In places the sandy underlying material is coarser textured and is below a depth of 60 inches.

Included with this soil in mapping are small areas of Anselmo and Jansen soils and small cut areas. Anselmo soils have more sand in the subsoil than the Johnstown soil. They are in positions on divides similar to or slightly higher than those of the Johnstown soil. Jansen soils formed in 20 to 40 inches of loamy sediment or loess over sand, coarse sand, or gravelly coarse sand. They have a dark surface layer less than 20 inches thick. They are in positions on tableland similar to those of the Johnstown soil. The small cut areas have a light colored subsoil or underlying material that has been exposed by land leveling. Included areas make up less than 15 percent of the unit.

Permeability is moderate in the upper part of the Johnstown soil and rapid in the underlying material. Available water capacity is high. Organic matter content is moderate. The rate of water intake also is moderate. Runoff is medium. In areas where deep cuts have been made during land leveling, the organic matter content is low, tilth is poor, and available phosphorus and zinc are deficient.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Conservation of moisture and soil blowing are management concerns in areas where the soil is cultivated. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. Returning crop residue or green manure crops to the soil increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A gravity or sprinkler system can be used. Land leveling improves surface drainage and helps to achieve a uniform distribution of water in areas irrigated by a gravity system. A tailwater recovery system conserves irrigation water. Lining or sealing tailwater recovery pits helps to prevent seepage. An application rate that is suited to the moderate rate of water intake helps to control runoff of irrigation water. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface conserves moisture and helps to control soil blowing.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The natural plant community is mostly mid and tall grasses. The

climax vegetation is dominantly big bluestem, little bluestem, blue grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Switchgrass, indiagrass, sideoats grama, and other annual and perennial grasses, forbs, sedges, and shrubs make up the remaining 40 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem, little bluestem, indiagrass, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. If competing vegetation is removed by good site preparation and timely weed control, the seedlings generally can survive. They may require supplemental water during dry periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The foundations of dwellings and other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained base material helps to ensure better performance.

The capability units are Ile-1, dryland, and Ile-6, irrigated; Silty range site; windbreak suitability group 3.

**JyC—Johnstown loam, 3 to 6 percent slopes.** This deep, gently sloping, well drained soil is on narrow, convex divides in the uplands and on side slopes dissected by drainageways. It formed in loamy and silty sediment or loess. Areas range from 5 to about 150 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 9 inches thick. The subsoil is grayish brown, friable clay loam about 6 inches thick. Below this is a buried subsoil about 31 inches thick. This subsoil is dark grayish brown, firm clay loam in the upper part; light olive brown, firm silty clay loam in the next part; and light yellowish brown, friable silty clay

loam in the lower part. The underlying material to a depth of 60 inches or more is light gray. It is calcareous loamy sand in the upper part and loamy fine sand in the lower part. In some places the surface layer is fine sandy loam. In other places the dark upper layers are less than 20 inches thick. In some areas the sandy underlying material is coarser textured and is below a depth of 60 inches.

Included with this soil in mapping are small areas of Anselmo, Jansen, and O'Neill soils and small severely eroded areas. Anselmo soils have more sand in the subsoil than the Johnstown soil. They are in positions on divides and side slopes similar to or slightly higher than those of the Johnstown soil. Jansen and O'Neill soils formed in 20 to 40 inches of loamy sediment or loess over sand, coarse sand, or gravelly coarse sand. They have more sand in the subsoil than the Johnstown soil. They are in upland positions similar to those of the Johnstown soil. Included areas make up less than 15 percent of the unit.

Permeability is moderate in the upper part of the Johnstown soil and rapid in the underlying material. Available water capacity is high. Organic matter content is moderate. The rate of water intake also is moderate. Runoff is medium.

Most of the acreage is used as irrigated cropland. The rest is used for dryland farming or supports native grasses and is used for grazing.

If used for dryland farming, this soil is suited to wheat and alfalfa. Water erosion is the main hazard. Soil blowing also is a hazard. Terraces, contour farming, and grassed waterways help to control water erosion. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Crop stubble that is left standing throughout winter catches blowing snow and thus increases the moisture supply. A cropping system that includes close-growing crops, such as wheat, alfalfa, and introduced grasses, helps to control erosion. Returning crop residue or green manure crops to the soil increases the organic matter content. Additional phosphorus is needed in the eroded areas.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Contour bench leveling is suitable in some of the less sloping areas irrigated by a gravity system. Because of the slope, controlling the runoff and erosion caused by rainfall and the additional irrigation water is difficult. In areas irrigated by center-pivot sprinkler systems, terraces help to intercept runoff and thus prevent excessive water erosion, especially along wheel tracks. A cover of grasses on the terraces minimizes the depth of the wheel tracks. A system of conservation tillage, such as no-till planting, that leaves

crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. The rate of water application should be adjusted to the moderate rate of water intake. Returning crop residue or green manure crops to the soil increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing and water erosion. The natural plant community is mostly mid and tall grasses. The climax vegetation is dominantly big bluestem, little bluestem, blue grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Switchgrass, indiagrass, sideoats grama, and other annual and perennial grasses, forbs, sedges, and shrubs make up the remaining 40 percent. If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, big bluestem, little bluestem, indiagrass, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. If competing vegetation is removed by good site preparation and timely weed control, the seedlings generally can survive. They may require supplemental water during dry periods. Planting the trees on the contour and leaving strips of sod or growing a cover crop between the tree rows reduce the hazard of erosion.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The foundations of dwellings and other buildings should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained base material helps to ensure better performance.

The capability units are IIIe-1, dryland, and IIIe-6, irrigated; Silty range site; windbreak suitability group 3.

**LcG—Labu-Sansarc silty clays, 11 to 40 percent slopes.** These moderately steep to very steep, well drained soils are on upland breaks to the Niobrara River. Most areas are dissected by drainageways. The soils formed in material weathered from clayey shale. The moderately deep Labu soil is on the long, smooth lower side slopes that are typically less than 30 percent. The shallow Sansarc soil is on the short, steep parts of ridgetops and the upper side slopes. Areas range from 40 to 200 acres in size. They are 40 to 60 percent Labu soil and 30 to 45 percent Sansarc soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Labu soil has a surface layer of dark grayish brown, firm silty clay about 5 inches thick. The subsoil is silty clay about 13 inches thick. The upper part is very firm and light olive brown; the next part is very firm and light olive brown and has grayish brown tongues; and the lower part is firm, calcareous, and grayish brown. The underlying material is light brownish gray, calcareous clay about 5 inches thick. It contains 30 percent partially weathered shale fragments. Light brownish gray, calcareous, bedded shale is at a depth of about 23 inches. In some places the soil has a thick, dark surface layer. In other places the depth to bedded shale is more than 40 inches.

Typically, the Sansarc soil has a surface layer of dark grayish brown, friable silty clay about 3 inches thick. Below this is a transition layer of grayish brown, firm clay about 3 inches thick. It contains 20 percent partially weathered shale fragments. The underlying material is light brownish gray, calcareous clay about 6 inches thick. It contains 40 to 50 percent partially weathered shale fragments. Light brownish gray, calcareous, bedded shale is at a depth of about 12 inches. In places the soil has a thick, dark surface layer.

Included with these soils in mapping are small areas of Simeon, Tassel, and Valentine soils. Also included are outcrops of sandstone or shale. Simeon and Valentine soils are sandy. They are on steep upland breaks and the upper side slopes. Tassel soils are on the higher ridges and side slopes. They are shallow over weathered sandstone. The sandstone and shale outcrops are on ridgetops and very steep breaks. In places the ridgetops are capped with a thin layer of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Labu and Sansarc soils. Available water capacity is low in the Labu soil and very low in the Sansarc soil. The fine, plastic clay in both soils holds some of the moisture under too much tension to be extracted by plant roots. Organic matter content is moderately low. Runoff is rapid on the Labu

soil and very rapid on the Sansarc soil. The soils shrink markedly during dry periods and swell markedly during wet periods. Cracks 1 to 3 inches wide form when the soils are dry.

Most of the acreage supports native grasses and is used for grazing or as habitat for wildlife. These soils are unsuitable as cropland because of the slope and a severe hazard of erosion.

If these soils are used as range, the climax vegetation on the Labu soil is dominantly big bluestem, little bluestem, green needlegrass, sideoats grama, and western wheatgrass. These species make up 75 percent or more of the total annual forage on this soil. Blue grama, Kentucky bluegrass, sedges, and other annual and perennial grasses and forbs make up the remaining 25 percent. Under continuous heavy grazing, big bluestem, little bluestem, and green needlegrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, Kentucky bluegrass, needleandthread, plains muhly, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is a hazard.

The climax vegetation on the Sansarc soil is dominantly little bluestem, western wheatgrass, green needlegrass, sideoats grama, and big bluestem. These species make up 85 percent or more of the total annual forage on this soil. Blue grama, sedges, and other annual and perennial grasses and forbs make up the remaining 15 percent. Under continuous heavy grazing, big bluestem, little bluestem, green needlegrass, and sideoats grama decrease in abundance. Initially, these species are replaced by blue grama, needleandthread, threadleaf sedge, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is a hazard.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Labu soil and 0.7 on the Sansarc soil. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling water erosion. The very steep slopes, dense clumps of trees, and rock

outcrops can hinder the movement of range animals from one area to another. Measures that control woody plants may be needed.

These soils generally are not suited to the trees and shrubs grown as windbreaks because of the slope. Some areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

These soils provide habitat for woodland and rangeland wildlife. The habitat on the upper slopes generally occurs as areas of native grasses and areas of eastern redcedar. Hardwood trees, such as oak and ash, and many shrubs grow on the lower slopes adjacent to most drainageways. The trees are thick enough to shade out the grasses in many areas. Woodland wildlife, such as deer, turkey, raccoons, porcupines, tree squirrels, and cottontail rabbits, use this habitat throughout the year. Rangeland and openland wildlife, such as grouse, use the edges of this habitat for escape and shelter. Some wetland wildlife, such as ducks, use the streams and old oxbows adjacent to narrow bottom land.

These soils generally are not suited to sanitary facilities because of the slope and the slow permeability. A suitable alternative site is needed. Strengthening the foundations of dwellings and other buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Providing coarse grained subgrade or base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Cutting and filling generally are needed to provide a suitable grade for the roads.

The capability unit is Vle-4, dryland; windbreak suitability group 10. The Labu soil is in the Clayey range site, and the Sansarc soil is in the Shallow Clay range site.

**LfB—Libory loamy fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, moderately well drained soil is in upland swales. It formed in sandy eolian material over loamy and silty alluvium. Areas range from 10 to 320 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is brown, very friable fine sand about 7 inches thick. The subsoil is about 34 inches thick. It is

pale brown, loose fine sand in the upper part; brown, mottled, friable loam in the next part; and light yellowish brown, mottled, friable loam in the lower part. The underlying material to a depth of more than 60 inches is light gray, mottled loam. In some places the sandy material is less than 20 inches or more than 36 inches deep over the loamy material. In other places coarse sand or gravelly coarse sand is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Dunday, Els, Elsmere, and Valentine soils. Dunday and Valentine soils are on the higher parts of hummocky areas and side slopes. Dunday soils are somewhat excessively drained. They do not have loamy underlying material. Valentine soils are excessively drained. Els and Elsmere soils are in the slightly lower depressions and are somewhat poorly drained. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Libory soil and moderate in the lower part. Available water capacity is high. Organic matter content is moderately low. The rate of water intake is high. Runoff is slow. In the spring and in other wet periods, a water table is perched for a short time above the loamy underlying material. Depth to the perched water table generally ranges from 1.5 to 3.0 feet.

Most of the acreage supports native grasses and is used for grazing or hay. The rest is used as irrigated cropland. Some small areas are used for dryland farming.

If used for dryland farming, this soil is suited to wheat and alfalfa. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. A system of conservation tillage that keeps all or part of the crop residue on the surface helps to prevent excessive soil blowing and conserves moisture. Wheat and the first cutting of alfalfa generally are the most dependable crops because they grow and mature in the spring, when the amount of rainfall is highest. Applying feedlot manure increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation, which does not require land leveling. In periods of above normal rainfall, the perched water table is a problem in places. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil blowing and conserves moisture. Timely applications of water and carefully selected application rates are needed. Excess water leaches plant nutrients below the root zone. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If this soil is used as range or native hayland, the climax vegetation is dominantly big bluestem, little bluestem, switchgrass, plains bluegrass, and indiagrass. These species make up 85 percent or more of the total annual forage. Sedges and other annual and perennial grasses and forbs make up the remaining 15 percent. Under continuous heavy grazing, big bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.0 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying help to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Insufficient moisture and soil blowing are the principal hazards. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Irrigation can be helpful in establishing the seedlings during periods of low rainfall. Undesirable grasses and weeds can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately

filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The absorption fields should be constructed on fill material, so that they are a sufficient distance above the perched water table. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoon on fill material raises the bottom of the lagoon a sufficient distance above the perched water table. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods. Dwellings and other buildings should be constructed on elevated, well compacted fill material. This measure helps to overcome the wetness caused by the perched water table. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by wetness.

The capability units are Ille-6, dryland, and Ille-10, irrigated; Sandy Lowland range site; windbreak suitability group 5.

#### **Lo—Loup fine sandy loam, 0 to 2 percent slopes.**

This deep, nearly level, poorly drained soil is on bottom land in sandhill valleys. It is subject to rare flooding. It formed in loamy and sandy alluvium. Areas range from 10 to more than 1,000 acres in size.

Typically, the surface layer is dark gray, very friable fine sandy loam about 10 inches thick. Below this is a transition layer about 5 inches thick. This layer is gray, very friable fine sand that has grayish brown mottles. The underlying material is about 33 inches of light gray, mottled fine sand and sand. Below this to a depth of about 60 inches is a buried layer of dark gray loamy fine sand. In places the dark surface layer is less than 7 inches thick or is more than 20 inches thick. In some areas near the Sandhills, a thin layer of light colored fine sand is at the surface. In a few places the underlying material is finely stratified with loamy material.

Included with this soil in mapping are small areas of Els, Elsmere, lpage, and Marlake soils. Also included are small areas of soils that are moderately or strongly affected by alkali. Els and Elsmere soils are on the slightly higher parts of the bottom land in sandhill valleys. They are somewhat poorly drained. lpage soils are moderately well drained. They are in the higher positions on small hummocks and low ridges. Marlake soils are in depressions and are covered with water during most of the growing season. The alkali-affected soils are common in transition areas between the Loup soil and the better drained surrounding soils. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Loup soil. Available water

capacity is low. Organic matter content is high. Runoff is slow. The seasonal high water table is at the surface in wet years and at a depth of about 1.5 feet in dry years. The water table normally recedes to a depth of 2 to 3 feet by late summer.

Most of the acreage supports native grasses and is used for grazing or hay. This soil generally is too wet for cultivation.

If this soil is used as range, either for grazing or haying, the climax vegetation is dominantly switchgrass, indiagrass, prairie cordgrass, and big bluestem. These species make up 70 percent or more of the total annual forage. Plains bluegrass, northern reedgrass, and other perennial grasses, forbs, and sedges make up the remaining 30 percent. Under continuous heavy grazing or improper haying, big bluestem, northern reedgrass, prairie cordgrass, switchgrass, and indiagrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, plains bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing and heavy machinery traffic cause surface compaction and create small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying activities generally extend over a period of several weeks, large meadows can be divided

into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is suited to the trees and shrubs grown as windbreaks. Wetness is the main limitation. The only suitable species are those that can withstand a high water table. Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Weeds and undesirable grasses that compete with the trees can be controlled by timely cultivation and by applications of approved herbicide.

This soil generally is not suitable as a site for sanitary facilities because of the wetness and the flooding. A suitable alternative site is needed. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods. Constructing buildings on raised, well compacted fill material helps to prevent the structural damage caused by floodwater and helps to overcome the wetness caused by the high water table. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by wetness.

The capability unit is Vw-7, dryland; Wet Subirrigated range site; windbreak suitability group 2D.

**Lp—Loup fine sandy loam, wet, 0 to 2 percent slopes.** This deep, nearly level, very poorly drained soil is on bottom land and valley floors in the Sandhills. It is subject to rare flooding and is commonly ponded by a high water table in spring and during other wet periods. It formed in loamy and sandy alluvium. Areas range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 10 inches thick. The underlying material extends to a depth of 60 inches or more. It is light brownish gray fine sand in the upper part; light gray, mottled fine sand in the next part; and light brownish gray, mottled loamy fine sand in the lower part. In some places the dark surface layer is less than 7 inches thick or more than 20 inches thick. In other places the underlying material is finely stratified with loamy material.

Included with this soil in mapping are small areas of

Els, Elsmere, Gannett, and Marlake soils. Els, Elsmere, and Gannett soils are slightly higher on the landscape than the Loup soil. Els and Elsmere soils are somewhat poorly drained. Gannett soils are poorly drained. They contain less sand in the solum than the Loup soil. Marlake soils are in the lowest depressions in the valleys and are covered with water during most of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Loup soil. Available water capacity is low. Organic matter content is high. Runoff is ponded. The seasonal high water table is 0.5 foot above the surface in wet years and 1.0 foot below the surface in dry years. Water may be on the surface for a week or more during wet periods. By late summer, the water table drops to a depth of 1 or 2 feet.

Most of the acreage supports native grasses and is used for grazing or hay. This soil is too wet for cultivation.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, northern reedgrass, bluejoint reedgrass, and various sedges. These species make up 80 percent or more of the total annual forage. Rushes and other perennial grasses and forbs make up the remaining 20 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, plains bluegrass, green muhly, and various sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, plains bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 2.1 animal unit months per acre. This soil produces high yields, but the forage is of low quality. The forage is of higher quality early in the growing season. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. In some years hay cannot be harvested because of the excessive wetness. When the

soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is unsuited to the trees and shrubs grown as windbreaks because of the wetness. Some areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other management is applied.

This soil is not suitable as a site for sanitary facilities or dwellings because of the ponding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of ponding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by ponding.

The capability unit is Vw-7, dryland; Wetland range site; windbreak suitability group 10.

#### **LtB—Loup-Els complex, 0 to 3 percent slopes.**

These deep, nearly level and very gently sloping soils are on bottom land and valley floors in sandhill valleys. They are subject to rare flooding. The Loup soil formed in loamy and sandy alluvium. The Els soil formed in sandy eolian and alluvial material. The Loup soil is poorly drained and nearly level. It is in the lower areas. The Els soil is somewhat poorly drained and is nearly level and very gently sloping. It is in the slightly higher areas. Areas range from 20 to more than 1,000 acres in size. They are about 40 to 50 percent Loup soil and 40 to 50 percent Els soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Loup soil has a surface layer of very dark gray, friable fine sandy loam about 5 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 6 inches thick. Below this is a transition layer of gray, mottled, loose loamy sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray, mottled sand. In a few places the dark surface layer is less than 7 inches thick. In a few areas ponding may occur during wet periods.

Typically, the Els soil has a surface layer of dark gray, very friable loamy fine sand about 6 inches thick. Below this is a transition layer of grayish brown, very friable loamy fine sand about 3 inches thick. The underlying material is about 41 inches thick. It is brown fine sand in the upper part and mottled light gray and pale brown sand in the lower part. Below this to a depth of 60 inches is a buried layer of dark gray fine sandy loam. In a few areas the dark surface layer is more than 10 inches thick. In some areas the soil does not have a buried layer.

Included with these soils in mapping are small areas of lpage and Marlake soils. Also included are small areas of soils that are moderately or strongly affected by alkali. lpage soils are moderately well drained and are in the higher hummocky areas. Marlake soils are very poorly drained, are in the lowest depressions in the sandhill valleys, and are ponded during much of the growing season. The alkali-affected soils are common in transition areas to the better drained surrounding soils. Included areas make up 5 to 10 percent of the unit.

Permeability is rapid in the Loup and Els soils. Available water capacity is low. Organic matter content is high in the Loup soil and moderately low in the Els soil. Runoff is slow on both soils. The seasonal high water table in the Loup soil is at the surface in wet years and at a depth of about 1.5 feet in dry years. Depth to the seasonal high water table in the Els soil ranges from 1.5 feet in wet years to 3.0 feet in dry years.

Nearly all of the acreage supports native grasses and is used for hay or grazing. These soils generally are unsuitable for cultivation because of the wetness.

If these soils are used as range, either for grazing or hay, the climax vegetation on the Loup soil is dominantly switchgrass, indiagrass, prairie cordgrass, and big bluestem. These species make up 70 percent or more of the total annual forage on this soil. Plains bluegrass, northern reedgrass, and other annual or perennial grasses, forbs, and sedges make up the remaining 30 percent. Under continuous heavy grazing or improper haying, big bluestem, northern reedgrass, prairie cordgrass, switchgrass, and indiagrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

The climax vegetation on the Els soil is dominantly big bluestem, little bluestem, indiagrass, and switchgrass. These species make up 85 percent or more of the total annual forage on this soil. Prairie cordgrass, sedges, and other annual and perennial grasses and forbs make up the remaining 15 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western

wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clover, and other forbs dominate the site.

If the range is in excellent condition the suggested initial stocking rate, in animal unit months per acre, is 1.9 on the Loup soil and 1.7 on the Els soil. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. These soils generally are first to be overgrazed when they are grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying activities generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

These soils are suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a high water table. Establishing trees can be difficult in wet years. Preparing the site and planting in the spring may not be

possible until the water table drops and the soils are sufficiently dry. Soil blowing can be controlled by growing a cover crop between the tree rows. Competition from grasses or weeds is a management concern. Competing weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

The Loup soil generally is not suitable as a site for sanitary facilities because of the wetness. A suitable alternative site is needed. The Els soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Fill material can elevate the absorption field a sufficient distance above the seasonal high water table. Constructing sewage lagoons on fill material raises the bottom of the lagoon a sufficient distance above the seasonal high water table in the Els soil. Lining or sealing the lagoon helps to prevent seepage. The sides of shallow excavations in these soils can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods.

Constructing dwellings and other buildings on elevated, well compacted fill material helps to overcome the wetness caused by the high water table and protects the site against flooding. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness. Providing a good surface drainage system and a gravel moisture barrier in the subgrade minimizes the road damage caused by frost action in the Els soil. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. Onsite investigation is needed before any engineering practices are applied.

The capability unit is Vw-7, dryland. The Loup soil is in the Wet Subirrigated range site and windbreak suitability group 2D. The Els soil is in the Subirrigated range site and windbreak suitability group 2S.

**Ma—Marlake fine sandy loam, 0 to 1 percent slopes.** This deep, nearly level, very poorly drained soil is mostly in depressions or basins and in low areas bordering lakes on sandhill valley floors. It is subject to ponding by water from a seasonal high water table. It formed in sandy alluvium. Areas range from 10 to 640 acres in size.

Typically, about 4 inches of very dark grayish brown, partially decomposed plant material is on the surface. The surface layer is dark gray, friable fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is mottled loamy fine sand stratified with fine sandy loam. It is gray in the upper

part and grayish brown in the lower part. In places the surface layer is loamy fine sand or loam.

Included with this soil in mapping are small areas of Els, Gannett, Loup, and Tryon soils. Also included are a few intermittent lakes and areas where thick deposits of organic material have accumulated at the surface. Els soils are somewhat poorly drained. They are on the higher bottom land and in depressions in sandhill valleys. Gannett soils are poorly drained and are in the slightly higher depressional areas in sandhill valleys. Loup and Tryon soils are poorly drained or very poorly drained and are in the slightly higher areas in sandhill valleys. The intermittent lakes have water above the surface for a long enough period to prevent plant growth. They are in the lowest positions on the landscape. The areas where organic material has accumulated are primarily in Clapper Marsh. They are in the higher areas where mounds of partially decayed vegetation have formed. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Marlake soil. Available water capacity is low. Organic matter content is high. This soil is ponded for long periods during most years. The seasonal high water table ranges from more than 2 feet above the surface in wet years to a depth of about 1 foot in dry years. During extended dry periods the water table normally recedes below the surface.

This soil provides good habitat for wetland wildlife. It is too wet for cultivated crops, hay, or range. The vegetation is coarse and is not palatable to livestock. It consists mainly of cattails, rushes, arrowheads, willows, and other water-tolerant plants. Excessive wetness prevents mowing, except in extremely dry years.

This soil is unsuitable for the trees and shrubs grown as windbreaks because of the wetness. A few marginal areas can be used for water-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

This soil generally is not suitable as a site for sanitary facilities or dwellings because of the frequent ponding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of ponding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by ponding and wetness.

The capability unit is VIIIw-7, dryland; windbreak suitability group 10. No range site is assigned.

**McG—McKelvie-Tassel-Ronson complex, 15 to 70 percent slopes.** These soils are on upland breaks to the Niobrara River and its tributaries. The moderately steep to very steep McKelvie soil formed in sandy

eolian material and sandy material weathered from sandstone. The moderately steep to very steep Tassel soil and the moderately steep and steep Ronson soil formed in material weathered from sandstone. Most areas are dissected by drainageways. The deep, excessively drained McKelvie soil is on the mid and lower side slopes of the breaks. The shallow, somewhat excessively drained Tassel soil is on ridgetops and the upper side slopes. The moderately deep, well drained Ronson soil is on smooth, concave side slopes. Areas range from about 150 to more than 1,000 acres in size. They are 30 to 50 percent McKelvie soil, 15 to 35 percent Tassel soil, and 10 to 30 percent Ronson soil. The three soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the McKelvie soil has a surface layer of grayish brown, very friable loamy fine sand about 6 inches thick. Below this is a transition layer of light brownish gray, very friable loamy fine sand about 7 inches thick. The underlying material to a depth of more than 60 inches is light gray fine sand. Few to many  $\frac{1}{16}$ - to 2-inch sandstone fragments are throughout the profile. In some areas the dark surface layer is more than 10 inches thick. In other areas sandstone is at a depth of 40 to 60 inches. In places the soil does not contain sandstone fragments.

Typically, the Tassel soil has a surface layer of grayish brown, very friable fine sandy loam about 6 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam about 4 inches thick. White, calcareous, soft sandstone is at a depth of about 10 inches.

Typically, the Ronson soil has a surface layer of dark gray, very friable fine sandy loam about 8 inches thick. Below this is a transition layer of mixed grayish brown and brown, very friable fine sandy loam about 6 inches thick. The underlying material is fine sandy loam about 13 inches thick. It is pale brown in the upper part and very pale brown in the lower part. White, noncalcareous, soft sandstone is at a depth of about 27 inches. In some areas the surface layer is thinner and lighter colored. In other areas the depth to soft sandstone is more than 40 inches. In places the soft sandstone is calcareous.

Included with these soils in mapping are areas of Almeria, Anselmo, Meadin, and Vetal soils and small outcrops of sandstone and siltstone. Almeria soils are on bottom land and are poorly drained. Anselmo soils are in the less sloping areas in canyons. They are loamy. They do not contain sandstone. They have a dark surface layer that is thicker than that of the McKelvie, Tassel, and Ronson soils. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are on ridgetops and the upper side slopes. Vetal soils

are on foot slopes. They do not contain sandstone and have dark upper layers more than 20 inches thick. The small outcrops of sandstone and siltstone are on ridgetops and very stony breaks. Included areas make up less than 15 percent of the unit.

Permeability is rapid in the McKelvie soil and moderately rapid in the Tassel and Ronson soils. Available water capacity is low in the McKelvie and Ronson soils and very low in the Tassel soil. Organic matter content is low in the McKelvie and Tassel soils and moderate in the Ronson soil. Runoff is slow to rapid on the McKelvie soil, rapid on the Tassel soil, and medium on the Ronson soil.

All of the acreage supports native vegetation. Most areas are used for summer grazing or as habitat for wildlife. These soils are unsuitable as cropland because of the slope and a severe hazard of erosion.

If these soils are used for range, the climax vegetation on the McKelvie soil is dominantly little bluestem, sand bluestem, needleandthread, prairie sandreed, and blue grama. These species make up at least 60 percent of the total annual forage on this soil. Switchgrass, sedges, and other perennial grasses and forbs make up the rest. Trees, dominantly eastern redcedar, ponderosa pine, and bur oak, cover 10 to 50 percent of the area. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by blue grama, needleandthread, prairie sandreed, and hairy grama. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

The climax vegetation on the Tassel soil is dominantly little bluestem, sand bluestem, prairie sandreed, and sideoats grama. These species make up 70 percent or more of the total annual forage on this soil. Needleandthread, threadleaf sedge, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the rest. Under continuous heavy grazing, little bluestem and sand bluestem decrease in abundance. Initially, these species are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, annual grasses, and forbs. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

The climax vegetation on the Ronson soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 75 percent or more of the total annual forage on this soil. Switchgrass, sedges, and other annual and perennial grasses, forbs, and shrubs make up the rest. Trees, dominantly eastern redcedar, ponderosa pine, and bur oak, cover 10 to 50 percent of

the area. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, grasses decrease in abundance and less desirable woody plants, trees, and shrubs rapidly increase.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.6 on the McKelvie and Ronson soils and 0.7 on the Tassel soil. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A major management problem is achieving a uniform distribution of grazing in areas of rough terrain. Livestock tend to overuse areas near watering and salting facilities and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is effective in controlling water erosion and soil blowing. The very steep slopes and rock outcrops can hinder the movement of range animals from one area to another. Measures that control woody plants may be needed.

These soils generally are not suited to the trees and shrubs grown as windbreaks because of the slope. Some areas can be used for drought-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

These soils provide habitat for woodland and rangeland wildlife. The habitat on the upper slopes generally occurs as areas of native grasses and areas of eastern redcedar and ponderosa pine. Hardwood trees, such as oak and ash, and many shrubs grow on the lower slopes adjacent to most drainageways. The trees are thick enough to shade out the grasses in many areas. Woodland wildlife, such as deer, turkey, raccoons, porcupines, tree squirrels, and cottontail rabbits, use this habitat throughout the year. Rangeland and openland wildlife, such as grouse, use the edges of this habitat for escape and shelter. Some wetland wildlife, such as ducks, use the streams and old oxbows adjacent to the narrow bottom land.

These soils generally are not suitable as sites for sanitary facilities because of the slope. A suitable alternative site is needed. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally

are needed to provide a suitable grade for roads.

The capability unit is VIIe-5, dryland; windbreak suitability group 10. The McKelvie and Ronson soils are in the Savannah range site, and the Tassel soil is in the Shallow Limy range site.

#### **MeB—Meadin sandy loam, 0 to 3 percent slopes.**

This deep, nearly level and very gently sloping, excessively drained soil is on uplands. It formed in 10 inches of sandy and loamy material overlying gravelly coarse sand and coarse sand. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 5 inches thick. Below this is a transition layer of brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is light yellowish brown gravelly coarse sand in the upper part and very pale brown coarse sand in the lower part. In some places the surface layer is loam, fine sandy loam, or loamy fine sand. In other places a clayey layer 2 to 4 inches thick is above the gravelly coarse sand. In a few places the gravelly coarse sand is at the surface.

Included with this soil in mapping are small areas of Jansen, O'Neill, Pivot, and Simeon soils. Jansen soils have more clay and less sand in the subsoil than the Meadin soil. They do not have coarse textured material within a depth of 20 inches. They are on tableland and in upland positions similar to those of the Meadin soil. O'Neill soils formed in 20 to 40 inches of loamy material overlying gravelly coarse sand. They are on divides and in upland positions similar to those of the Meadin soil. Pivot soils formed in 20 to 40 inches of sandy eolian or alluvial material over coarse sand or gravelly coarse sand. They are in upland positions similar to or slightly higher than those of the Meadin soil. Simeon soils do not have a thick, dark surface layer. They contain less gravel than the Meadin soil. They are in positions on breaks and side slopes similar to or slightly higher than those of the Meadin soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Meadin soil. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is high. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing. A few areas are used as irrigated cropland. This soil is unsuitable for dryland crops because of droughtiness and the hazard of soil blowing. The low available water capacity is an additional limitation.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation because of the high rate of water intake.

Timely applications of water and carefully selected application rates are needed. Because of the very rapid permeability and high rate of water intake, leaching of nutrients below the root zone is a problem if the soil is irrigated. Because of the low available water capacity, timely irrigation is critical. Slight delays in the application of water can result in partial to complete crop losses. Tillage practices that keep crops or crop residue on the surface help to control soil blowing and conserve moisture. Returning crop residue to the soil and applying feedlot manure improve fertility and increase the organic matter content.

If this soil is used as range, the climax vegetation is dominantly blue grama, clubmoss, needleandthread, fringed sagewort, and prairie sandreed. These species make up 75 percent or more of the total annual forage. Sand bluestem, hairy grama, sand dropseed, and other perennial grasses and forbs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain sand bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Because of the low available water capacity, the soil is droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

This soil generally is not suited to the trees and shrubs grown as windbreaks because of the shallowness to coarse sand and the low available water capacity. Some areas can be used for drought-tolerant

trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

This soil generally is suitable as a site for dwellings and roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

The capability units are VIs-4, dryland, and IVs-14, irrigated; Shallow to Gravel range site; windbreak suitability group 10.

**MeF—Meadin sandy loam, 3 to 30 percent slopes.**

This deep, gently sloping to steep, excessively drained soil is on convex side slopes and ridgetops dissected by drainageways and on breaks. It formed in 12 inches of sandy and loamy material overlying gravelly coarse sand. Areas range from 5 to 220 acres in size.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 7 inches thick. Below this is a transition layer of brown, very friable sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is gravelly coarse sand. It is pale brown in the upper part and light gray in the lower part. In some places the surface layer is fine sandy loam. In other places erosion has exposed the underlying gravelly coarse sand.

Included with this soil in mapping are small areas of O'Neill, Pivot, and Simeon soils. O'Neill and Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. They are in the slightly higher positions on side slopes and ridgetops. Simeon soils do not have a thick, dark surface layer and contain less gravel than the Meadin soil. They are in upland positions similar to those of the Meadin soil. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Meadin soil. Available water capacity is low. Organic matter content is moderately low. Runoff is slow to rapid, depending on the slope.

Nearly all of the acreage supports native grasses and is used for grazing. This soil is unsuited to cultivated crops because of the slope, the low available water capacity, and the hazards of soil blowing and water erosion.

If this soil is used as range, the climax vegetation is dominantly blue grama, clubmoss, needleandthread, fringed sagewort, and prairie sandreed. These species make up 75 percent or more of the total annual forage. Sand bluestem, hairy grama, sand dropseed, and other perennial grasses and forbs make up the remaining 25

percent. Under continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain sand bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling water erosion and soil blowing. Because of the low available water capacity, the soil is droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

This soil generally is not suited to the trees and shrubs grown as windbreaks because of the shallowness to gravelly coarse sand, the low available water capacity, and the slope. Some areas can be used for drought-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

In areas where slopes are more than 15 percent, this soil generally is not suitable as a site for sanitary facilities. A suitable alternative site is needed. In areas where slopes are less than 15 percent, installing the distribution lines on the contour and land shaping help to ensure that septic tank absorption fields function properly. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Steep slopes increase the difficulty of digging. Dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads.

The capability unit is VIs-4, dryland; Shallow to Gravel range site; windbreak suitability group 10.

**Oe—O'Neill fine sandy loam, 0 to 2 percent slopes.**

This deep, nearly level, well drained soil is on upland divides and tableland. It formed in 26 inches of loamy material overlying gravelly coarse sand. Areas range from 5 to 500 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam about 18 inches thick. It is friable in the upper part and very friable in the lower part. The underlying material to a depth of 60 inches or more is gravelly coarse sand. It is pale brown in the upper part and light yellowish brown in the lower part. In some places the surface layer is sandy loam or loam. In other places the soil is dark to a depth of more than 20 inches. In a few areas the underlying material is fine sand or sand.

Included with this soil in mapping are small areas of Anselmo, Jansen, Meadin, and Pivot soils. Anselmo soils do not have coarse sand or gravelly coarse sand in the underlying material. They are in positions on divides and tableland similar to those of the O'Neill soil. Jansen soils are in positions on tableland similar to those of the O'Neill soil. They have more clay in the subsoil than the O'Neill soil. Meadin and Pivot soils are in upland positions similar to those of the O'Neill soil. They have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils are sandier than the O'Neill soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the subsoil of the O'Neill soil and very rapid in the underlying material. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is moderately high. Runoff is slow.

Most of the acreage is cultivated. The rest supports native grasses and is used for grazing or hay. Almost all of the cropland is irrigated.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. Soil blowing is the main hazard in areas where the surface is not well protected by crops or crop residue. A system of conservation tillage that keeps all or part of the crop residue on the surface helps to prevent excessive soil blowing and conserves moisture. Applying feedlot manure and returning crop residue to the soil increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suitable. Some land grading generally is needed if gravity systems are used. Avoiding deep cuts

when ditches are established or the landscape is leveled helps to keep irrigation water from seeping through the coarse textured underlying material. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a serious hazard. A system of conservation tillage that keeps crops or crop residue on the surface most of the time helps to control soil blowing and conserves moisture. Applying feedlot manure increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 70 percent or more of the total annual forage. Switchgrass, sand dropseed, cudweed sagewort, sedges, and other perennial grasses and forbs make up the remaining 30 percent. If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

This soil is suited to the trees and shrubs grown as windbreaks. Because of the low available water capacity, the only suitable species are those that are tolerant of drought. Growing a cover crop between the tree rows helps to control soil blowing. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Irrigation can be helpful in establishing the seedlings and during periods of low rainfall. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings. The road damage caused by frost action can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IIIe-3, dryland, and IIIe-9,

irrigated; Sandy range site; windbreak suitability group 6G.

**On—O'Neill loam, 0 to 2 percent slopes.** This deep, nearly level, well drained soil is on upland divides and tableland. It formed in 29 inches of loamy material overlying coarse sand. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 5 inches thick. The subsurface layer is dark brown, friable loam about 3 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. It is brown in the upper part and light yellowish brown in the lower part. The underlying material to a depth of 60 inches or more is coarse sand. It is light yellowish brown in the upper part and very pale brown in the lower part. In some places the surface layer is fine sandy loam. In other places the underlying material is gravelly coarse sand or sand. In a few areas the soil is dark to a depth of more than 20 inches.

Included with this soil in mapping are small areas of Anselmo, Jansen, Meadin, and Pivot soils. Anselmo soils do not have coarse sand or gravelly coarse sand in the underlying material. They are in positions on divides and tableland similar to those of the O'Neill soil. Jansen soils are in positions on tableland similar to those of the O'Neill soil. They have more clay in the subsoil than the O'Neill soil. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are in upland positions similar to or slightly lower than those of the O'Neill soil. Pivot soils are in upland positions similar to those of the O'Neill soil. They are sandier than the O'Neill soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the subsoil of the O'Neill soil and very rapid in the underlying material. Available water capacity is low. Organic matter content is moderate. The rate of water intake also is moderate. Runoff is slow.

Most of the acreage is cultivated. The rest supports native grasses and is used for grazing or hay. Almost all of the cropland is irrigated.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa mature before the weather becomes hot and dry. Soil blowing is the main hazard in areas where the surface is not well protected by crops or crop residue. A system of conservation tillage that keeps all or part of the crop residue on the surface helps to prevent excessive soil blowing and conserves moisture. Applying feedlot manure and returning crop residue to the soil increase the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Sprinkler and gravity irrigation

systems are suitable. Some land grading generally is needed if gravity systems are used. Avoiding deep cuts when ditches are established or the landscape is leveled helps to keep irrigation water from seeping through the coarse textured underlying material. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a serious hazard. A system of conservation tillage that keeps crops or crop residue on the surface most of the time helps to control soil blowing and conserves moisture. Applying feedlot manure increases the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 70 percent or more of the total annual forage. Switchgrass, sand dropseed, sedges, cudweed sagewort, and other perennial grasses and forbs make up the remaining 30 percent. If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

This soil is suited to the trees and shrubs grown as windbreaks. Because of the low available water capacity, the only suitable species are those that are tolerant of drought. Growing a cover crop between the tree rows helps to control soil blowing. Seedling establishment is restricted mainly by droughtiness and competition for moisture from grasses and weeds. Irrigation can be helpful in establishing the seedlings and during periods of low rainfall. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings. The road damage caused by frost action can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing

adequate roadside ditches help to provide the needed surface drainage.

The capability units are 11c-1, dryland, and 11s-7, irrigated; Sandy range site; windbreak suitability group 6G.

**OsC—O'Neill-Meadin sandy loams, 2 to 6 percent slopes.** These deep, gently sloping soils are on ridgetops and side slopes dissected by drainageways. The well drained O'Neill soil formed in 30 inches of loamy material overlying sand and coarse sand. The excessively drained Meadin soil formed in 12 inches of sandy and loamy material overlying coarse sand and gravelly coarse sand. The O'Neill soil is on the concave middle and lower side slopes. The Meadin soil is on the convex upper side slopes and narrow ridgetops. Areas range from 5 to 300 acres in size. They are 45 to 65 percent O'Neill soil and 20 to 40 percent Meadin soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the O'Neill soil has a surface layer of dark grayish brown, very friable sandy loam about 8 inches thick. The subsoil is about 22 inches thick. It is dark brown, very friable fine sandy loam in the upper part and brown, very friable sandy loam in the lower part. The underlying material extends to a depth of more than 60 inches. It is pale brown sand in the upper part, very pale brown sand in the next part, and white coarse sand in the lower part. In some places the surface layer is loam, fine sandy loam, or loamy sand. In other places the underlying material is gravelly coarse sand. In a few areas the surface layer is less than 7 inches thick. In some areas it is more than 20 inches thick.

Typically, the Meadin soil has a surface layer of grayish brown, very friable sandy loam about 8 inches thick. Below this is a transition layer of brown, loose loamy sand about 4 inches thick. The underlying material extends to a depth of more than 60 inches. It is light yellowish brown coarse sand in the upper part, very pale brown coarse sand in the next part, and light gray gravelly coarse sand in the lower part. In some places the surface layer is loam, fine sandy loam, or loamy sand. In other places the underlying material is within a depth of 8 inches. In a few areas the surface layer is dark and is less than 8 inches thick.

Included with these soils in mapping are small areas of Anselmo, Jansen, and Pivot soils. Anselmo soils do not have coarse sand or gravelly coarse sand within a depth of 60 inches. They are on ridgetops and side slopes. Jansen soils have more clay in the subsoil than the O'Neill and Meadin soils. They are in the higher, less sloping areas on side slopes in the uplands. Pivot soils contain more sand in the solum than the O'Neill

and Meadin soils. They are in positions on upland ridgetops similar to those of the O'Neill and Meadin soils or are on the less sloping side slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the O'Neill soil and very rapid in the underlying material. It is rapid in the Meadin soil. Available water capacity is low in both soils. Organic matter content is moderately low. Runoff is slow or medium. The rate of water intake is moderately high in the O'Neill soil and high in the Meadin soil.

About half of the acreage is used for dryland or irrigated crops. The rest supports native grasses and is used for grazing.

If used for dryland farming, these soils are poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the most dependable crops because they grow and mature in the spring, when the amount of rainfall is highest. Crop response on the Meadin soil is poor, and growth is spotty. The main hazards are soil blowing and water erosion. A cropping system that keeps crops, grass, or crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Applications of feedlot manure increase the organic matter content.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Wheel-track erosion is a management concern if a center-pivot system is used. Soil blowing and water erosion are hazards if the surface is not protected. A system of conservation tillage and a cropping system that keeps crops, grass, or crop residue on the surface most of the time help to control runoff and erosion. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If these soils are used as range, the climax vegetation on the O'Neill soil is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 70 percent or more of the total annual forage on this soil. Switchgrass, sand dropseed, sedges, cudweed sagewort, and other annual and perennial grasses and forbs make up the remaining 30 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Meadin soil is

dominantly blue grama, clubmoss, needleandthread, fringed sagewort, and prairie sandreed. These species make up 75 percent or more of the total annual forage on this soil. Sand bluestem, hairy grama, sand dropseed, and other annual and perennial grasses and forbs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the O'Neill soil and 0.6 on the Meadin soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Because of the low available water capacity, the soils are droughty. The amount of forage produced depends on the frequency and amount of rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The O'Neill soil is suited to the trees and shrubs grown as windbreaks. Because of the low available water capacity, the only suitable species are those that are tolerant of drought. The Meadin soil generally is not suited to windbreaks because of the shallowness to coarse sand and gravelly coarse sand and the low

available water capacity. Onsite investigation is needed when suitable sites for trees and shrubs are selected. Planting the trees on the contour and terracing help to control water erosion. Growing a cover crop between the tree rows helps to control soil blowing. Inadequate rainfall can hinder seedling establishment. Competition for moisture from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

These soils generally are suitable as sites for dwellings. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. The Meadin soil is suitable as a site for roads. The road damage caused by frost action in the O'Neill soil can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are IVe-3, dryland, and IVe-9, irrigated. The O'Neill soil is in the Sandy range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

**OsD—O'Neill-Meadin sandy loams, 6 to 11 percent slopes.** These deep, strongly sloping soils are on ridgetops and side slopes dissected by drainageways. The well drained O'Neill soil formed in 24 inches of loamy material overlying gravelly coarse sand. The excessively drained Meadin soil formed in 12 inches of sandy and loamy material overlying gravelly coarse sand. The O'Neill soil is on the concave middle and lower side slopes. The Meadin soil is on the convex upper side slopes and narrow ridgetops. Areas range from 5 to 100 acres in size. They are 40 to 65 percent O'Neill soil and 20 to 45 percent Meadin soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the O'Neill soil has a surface layer of dark grayish brown, very friable sandy loam about 6 inches thick. The subsoil is fine sandy loam about 18 inches thick. It is dark grayish brown and friable in the upper part and brown and very friable in the lower part. The underlying material to a depth of more than 60 inches is light yellowish brown and brownish yellow gravelly

coarse sand. In places the surface layer is loam, fine sandy loam, or loamy sand. In a few areas it is less than 7 inches thick. In some areas it is more than 20 inches thick. In other areas the underlying material is sand or coarse sand.

Typically, the Meadin soil has a surface layer of dark grayish brown, very friable sandy loam about 4 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 5 inches thick. Below this is a transition layer of brown, very friable loamy sand about 3 inches thick. The underlying material to a depth of 60 inches or more is pale brown and very pale brown gravelly coarse sand. In some places the surface layer is loam, fine sandy loam, or loamy sand. In other places the underlying material is within a depth of 8 inches. In a few areas the surface layer is dark and is less than 8 inches thick. In some areas the underlying material is less than 15 percent gravel.

Included with these soils in mapping are small areas of Anselmo, Jansen, and Pivot soils. Anselmo soils do not have coarse sand or gravelly coarse sand within a depth of 60 inches. They are in positions on ridgetops and side slopes similar to those of the O'Neill and Meadin soils. Jansen soils have more clay in the subsoil than the O'Neill and Meadin soils. They are in the less sloping, higher areas on side slopes. Pivot soils contain more sand in the solum than the O'Neill and Meadin soils. They are in positions on upland ridgetops similar to those of the O'Neill and Meadin soils or are on the less sloping side slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the subsoil of the O'Neill soil and very rapid in the underlying material. It is rapid in the Meadin soil. Available water capacity is low in both soils. Organic matter content is moderately low. Runoff is medium. The rate of water intake is moderately high in the O'Neill soil and high in the Meadin soil.

About half of the acreage supports native grasses and is used for grazing. The rest is used for irrigated crops. These soils are unsuitable for dryland farming because of droughtiness and the hazard of erosion.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. Gravity irrigation is not suitable because of the slope. Wheel-track erosion is a management concern if a center-pivot sprinkler system is used. Soil blowing and water erosion are hazards if the surface is not protected. A system of conservation tillage that keeps crops, grass, or crop residue on the surface most of the time helps to control runoff, water erosion, and soil blowing. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If these soils are used as range, the climax

vegetation on the O'Neill soil is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 70 percent or more of the total annual forage on this soil. Switchgrass, sand dropseed, cudweed sagewort, sedges, and other annual and perennial grasses and forbs make up the remaining 30 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Meadin soil is dominantly blue grama, clubmoss, needleandthread, fringed sagewort, and prairie sandreed. These species make up 75 percent or more of the total annual forage on this soil. Sand bluestem, hairy grama, sand dropseed, and other annual and perennial grasses and forbs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the O'Neill soil and 0.6 on the Meadin soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Because of the low available water capacity, the soils are droughty. The amount of forage produced depends on the frequency and amount of rainfall. Abandoned cropland

should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The O'Neill soil is suited to some of the trees and shrubs grown as windbreaks. Because of the low available water capacity, the only suitable species are those that are tolerant of drought. The Meadin soil generally is not suited to windbreaks because of the shallowness to gravelly coarse sand and the low available water capacity. Onsite investigation is needed when suitable sites for trees and shrubs are selected. Planting the trees on the contour and terracing help to control water erosion. Growing a cover crop between the tree rows helps to control soil blowing. Insufficient rainfall is the main hazard affecting seedling establishment. Competition for moisture from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. Grading is required to modify the slope and to shape the lagoon. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads. The road damage caused by frost action in the O'Neill soil can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are VIe-3, dryland, and IVe-9, irrigated. The O'Neill soil is in the Sandy range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

**Pg—Pits, sand and gravel.** This map unit consists of open excavations from which sand and gravel have been removed. Slopes are uneven and broken. They range from gently sloping at the bottom of pits to almost vertical at the rim. Many pits are filled with water. Areas are irregular in shape and range from 5 to 160 acres in size. Included in this unit in mapping are old pits that are no longer being used.

The material at the bottom of the pits is mainly sand and gravel, but the material varies widely in texture because of mixing and sorting during excavation. Mounds of discarded sand are common in old gravel pits. Mounds of spoil overburden are common on the perimeter of the excavations. The bottom and sides of the pits support little or no vegetation.

Most of the pits are privately owned and operated. Sand and gravel extracted from these pits are used as aggregate for concrete and for surfacing dirt roads.

Abandoned pits are not suitable for cultivation and have little value for range unless vegetation is established. Some can be developed for recreational activities, especially fishing, and some provide limited cover for wildlife.

The capability unit is Vllls-8, dryland; windbreak suitability group 10. No range site is assigned.

**PtB—Pivot loamy sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, somewhat excessively drained soil is on uplands and the floors of dry sandhill valleys. It formed in 23 inches of sandy eolian material and sandy alluvium overlying coarse sand or gravelly coarse sand. Areas range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 9 inches thick. The subsurface layer also is dark grayish brown, very friable loamy sand. It is about 7 inches thick. Below this is a transition layer of grayish brown, very friable loamy sand about 6 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown sand in the upper part, very pale brown coarse sand in the next part, and very pale brown gravelly coarse sand in the lower part. In some places the surface layer is loamy fine sand, sandy loam, or fine sandy loam. In other places it is dark and is less than 10 inches thick. In some areas thin strata of loamy material are below the coarse sand. In other areas the underlying material is fine sand or sand.

Included with this soil in mapping are small areas of Meadin, O'Neill, and Valentine soils. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are in upland positions similar to or slightly lower than those of the Pivot soil. O'Neill soils are finer textured above the coarse sand, sand, or gravelly coarse sand

than the Pivot soil. They are in upland positions similar to those of the Pivot soil. Valentine soils are in the higher hummocky areas and are excessively drained. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Pivot soil and very rapid in the lower part. Available water capacity is low. Organic matter content is moderately low. The rate of water intake is very high. Runoff is very slow.

About two-thirds of the acreage supports native grasses and is used for grazing or hay. Some small areas are used for dryland farming. Some areas are used as irrigated cropland.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the better suited crops because they grow and mature in the spring, when the amount of rainfall is highest. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. Conserving moisture is a problem. Soil blowing can be controlled and moisture conserved by a cropping system that keeps crops, crop residue, or grass on the surface. The cropping sequence should include a limited proportion of row crops and the maximum proportion of close-growing crops that protect the surface. Returning crop residue to the soil increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard. A system of conservation tillage that keeps crops or crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil and applying feedlot manure increase the organic matter content.

If this soil is used as range, the climax vegetation is dominantly needleandthread, blue grama, sand bluestem, prairie junegrass, little bluestem, and prairie sandreed. These species make up 55 percent or more of the total annual forage. Sand dropseed, sedges, common pricklypear, and other perennial grasses and forbs make up the remaining 45 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie junegrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Drought and competition for moisture from grasses and weeds are hazards. Young trees and shrubs should be watered during periods of low rainfall. Weeds and undesirable grasses near the tree rows can be controlled by timely cultivation and by applications of approved herbicide.

This soil generally is suitable as a site for buildings and roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

The capability units are IVe-5, dryland, and IIIe-14, irrigated; Sandy range site; windbreak suitability group 5.

**RtB—Ronson-Tassel fine sandy loams, 0 to 3 percent slopes.** These nearly level and very gently sloping, well drained soils are on uplands. The moderately deep Ronson soil generally is in swales. The shallow Tassel soil is on knolls. Both soils formed in material weathered from soft sandstone. Areas range from 10 to more than 200 acres in size. They are 40 to 60 percent Ronson soil and 30 to 50 percent Tassel soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Ronson soil has a surface layer of very dark grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is very dark grayish brown and dark brown, very friable fine sandy loam about 8 inches thick. Both the surface layer and subsurface layer have few fine, noncalcareous sandstone fragments. Below the subsurface layer is a transition layer of brown, very friable sandy loam about 4 inches thick. It has few or common fine, noncalcareous sandstone fragments. The underlying material is light olive brown sandy loam about 10 inches thick. It has common fine, noncalcareous sandstone fragments. White, soft, calcareous sandstone is at a depth of about 27 inches. In some places the surface layer is thinner, lighter colored, or sandier. In other places the soil has a silty or clayey subsoil. In some areas the depth to soft sandstone is more than 40 inches. In a few areas there is a discontinuous stone line in the underlying layer.

Typically, the Tassel soil has a surface layer of dark grayish brown, very friable fine sandy loam about 6 inches thick. The layer has few fine and medium, calcareous sandstone fragments. The underlying material is light brownish gray fine sandy loam about 11 inches thick. It has many medium and coarse, calcareous sandstone fragments. White, soft, calcareous sandstone is at depth of about 17 inches. In some places the surface layer is sandy loam or loamy fine sand. In other places it is dark and is more than 7 inches thick. In some areas the soil above the sandstone is calcareous. In a few places small sandstone rocks are on the surface.

Included with these soils in mapping are small areas of Anselmo and Dunday soils. These included soils do not have sandstone within a depth of 60 inches. Anselmo soils are on upland divides and side slopes. Dunday soils are sandier throughout than the Ronson and Tassel soils. They are on upland side slopes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately rapid in the Ronson and Tassel soils. Available water capacity is low in the

Ronson soil and very low in the Tassel soil. Organic matter content is moderate in the Ronson soil and low in the Tassel soil. The rate of water intake is moderately high in both soils. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing or hay. Some small areas are used for dryland farming. Some areas are used as cropland irrigated by sprinklers.

If used for dryland farming, these soils are poorly suited to cultivated crops. They are best suited to alfalfa and introduced grasses for hay or pasture because of the low or very low available water capacity and the moderately deep or shallow root zone. Soil blowing is a moderate hazard. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Wind stripcropping also helps to control soil blowing. Returning crop residue or green manure crops to the soils improves fertility and increases the organic matter content. Deep tillage should be avoided so that sandstone rocks are not brought to the surface.

If irrigated, these soils are suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Because of the moderately deep or shallow root zone and the low or very low available water capacity, timely applications of water and carefully selected application rates are needed. Soil blowing is a moderate hazard. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control soil blowing, conserves moisture, and increases the rate of water infiltration. Returning crop residue or green manure crops to the soils increases the organic matter content.

If these soils are used as range, the climax vegetation on the Ronson soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 75 percent or more of the total annual forage on this soil. Switchgrass, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Tassel soil is dominantly little bluestem, sand bluestem, prairie sandreed, and sideoats grama. These species make up 70 percent or more of the total annual forage on this soil. Needleandthread, threadleaf sedge, blue grama,

and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. Under continuous heavy grazing, little bluestem and sand bluestem decrease in abundance. Initially, these species are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, annual grasses, and forbs. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Ronson soil and 0.7 on the Tassel soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The Ronson soil is suited to the trees and shrubs grown as windbreaks. The Tassel soil is unsuitable for windbreaks because of the shallow root zone and the very low available water capacity. Before a windbreak is planned, onsite investigation is needed. Insufficient rainfall is the main hazard affecting seedling establishment on the Ronson soil. Because of the low available water capacity, only drought-tolerant species should be planted. Growing a cover crop between the tree rows helps to control soil blowing. Competition for moisture from weeds and grasses is a management

concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

If these soils are used as sites for septic tank absorption fields, raising or mounding the site with suitable fill material improves the filtering capacity of the fields. Sewage lagoons can be constructed if they are sealed after excavation. Sealing the lagoon helps to prevent seepage.

These soils generally are suitable as sites for dwellings and other buildings and for shallow excavations. The Tassel soil generally is suitable as a site for roads. The road damage caused by frost action in the Ronson soil can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. Onsite investigation is needed before any engineering practices are applied.

The capability units are IVE-3, dryland, and IVE-9, irrigated. The Ronson soil is in the Sandy range site and windbreak suitability group 6R. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**RtC—Ronson-Tassel fine sandy loams, 3 to 6 percent slopes.** These gently sloping, well drained soils are on uplands. The moderately deep Ronson soil generally is on the smooth, lower side slopes. The shallow Tassel soil is on the upper ridges and side slopes. Both soils formed in material weathered from soft sandstone. Areas range from 10 to more than 200 acres in size. They are 40 to 60 percent Ronson soil and 30 to 50 percent Tassel soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Ronson soil has a surface layer of dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer also is dark grayish brown, very friable fine sandy loam. It is about 7 inches thick. Below this is a transition layer of brown, very friable fine sandy loam about 5 inches thick. The underlying material is pale brown and light gray sandy loam about 19 inches thick. It has many fine fragments of sandstone. Pale yellow, calcareous, soft sandstone is at a depth of about 37 inches. In some areas the surface layer is thinner, lighter colored, or sandier. In other areas the soil has a silty or clayey subsoil. In places the depth to soft sandstone is more than 40 inches.

Typically, the Tassel soil has a surface layer of grayish brown, very friable, calcareous fine sandy loam about 6 inches thick. The underlying material is light

brownish gray, calcareous fine sandy loam about 3 inches thick. It has few fine calcareous fragments of sandstone. White, calcareous, soft sandstone is at a depth of about 9 inches. In some places the surface layer is sandy loam or loamy fine sand. In other places it is dark and is more than 7 inches thick. In some areas the soil above the sandstone is noncalcareous. In other areas small sandstone rocks are on the surface.

Included with these soils in mapping are small areas of Anselmo, Dunday, and Valentine soils. Anselmo and Dunday soils are in positions on side slopes slightly lower than or similar to those of the Ronson and Tassel soils. They do not have sandstone within a depth of 60 inches. Dunday soils are sandier throughout than the Ronson and Tassel soils. Valentine soils are sandy throughout. They are in hummocky areas. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately rapid in the Ronson and Tassel soils. Available water capacity is low in the Ronson soil and very low in the Tassel soil. Organic matter content is moderate in the Ronson soil and low in the Tassel soil. The rate of water intake is moderately high in both soils. Runoff is medium.

Most of the acreage supports native grasses and is used for grazing or hay. Some small areas are used for dryland farming. Some areas are used as cropland irrigated by sprinklers.

If used for dryland farming, these soils are poorly suited to cultivated crops. They are best suited to alfalfa and introduced grasses for hay or pasture because of the low or very low available water capacity and the moderately deep or shallow root zone. Soil blowing and water erosion are hazards. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Contour farming helps to control water erosion. Stripcropping helps to control soil blowing. Returning crop residue or green manure crops to the soils improves fertility and increases the organic matter content. Deep tillage should be avoided so that sandstone rocks are not brought to the surface.

If irrigated, these soils are suited to corn, alfalfa, and introduced grasses. A sprinkler system is the best method of irrigation. Because of the moderately deep or shallow root zone and the low or very low available water capacity, timely applications of water and carefully selected application rates are needed. Soil blowing and water erosion are hazards. Contour farming and a system of conservation tillage, such as no-till planting, that keeps crop residue on the surface help to control water erosion and soil blowing, conserve moisture, and increase the rate of water infiltration. Returning crop residue or green manure crops to the soils increases the organic matter content.

If these soils are used as range, the climax vegetation on the Ronson soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 75 percent or more of the total annual forage on this soil. Switchgrass, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Tassel soil is dominantly little bluestem, sand bluestem, prairie sandreed, and sideoats grama. These species make up 70 percent or more of the total annual forage on this soil. Needleandthread, threadleaf sedge, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. Under continuous heavy grazing, little bluestem and sand bluestem decrease in abundance. Initially, these species are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, annual grasses, and forbs. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Ronson soil and 0.7 on the Tassel soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter

range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The Ronson soil is suited to some of the trees and shrubs grown as windbreaks. The Tassel soil is not suitable for windbreaks because of the shallow root zone and the very low available water capacity. Before a windbreak is planned, onsite investigation is needed. Insufficient rainfall is the main hazard affecting seedling establishment on the Ronson soil. Because of the low available water capacity, only drought-tolerant species should be planted. Growing a cover crop between the tree rows helps to control soil blowing. Planting the trees on the contour and terracing help to control water erosion. Competition for moisture from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

If these soils are used as sites for septic tank absorption fields, raising or mounding the site with suitable fill material improves the filtering capacity of the fields. Sewage lagoons can be constructed if they are sealed after excavation. Sealing the lagoon helps to prevent seepage.

These soils generally are suitable as sites for dwellings and shallow excavations. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. The road damage caused by frost action in the Ronson soil can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. The Tassel soil generally is suitable as a site for roads. Onsite investigation is needed before any engineering practices are applied.

The capability units are IVe-3, dryland, and IVe-9, irrigated. The Ronson soil is in the Sandy range site and windbreak suitability group 6R. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**RtD—Ronson-Tassel fine sandy loams, 6 to 11 percent slopes.** These strongly sloping, well drained soils are on ridges and side slopes in the uplands. The moderately deep Ronson soil generally is on the smooth, lower side slopes. The shallow Tassel soil is on

the upper ridges and side slopes. Both soils formed in material weathered from soft sandstone. Areas range from 15 to more than 150 acres in size. They are 35 to 60 percent Ronson soil and 25 to 50 percent Tassel soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Ronson soil has a surface layer of dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is very dark grayish brown, very friable fine sandy loam about 6 inches thick. Below this is a transition layer of light brownish gray, very friable fine sandy loam about 7 inches thick. The underlying material is light brownish gray, fine sandy loam about 5 inches thick. Both the transition layer and the underlying material have many fine and medium fragments of sandstone. White and pale yellow, calcareous, soft sandstone is at a depth of about 24 inches. In some places the surface layer is thinner and lighter colored. In other places the depth to soft sandstone is more than 40 inches.

Typically, the Tassel soil has a surface layer of dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The subsurface layer also is dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The surface layer and subsurface layer have few fine calcareous fragments of sandstone. The underlying material is grayish brown, calcareous fine sandy loam about 5 inches thick. It has many fine and medium, calcareous fragments of sandstone. White, calcareous, soft sandstone is at a depth of about 11 inches. In some places the surface layer is sandy loam or loamy fine sand. In other places it is dark and is more than 7 inches thick. In some areas the soil above the sandstone is noncalcareous.

Included with these soils in mapping are small areas of Dunday and Valentine soils and outcrops of sandstone. Dunday soils do not have sandstone within a depth of 60 inches and are sandier throughout than the Ronson and Tassel soils. They are on the lower side slopes. Valentine soils are sandy throughout. They are in hummocky areas. The rock outcrops generally are on the top of ridges. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Ronson and Tassel soils. Available water capacity is low in the Ronson soil and very low in the Tassel soil. Organic matter content is moderate in the Ronson soil and low in the Tassel soil. Runoff is medium on the Ronson soil and medium or rapid on the Tassel soil.

Nearly all of the acreage supports native grasses and is used for grazing or hay. These soils generally are unsuitable for dryland and irrigated crops because of the slope, the low or very low available water capacity,

and the moderately deep or shallow root zone.

If these soils are used as range, the climax vegetation on the Ronson soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 75 percent or more of the total annual forage on this soil. Switchgrass, sedges, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Tassel soil is dominantly little bluestem, sand bluestem, prairie sandreed, and sideoats grama. These species make up 70 percent or more of the total annual forage on this soil. Needleandthread, threadleaf sedge, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. Under continuous heavy grazing, little bluestem and sand bluestem decrease in abundance. Initially, these species are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, annual grasses, and forbs. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Ronson soil and 0.7 on the Tassel soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities and the steeper slopes may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the following

year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

The Ronson soil is suited to some of the trees and shrubs grown as windbreaks. The Tassel soil is unsuitable for windbreaks because of the shallow root zone and the low available water capacity. Before a windbreak is planned, onsite investigation is needed. Insufficient rainfall is the main hazard affecting seedling establishment on the Ronson soil. Because of the low available water capacity, only drought-tolerant species should be planted. A cover crop between the tree rows helps to control soil blowing. Planting the trees on the contour and terracing help to control water erosion. Competition for moisture from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

If these soils are used as sites for septic tank absorption fields, raising or mounding the site with suitable fill material improves the filtering capacity of the fields. Sewage lagoons can be constructed if they are sealed after excavation. Sealing the lagoon helps to prevent seepage. Grading is required to modify the slope and shape the lagoon. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads. The road damage caused by frost action in the Ronson soil can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. Onsite investigation is needed before any engineering practices are applied.

The capability unit is V1e-3, dryland. The Ronson soil is in the Sandy range site and windbreak suitability group 6R. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**ScB—Sandose loamy fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, well drained soil is on broad divides and in swales on uplands. It formed in sandy eolian material over loamy sediment. Areas range from 10 to 240 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 10 inches thick. The subsurface layer is brown, very friable loamy fine sand about 5 inches thick. The subsoil is about 31 inches thick. It is pale brown, very friable loamy fine sand in the upper part; light yellowish brown, firm loam in the next part; and light gray, firm, calcareous loam in the lower part. The underlying material to a depth of more than 60 inches is light gray, calcareous very fine sandy loam. In some places the sandy material is less than 20 inches or more than 40 inches deep over the loamy material. In other places the dark surface layer is less than 10 inches thick. In a few areas the loamy material is at the surface.

Included with this soil in mapping are small areas of Anselmo, Dunday, Jansen, Johnstown, and Valentine soils. Anselmo, Dunday, and Valentine soils are on side slopes and in positions higher than those of the Sandose soil. Anselmo soils have less sand and more silt and clay than the Sandose soil. Dunday and Valentine soils have more sand and less silt and clay in the underlying material than the Sandose soil. Jansen and Johnstown soils are in positions on upland divides similar to or slightly lower than those of the Sandose soil. Jansen soils have sand, coarse sand, or gravelly coarse sand at a depth of 20 to 40 inches. Johnstown soils have more clay and less sand in the subsoil than the Sandose soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the upper part of the Sandose soil and moderate in the loamy underlying material. Available water capacity is high. Organic matter content is moderately low. The rate of water intake is high. Runoff is slow.

Most of the acreage is used as cropland, nearly all of which is irrigated. The rest supports native grasses and is used for grazing or hay.

If used for dryland farming, this soil is suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the most dependable crops because they grow and mature in the spring, when the amount of rainfall is highest. The soil is highly susceptible to soil blowing. A cropping system that keeps crops, grass, or crop residue on the surface helps to control soil blowing, conserves moisture, and helps to maintain the organic matter content. Applying feedlot manure increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation because of the high rate of water intake. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Returning crop residue to the soil increases the organic matter

content. Keeping crops, grass, or crop residue on the surface helps to control soil blowing and conserves moisture.

If this soil is used as range, the climax vegetation is dominantly little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 65 percent or more of the total annual forage. Sand bluestem, sedges, and other annual and perennial grasses and forbs make up the remaining 35 percent. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Insufficient moisture and soil blowing are the principal hazards. Soil blowing can be controlled by strips of sod or a cover crop between the tree rows. Competition from weeds and grasses in the rows is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by

applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

This soil generally is suitable as a site for dwellings without basements and for roads. The foundations of dwellings with basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling.

The capability units are IIIe-6, dryland, and IIIe-10, irrigated; Sandy range site; windbreak suitability group 5.

#### **SkB—Simeon loamy sand, 0 to 3 percent slopes.**

This deep, nearly level and very gently sloping, excessively drained soil is on uplands and in swales in the Sandhills. It formed in sandy alluvium that in some areas has been reworked by the wind. Areas range from 20 to more than 500 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 5 inches thick. Below this is a transition layer of brown, loose sand about 5 inches thick. The underlying material to a depth of more than 60 inches is very pale brown coarse sand. It contains as much as 10 percent gravel. In some areas it has strata of gravelly coarse sand.

Included with this soil in mapping are small areas of Meadin and Pivot soils. These soils have a dark surface layer that is thicker than that of the Simeon soil. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are in positions on uplands similar to or lower than those of the Simeon soil. Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. They are in positions on uplands similar to those of the Simeon soil. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Simeon soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is very slow.

Most of the acreage supports native grasses and is used for grazing. A few areas are used as irrigated cropland. This soil is unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for

gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing. Grazing of crop residue should be restricted because of a need for a maximum cover of crop residue.

If this soil is used as range, the climax vegetation is dominantly blue grama, prairie sandreed, needleandthread, sand bluestem, little bluestem, and clubmoss. These species make up 80 percent or more of the total annual forage. Hairy grama, fringed sagewort, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain little bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Because of the low available water capacity, the soil is droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

This soil generally is unsuited to the trees and shrubs grown as windbreaks because it is very droughty and is subject to severe soil blowing. Some areas can be used for drought-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if special management is applied.

This soil generally is suitable as a site for buildings and roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

The capability units are VIs-4, dryland, and IVs-14, irrigated; Shallow to Gravel range site; windbreak suitability group 10.

#### **SkD—Simeon loamy sand, 3 to 9 percent slopes.**

This deep, gently sloping and strongly sloping, excessively drained soil is on uplands and side slopes dissected by drainageways. It formed in sandy alluvium that in some areas has been reworked by the wind. Areas range from 20 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 5 inches thick. Below this is a transition layer of brown, very friable loamy sand about 7 inches thick. The underlying material extends to a depth of more than 60 inches. It is light yellowish brown loamy coarse sand in the upper part, pale brown coarse sand in the next part, and very pale brown sand in the lower part. In some places the underlying material is fine sand. In other places it has thin layers of gravelly coarse sand.

Included with this soil in mapping are small areas of Meadin and Pivot soils. These soils are in positions on uplands similar to those of the Simeon soil. They have a dark surface layer that is thicker than that of the Simeon soil. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. They are somewhat excessively drained. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Simeon soil. Available water capacity is low. Organic matter content also is low. Runoff is very slow.

Most of the acreage supports native grasses and is used for grazing. This soil is unsuited to cultivated crops because of droughtiness and the hazard of soil blowing.

If this soil is used as range, the climax vegetation is dominantly blue grama, prairie sandreed, needleandthread, sand bluestem, little bluestem, and clubmoss. These species make up 80 percent or more of the total annual forage. Hairy grama, fringed sagewort, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama,

blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain little bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling water erosion and soil blowing. Because of the low available water capacity, the soil is droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

This soil generally is unsuited to the trees and shrubs grown as windbreaks because it is very droughty and is subject to severe soil blowing and water erosion. Some areas can be used for drought-tolerant trees and shrubs that enhance recreational areas and wildlife habitat if special management is applied.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The soil generally is suitable as a site for dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded.

The capability unit is VIs-4, dryland; Shallow to Gravel range site; windbreak suitability group 10.

**SvD—Simeon-Valentine fine sands, 0 to 9 percent slopes.** These deep, nearly level to strongly sloping, excessively drained soils are on uplands adjacent to breaks along the Niobrara River and its major tributaries. The Simeon soil formed in sandy alluvium that in some areas has been reworked by the wind. The

Valentine soil formed in sandy eolian material. The Simeon soil is in the nearly level and very gently sloping areas between higher hummocky areas. The Valentine soil is in the gently sloping to strongly sloping hummocky areas. Areas range from 40 to 250 acres in size. They are 50 to 60 percent Simeon soil and 25 to 40 percent Valentine soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Simeon soil has a surface layer of dark grayish brown, very friable fine sand about 5 inches thick. Below this is a transition layer of brown, very friable sand about 4 inches thick. The underlying material to a depth of more than 60 inches is very pale brown sand and coarse sand. In some places thin layers of gravelly coarse sand are in the underlying material. In other places loamy material is below a depth of 50 inches. In some areas the surface layer is sand or loamy sand.

Typically, the Valentine soil has a surface layer of grayish brown, very friable fine sand about 6 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sand.

Included with these soils in mapping are small areas of Meadin and Pivot soils. These included soils are in positions on uplands similar to those of the Simeon and Valentine soils. They have a dark surface layer that is thicker than that of the Simeon and Valentine soils. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up as much as 10 percent of the unit.

Permeability is rapid in the Simeon and Valentine soils. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is very slow on the Simeon soil and slow on the Valentine soil.

Nearly all of the acreage supports native grasses and is used for grazing. A few areas are used as irrigated cropland. These soils are unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soils are too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing and water erosion are hazards if the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing and water erosion. Grazing of crop

residue should be restricted because of the need for a maximum cover of crop residue.

If these soils are used as range, the climax vegetation on the Simeon soil is dominantly blue grama, prairie sandreed, needleandthread, sand bluestem, little bluestem, and clubmoss. These species make up 80 percent or more of the total annual forage on this soil. Hairy grama, fringed sagewort, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

The climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the annual forage on this soil. Sand lovegrass, blue grama, needleandthread, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.6 on the Simeon soil and 0.9 on the Valentine soil. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain little bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling water erosion and soil blowing. Because of the low available water capacity, the soils are droughty.

The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

The Valentine soil is suited to the trees and shrubs grown as windbreaks, but the Simeon soil is unsuited. Onsite investigation is needed to identify the areas best suited to windbreaks. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Generally, this soil is too droughty for good survival and growth of trees unless additional water can be applied. Soil blowing is a hazard. Seedlings can be damaged by the wind or covered by drifting sand. Planting the trees on the contour and maintaining strips of sod or other vegetation between the tree rows help to control soil blowing and water erosion. Weeds and undesirable grasses in areas next to the trees can be controlled by timely cultivation and by applications of approved herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

These soils generally are suitable as sites for dwellings and roads. Buildings on the Valentine soil should be designed so that they conform to the natural slope of the land, or the site should be graded.

The capability units are VIs-4, dryland, and IVs-14, irrigated. The Simeon soil is in the Shallow to Gravel range site and windbreak suitability group 10. The Valentine soil is in the Sands range site and windbreak suitability group 7.

**Tn—Tryon loamy fine sand, 0 to 2 percent slopes.** This deep, nearly level, poorly drained soil is in sandhill valleys. It is subject to rare flooding. It formed in eolian and alluvial sediment. Areas range from 10 to more than 500 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is mottled fine sand. It is light brownish gray in the upper part, light gray in the next part, and light brownish gray in the lower part. In places the dark surface soil is more than 10 inches thick.

Included with this soil in mapping are small areas of Els, Elsmere, Ipage, and Marlake soils. Els and Elsmere soils are somewhat poorly drained and are in positions in sandhill valleys slightly higher than those of the Tryon soil. Elsmere soils have a dark surface soil that is more

than 10 inches thick. lpage soils are moderately well drained. They are on small hummocks and low ridges on the higher parts of the sandhill valleys. Marlake soils are in depressions and are covered with water during most of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Tryon soil. Available water capacity is low. Organic matter content is high. Runoff is very slow. The seasonal high water table is at the surface in wet years and at a depth of about 1.5 feet in dry years. The water table normally recedes to a depth of about 2 to 3 feet in late summer.

Most of the acreage supports native grasses and is used for grazing or hay. The soil generally is too wet for cultivation.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly switchgrass, indiagrass, big bluestem, and prairie cordgrass. These species make up 60 percent or more of the total annual forage. Slender wheatgrass, plains bluegrass, and other perennial grasses, forbs, and sedges make up the remaining 40 percent. Under continuous heavy grazing or improper haying, big bluestem, prairie cordgrass, switchgrass, and indiagrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, plains bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity.

Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying activities generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a seasonal high water table. Wetness is the main limitation. Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Weeds and undesirable grasses that compete with the trees can be controlled by timely cultivation and by applications of approved herbicide.

This soil is not suitable as a site for sanitary facilities because of the wetness. A suitable alternative site is needed. The sides of shallow excavations can cave in unless they are temporarily shored. The excavations should be made during dry periods. Constructing dwellings and other buildings on raised, well compacted fill material increases the depth to the seasonal high water table and minimizes the damage caused by floodwater. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by wetness.

The capability unit is Vw-7, dryland; Wet Subirrigated range site; windbreak suitability group 2D.

**To—Tryon loamy fine sand, wet, 0 to 2 percent slopes.** This deep, nearly level, very poorly drained soil is on valley floors in the Sandhills. It is subject to rare flooding and commonly is subject to ponding by a seasonal high water table in the spring and during other wet periods. It formed in eolian and alluvial sediment. Areas range from 10 to 100 acres in size.

Typically, the surface layer is dark gray, mottled, very friable loamy fine sand about 6 inches thick. Below this is a transition layer of dark grayish brown and light brownish gray, very friable fine sandy loam about 3

inches thick. The underlying material to a depth of 60 inches is mottled. It is light brownish gray loamy fine sand in the upper part and light gray fine sand in the lower part. In places the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are small areas of Els, Elsmere, and Marlake soils. Els and Elsmere soils are somewhat poorly drained. They are in positions in sandhill valleys slightly higher than those of the Tryon soil. Elsmere soils have a dark surface soil that is more than 10 inches thick. Marlake soils are in depressions and are covered with water during most of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Tryon soil. Available water capacity is low. Organic matter content is high. Runoff is ponded. The seasonal high water table is about 0.5 foot above the surface in wet years and at a depth of about 1.0 foot in dry years. Water may be on the surface for a week or more during wet periods. By late summer, the water table normally recedes to a depth of 1 or 2 feet.

Most of the acreage supports native grasses and is used for grazing or hay. This soil is too wet for cultivation.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, northern reedgrass, and bluejoint reedgrass. These species make up 60 percent or more of the total annual forage. Slender wheatgrass, rushes, and other perennial grasses, forbs, and sedges make up the remaining 40 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, plains bluegrass, green muhly, and various sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, plains bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 2.1 animal unit months per acre. This soil can produce high yields, but the forage is of low quality. The forage is of higher quality early in the growing season. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. It should

be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. In some years hay cannot be harvested because of the excessive wetness. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

This soil is unsuited to trees and shrubs grown as windbreaks because of the wetness and ponding caused by the seasonal high water table. A few areas can be used for water-tolerant trees or shrubs that enhance recreational areas and wildlife habitat if they are hand planted or other special management is applied.

This soil is not suitable as a site for sanitary facilities, dwellings, or other buildings because of the ponding. A suitable alternative site is needed. Constructing local roads on suitable, well compacted fill material above the level of ponding, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by ponding and wetness.

The capability unit is Vw-7, dryland; Wetland range site; windbreak suitability group 10.

#### **TpB—Tryon-Els complex, 0 to 3 percent slopes.**

These deep, nearly level and very gently sloping soils are in sandhill valleys. They are subject to rare flooding. The Tryon soil is poorly drained, is nearly level, and is in the lower areas. The Els soil is somewhat poorly drained, is nearly level and very gently sloping, and is in the slightly higher areas. The Tryon soil formed in eolian and alluvial sediment. The Els soil formed in mixed eolian and alluvial sandy material. Areas range from 20 to about 300 acres in size. They are 40 to 55 percent Tryon soil and 35 to 50 percent Els soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Tryon soil has a surface layer of dark gray, very friable loamy fine sand about 5 inches thick. Below this is a transition layer of grayish brown, mottled, loose fine sand about 3 inches thick. The underlying material to a depth of more than 60 inches is mottled fine sand. It is light brownish gray in the upper part, light gray in the next part, and light brownish gray in the lower part. In a few places the dark surface layer is more than 10 inches thick. In a few areas ponding may occur during wet periods.

Typically, the Els soil has a surface layer of grayish brown, very friable fine sand about 6 inches thick. Below this is a transition layer of brown, loose fine sand

about 6 inches thick. The underlying material to a depth of more than 60 inches is mottled fine sand. It is light brownish gray in the upper part and light gray in the lower part. In a few areas the dark surface layer is more than 10 inches thick.

Included with these soils in mapping are small areas of Ipage and Marlake soils. Ipage soils are moderately well drained. They are in the higher hummocky areas. Marlake soils are very poorly drained. They are in the lowest depressions in the valleys. They are ponded during much of the growing season. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Tryon and Els soils. Available water capacity is low. Organic matter content is high in the Tryon soil and moderately low in the Els soil. Runoff is slow on the Els soil and very slow on the Tryon soil. The seasonal high water table in the Tryon soil is at the surface in wet years and at a depth of about 1.5 feet in dry years. Depth to the seasonal high water table in the Els soil ranges from 1.5 feet in wet years to 3.0 feet in dry years.

Nearly all of the acreage supports native grasses and is used for grazing or hay. These soils generally are unsuitable for cultivation because of the wetness.

If these soils are used as range, either for grazing or hay, the climax vegetation on the Tryon soil is dominantly switchgrass, indiagrass, big bluestem, and prairie cordgrass. These species make up 60 percent or more of the total annual forage on this soil. Slender wheatgrass, plains bluegrass, and other annual and perennial grasses, forbs, and sedges make up the remaining 40 percent. Under continuous heavy grazing or improper haying, big bluestem, prairie cordgrass, switchgrass, and indiagrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, western wheatgrass, and various sedges. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, plains bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

The climax vegetation on the Els soil is dominantly big bluestem, little bluestem, indiagrass, and switchgrass. These species make up 85 percent or more of the total annual forage on this soil. Prairie cordgrass, sedges, and other annual and perennial grasses and forbs make up the remaining 15 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these

species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clover, and other forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 1.9 on the Tryon soil and 1.7 on the Els soil. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. These soils generally are the first to be overgrazed when they are grazed in conjunction with better drained sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. Since haying activities generally extend over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

These soils are suited to some of the trees and shrubs grown as windbreaks. The only suitable species are those that can withstand a seasonal high water table. Establishing trees is difficult in wet years.

Preparing the site and planting in the spring may not be possible until the water table drops and the soil is sufficiently dry. Soil blowing can be controlled by growing a cover crop between the tree rows.

Competition for moisture from grasses or weeds is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by applications of approved herbicide.

The Tryon soil generally is not suitable as a site for sanitary facilities because of the wetness. A suitable alternative site is needed. The Els soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Fill material can elevate the absorption field a sufficient distance above the seasonal high water table. Constructing sewage lagoons on fill material raises the bottom of the lagoon a sufficient distance above the seasonal high water table in the Els soil. Lining or sealing the lagoon helps to prevent seepage. The sides of shallow excavations in these soils can slough or cave in unless they are temporarily shored. The excavations should be made during dry periods.

Constructing dwellings and other buildings on elevated, well compacted fill material increases the depth to the seasonal high water table and helps to prevent the structural damage caused by flooding. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness. The road damage caused by frost action in the Els soil can be minimized by establishing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage. Onsite investigation is needed before any engineering practices are applied.

The capability unit is Vw-7, dryland. The Tryon soil is in the Wet Subirrigated range site and windbreak suitability group 2D. The Els soil is in the Subirrigated range site and windbreak suitability group 2S.

#### **VaB—Valentine fine sand, 0 to 3 percent slopes.**

This deep, excessively drained, nearly level and very gently sloping soil is in swales in the Sandhills and on uplands. It formed in sandy eolian material. Areas range from 15 to 200 acres in size.

Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. Below this is a transition layer of grayish brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown fine sand. In some of the concave and lower

areas, the dark surface layer is more than 10 inches thick. In a few areas the underlying material has layers of coarse sand. In places, darker, loamy material is at a depth of more than 40 inches.

Included with this soil in mapping are small areas of Els and Ipage soils. Els soils are in the lower areas of valleys or depressions and are somewhat poorly drained. Ipage soils are in the slightly lower positions in the sandhill valleys and are moderately well drained. Included soils make up less than 15 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing or hay. A few areas are used as irrigated cropland. This soil is unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing. Grazing of crop residue should be restricted because of the need for a maximum cover of crop residue.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 85 percent or more of the total annual forage. Sand dropseed, switchgrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 15 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally

is the first to be overgrazed when it is grazed in conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing and drought are hazards. Young seedlings can be damaged by high winds or covered by drifting sand. The soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Strips of sod or other vegetation between the tree rows help to control soil blowing. Weeds and undesirable grasses near the trees can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The soil generally is suitable as a site for dwellings and roads.

The capability units are VIe-5, dryland, and IVe-12, irrigated; Sandy range site; windbreak suitability group 7.

#### **VaD—Valentine fine sand, 3 to 9 percent slopes.**

This deep, gently sloping to strongly sloping, excessively drained soil is on uplands and in the Sandhills. It formed in sandy eolian material. Areas range from 20 to 640 acres in size.

Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. Below this is a

transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand. In a few concave areas and in areas on foot slopes, the dark surface layer is more than 10 inches thick. In a few places the soil has a surface layer of loamy fine sand.

Included with this soil in mapping are small areas of Els and Ipage soils and blowouts. Els soils are somewhat poorly drained and are in the lower depressions. Ipage soils are moderately well drained. They are on low hummocks and ridges in sandhill valleys. The blowouts are in concave, dished-out areas on side slopes and the tops of dunes where the fine sand has no vegetative cover and is shifted by the wind. The wind easily erodes these areas, and establishing vegetation is difficult. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow.

About two-thirds of the acreage supports native grasses and is used for grazing. The rest is cropland and irrigated by sprinkler systems. This soil is unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is too sandy for gravity irrigation but can be irrigated by sprinklers. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing and water erosion. In order to obtain maximum cover, removal of crop residue and grazing the residue should be restricted. Applications of feedlot manure help to maintain the organic matter content.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the

site. As a result, excessive soil blowing and blowouts are common.

If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing and drought are hazards. Young seedlings can be damaged by high winds or covered by drifting sand. The soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Strips of sod or other vegetation between the tree rows help to control soil blowing and water erosion. Weeds and undesirable grasses near the trees can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily

shored. The soil generally is suitable as a site for dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded.

The capability units are VIe-5, dryland, and IVe-12, irrigated; Sands range site; windbreak suitability group 7.

**VaE—Valentine fine sand, rolling.** This deep, excessively drained soil is in areas of dunes in the Sandhills. It formed in sandy eolian material. Slopes range from 9 to 24 percent. Areas range from 40 to several thousand acres in size.

Typically, the surface layer is grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown fine sand. In a few areas the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Dunday, Els, and Ipage soils and blowouts. Dunday soils have a dark surface layer that is more than 10 inches thick. They are in the lower positions on side slopes in the Sandhills. Els soils are in depressions and are somewhat poorly drained. Ipage soils are moderately well drained. They are on low hummocky slopes or low ridges in sandhill valleys. The blowouts are in concave, dished-out areas on side slopes and the tops of dunes where the fine sand has no vegetative cover and is shifted by the wind. The wind easily erodes these areas, and establishing vegetation is difficult. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. Runoff is slow.

Nearly all of the acreage supports native grasses and is used for grazing. A few areas are periodically cut for hay. This soil is unsuitable for dryland and irrigated crops because of droughtiness, the hazard of soil blowing, and the slope.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the

native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing and drought are hazards. Young seedlings can be damaged by high winds or covered by drifting sand. The soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Strips of sod or other vegetation between the tree rows help to control soil blowing and water erosion. Weeds and undesirable grasses near the trees can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

In areas where slopes are more than 15 percent, this soil is not suitable as a site for septic tank absorption fields. A suitable alternative site is needed. In areas where slopes are less than 15 percent, installing absorption fields on the contour and land shaping help to ensure that the fields function properly. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for the roads.

The capability unit is V1e-5, dryland; Sands range site; windbreak suitability group 7.

**VaF—Valentine fine sand, rolling and hilly.** This deep, excessively drained soil is on rolling and hilly sand dunes in the uplands. It formed in sandy eolian material. The rolling parts are on smooth ridgetops and the lower side slopes. They have slopes of 9 to 24 percent. The hilly parts have slopes of 24 to 60 percent. They are commonly characterized by a succession of short, vertical exposures, or catsteps, which expose the sandy parent material. Areas range from 40 acres to several thousand acres in size. They are 40 to 70 percent Valentine fine sand, rolling, and 20 to 50 percent Valentine fine sand, hilly. The rolling and hilly slopes occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the surface layer is grayish brown, loose fine sand about 4 inches thick. Below this is a transition layer of pale brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sand.

Included with this soil in mapping are small areas of Els and lpage soils and blowouts. Els soils are in depressions and are somewhat poorly drained. lpage soils are moderately well drained. They are on low, hummocky slopes or low ridges in sandhill valleys. The blowouts are in concave, dished-out areas on side slopes and the tops of dunes where the fine sand has no vegetative cover and is shifted by the wind. The wind easily erodes these areas, and establishing vegetation is difficult. Included areas make up less than 10 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. Runoff is slow.

Nearly all of the acreage supports native grasses and is used for grazing (fig. 7). This soil is unsuitable for dryland and irrigated crops because of droughtiness, the hazard of soil blowing, and the slope.

If this soil is used as range, the climax vegetation on the rolling sites is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on these sites. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, little bluestem, sand lovegrass, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.



Figure 7.—Range in an area of Valentine fine sand, rolling and hilly.

The climax vegetation on the hilly sites is dominantly prairie sandreed, sand bluestem, little bluestem, switchgrass, and needleandthread. These species make up 75 percent or more of the total annual forage on these sites. Sand lovegrass, blue grama, sandhill muhly, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, little bluestem, sand lovegrass, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, hairy grama, sedges, sandhill muhly, sedges, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the rolling sites and 0.7 on the hilly sites. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities and the steeper slopes may be underused.

Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. The very steep slopes can hinder the movement of range animals from one area to another. Small soapweed increases in abundance when the range is used as summer pasture. It can be controlled by using the pasture as winter range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

The rolling areas of this soil are suited to the trees and shrubs grown as windbreaks, but the hilly areas generally are not suited. Onsite investigation is needed to identify the best suited areas. Young seedlings can be damaged by high winds and covered by drifting sand. Planting the trees on the contour and maintaining strips of sod between the tree rows help to control soil blowing and erosion. The trees should be planted in

shallow furrows with as little disturbance of the surface as possible. Irrigation is needed during dry periods. Sod is needed in the rows to prevent competition from weeds and undesirable grasses.

This soil generally is not suitable as a site for sanitary facilities because of the slope. A suitable alternative site is needed. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads.

The capability unit is VIIe-5, dryland. Valentine fine sand, rolling, is in the Sands range site and windbreak suitability group 7. Valentine fine sand, hilly, is in the Choppy Sands range site and windbreak suitability group 10.

**VbB—Valentine loamy fine sand, 0 to 3 percent slopes.** This deep, nearly level and very gently sloping, excessively drained soil is in swales in the Sandhills and on uplands. It formed in sandy eolian material. Areas range from 15 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. Below this is a transition layer of brown, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is pale brown and very pale brown fine sand. In some places the dark surface layer is more than 10 inches thick. In other places the depth to loamy material is more than 40 inches. In some areas the underlying material has layers of coarse sand. In a few areas the surface layer is fine sand.

Included with this soil in mapping are small areas of Els, lpage, Pivot, and Sandose soils. Els and lpage soils are mottled. Els soils are on bottom land in sandhill valleys and are somewhat poorly drained. lpage soils are on low hummocks and low ridges in sandhill valleys and are moderately well drained. Pivot soils are in the slightly higher positions on uplands. They have a dark surface layer that is more than 10 inches thick and have coarse textured underlying material at a depth of 20 to 40 inches. Sandose soils have loamy underlying material. They are on the slightly lower side slopes and in swales in the Sandhills. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing or hay. A few areas are used for dryland or irrigated crops.

If used for dryland farming, this soil is poorly suited to wheat and alfalfa. Wheat and the first cutting of alfalfa generally are the more dependable crops because they grow and mature in the spring, when the amount of rainfall is highest. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. The low available water capacity is a limitation. Soil blowing can be controlled and moisture conserved by a cropping system and a system of conservation tillage that keeps crops, grass, or crop residue on the surface. The cropping sequence should include a limited proportion of row crops and the maximum proportion of close-growing crops that protect the surface and conserve moisture. Stripcropping and stubble mulch tillage help to control soil blowing. Returning crop residue or green manure crops to the soil and applying feedlot manure increase the organic matter content.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Stubble mulch tillage and winter cover crops help to control soil blowing. Returning crop residue or green manure crops to the soil and applying feedlot manure increase the organic matter content.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, prairie sandreed, switchgrass, and needleandthread. These species make up 80 percent or more of the total annual forage. Blue grama, sand lovegrass, and other annual and perennial grasses, forbs, and shrubs make up the remaining 15 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. This soil generally is the first to be overgrazed when it is grazed in

conjunction with Sands or Choppy Sands range sites. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Irrigation is needed during droughty periods. Soil blowing can be controlled by strips of sod or other vegetation between the tree rows. Weeds and undesirable grasses near the trees can be controlled by timely cultivation and by applications of approved herbicide.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The soil generally is suitable as a site for dwellings and other buildings and for roads.

The capability units are IVe-5, dryland, and IVe-11, irrigated; Sandy range site; windbreak suitability group 5.

**VbD—Valentine loamy fine sand, 3 to 9 percent slopes.** This deep, gently sloping and strongly sloping, excessively drained soil is on uplands and in the Sandhills. It formed in sandy eolian material. Areas range from 20 to 800 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. Below this is a transition layer of brown, very friable loamy fine sand about 8 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand. In a few areas the surface layer is fine sand. In some areas it is dark and is more than 10 inches thick.

Included with this soil in mapping are small areas of Els, Ipage, and Sandose soils and blowouts. Els soils are on the bottom land in sandhill valleys and are somewhat poorly drained. Ipage soils are on low hummocky slopes or low ridges in sandhill valleys and are moderately well drained. Sandose soils have loamy underlying material. They are on the lower side slopes and in swales between ridges and dunes of sand. The blowouts are in concave, dished-out areas on side slopes and the tops of dunes where the fine sand has no vegetative cover and is shifted by the wind. The wind easily erodes these areas, and establishing vegetation is difficult. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. Available water capacity is low. Organic matter content also is low. The rate of water intake is very high. Runoff is slow.

About two-thirds of the acreage supports native grasses and is used for grazing or hay. The rest is used as irrigated cropland. This soil generally is unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and introduced grasses. A sprinkler system is the only suitable method of irrigation. The soil is too sandy for gravity irrigation. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to control soil blowing and water erosion. To obtain maximum crop residue cover, removal of the crop residue and grazing of the crop residue should be restricted. Applications of feedlot manure help to maintain the organic matter content.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If this soil is used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

This soil is suited to the trees and shrubs grown as windbreaks. Soil blowing and drought are hazards. Young seedlings can be damaged by high winds or covered by drifting sand. The soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Strips of sod or other vegetation between the tree rows help to control soil blowing and water erosion. Weeds and undesirable grasses near the trees can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The soil generally is suitable as a site for dwellings and roads. Buildings should be designed so

that they conform to the natural slope of the land, or the site should be graded.

The capability units are VIe-5, dryland, and IVe-11, irrigated; Sands range site; windbreak suitability group 7.

**VfD—Valentine-Els fine sands, 0 to 9 percent slopes.** These deep soils are in the Sandhills. The excessively drained, gently sloping and strongly sloping Valentine soil is in hummocky areas. The nearly level, somewhat poorly drained Els soil is in swales between the hummocky areas. It is subject to rare flooding. The Valentine soil formed in sandy eolian material. The Els soil formed in sandy eolian and alluvial material. Areas range from 10 to 1,000 acres in size. They are 40 to 55 percent Valentine soil and 30 to 45 percent Els soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of grayish brown, loose fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is pale brown and light yellowish brown fine sand.

Typically, the Els soil has a surface layer of grayish brown, very friable fine sand about 6 inches thick. Below this is a transition layer of brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is fine sand. It is light yellowish brown and mottled in the upper part, grayish brown and mottled in the next part, and light brownish gray in the lower part. In some places the surface layer is loamy fine sand or loamy sand. In other places it is dark and is more than 10 inches thick. In a few areas the depth to coarse sand is more than 20 inches.

Included with these soils in mapping are small areas of Ipage, Loup, Marlake, and Tryon soils and blowouts. Ipage soils are on low, hummocky slopes between the Valentine and Els soils. They are moderately well drained. Loup, Marlake, and Tryon soils are poorly drained or very poorly drained. Loup and Tryon soils are in depressions, on bottom land, and in low areas in the sandhill valleys. Marlake soils are in the lowest depressional areas. The blowouts are in concave, dished-out areas on side slopes and the tops of dunes where the fine sand has no vegetative cover and is shifted by the wind. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine and Els soils. Available water capacity is low. Organic matter content is low in the Valentine soil and moderately low in the Els soil. The rate of water intake is very high in both soils. Runoff is slow. Depth to the seasonal high water table in the Els soil ranges from about 1.5 feet in wet

years to 3.0 feet in dry years.

Most of the acreage supports native grasses and is used for grazing or hay. A small acreage is used as irrigated cropland. These soils are unsuited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. They are too sandy for gravity irrigation but can be irrigated by sprinklers. The seasonal high water table in the Els soil is a problem during the wettest periods, but during dry years subirrigation can benefit crops. Tiling normally is not required. Timely applications of water and carefully selected application rates are needed to prevent waterlogging in the Els soil and the leaching of plant nutrients below the root zone. Soil blowing and water erosion are hazards if the surface is not adequately protected by crops or crop residue. Soil blowing and water erosion can be controlled by planting cover crops and close-growing crops and by leaving crop residue on the surface. Grazing of crop residue should be limited. Applications of feedlot manure increase the organic matter content.

If these soils are used as range or native hayland, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on this soil. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Els soil is dominantly big bluestem, little bluestem, indiangrass, and switchgrass. These species make up 85 percent or more of the total annual forage on this soil. Prairie cordgrass, sedges, and other annual and perennial grasses and forbs make up the remaining 15 percent. Under continuous heavy grazing or improper haying, big bluestem, little bluestem, indiangrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clover also increase in abundance if they have been overseeded. If

overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clover, and other forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Valentine soil and 1.7 on the Els soil. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. The Els soil generally is grazed more heavily than the Valentine soil. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. For the dominant grasses, the maximum storage of these food reserves is completed by the first frost. The quality of hay is higher when grasses are cut earlier. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. When the Els soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring.

These soils are suited to some of the trees and shrubs grown as windbreaks. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Soil blowing is a hazard on both soils. Young seedlings can be damaged by sand blasting or covered by drifting sand during periods of high winds. Strips of sod between the tree rows help to control soil blowing and water erosion. The species selected for planting on the Els soil should be those that can tolerate occasional wetness. Establishing trees can be difficult in wet periods. Competition from weeds and grasses is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation and by

applications of approved herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The absorption fields should be constructed on fill material so that they are a sufficient distance above the seasonal high water table in the Els soil. Lining or sealing sewage lagoons helps to prevent seepage. Constructing sewage lagoons on fill material raises the lagoon above the seasonal high water table in the Els soil. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Digging in areas of the Els soil should be done during dry periods, when machinery can be operated more easily and cave-ins can be avoided.

The Valentine soil generally is suitable as a site for dwellings and roads. Dwellings on the Els soil should be constructed on elevated, well compacted fill material. This measure helps to prevent the structural damage caused by flooding and increases the depth to the seasonal high water table. Buildings on the Valentine soil should be designed so that they conform to the natural slope of the land, or the site should be graded. Constructing local roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by flooding and wetness in the Els soil. Providing a good surface drainage system and a gravel moisture barrier in the subgrade minimizes the road damage caused by frost action in the Els soil. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are Vle-5, dryland, and IVe-11, irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Els soil is in the Subirrigated range site and windbreak suitability group 2S.

**VhD—Valentine-Libory complex, 0 to 9 percent slopes.** These deep, nearly level to strongly sloping soils are on uplands. The Valentine soil is excessively drained and is gently sloping to strongly sloping. The Libory soil is moderately well drained and is nearly level and very gently sloping. The Valentine soil formed in sandy eolian material. The Libory soil formed in sandy eolian material over loamy and silty sediment. The Valentine soil is in convex hummocky areas. The Libory soil is in swales between the hummocks. Areas range from 10 to about 300 acres in size. They are 50 to 60 percent Valentine soil and 30 to 40 percent Libory soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable fine sand about 6

inches thick. Below this is a transition layer of brown, loose fine sand about 9 inches thick. The underlying material to a depth of 60 inches or more is pale brown fine sand. In places the dark surface layer is more than 10 inches thick.

Typically, the Libory soil has a surface layer of dark gray, very friable loamy fine sand about 5 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The subsoil is about 30 inches thick. It is pale brown, very friable loamy fine sand in the upper part; light brownish gray, mottled, firm silty clay loam in the next part; and light olive gray, mottled, firm silty clay loam in the lower part. The underlying material to a depth of 60 inches or more is light gray, mottled silty clay loam. In some places the sandy material is less than 20 inches or more than 36 inches deep over the loamy material. In other places the loamy material is at the surface. In some areas gravelly coarse sand or coarse sand is at a depth of 40 to 60 inches.

Included with these soils in mapping are small areas of Els, Elsmere, and Ipage soils. These included soils are sandy throughout. Els and Elsmere soils are somewhat poorly drained. They are in the lower depressions in sandhill valleys. Ipage soils do not have a thick, dark surface layer. They are moderately well drained and are in low, hummocky areas. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Valentine soil. It is rapid in the upper part of the Libory soil and moderate in the lower part. Available water capacity is low in the Valentine soil and high in the Libory soil. Organic matter content is low in the Valentine soil and moderately low in the Libory soil. The rate of water intake is very high in the Valentine soil and high in the Libory soil. Runoff is slow on both soils. The Libory soil has a seasonal perched water table at a depth of 1.5 to 3.0 feet.

Many areas formerly were used for dryland farming but have been reseeded to cool-season grasses and alfalfa or allowed to return to native vegetation. These areas, and the other areas of native vegetation, are used for grazing or hay. A few areas are used as irrigated cropland. These soils generally are unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. They are unsuited to gravity irrigation systems because of the hummocky topography and the very high or high rate of water intake. Soil blowing and water erosion are hazards. Management of irrigation water and tillage practices are very important in controlling soil blowing and water erosion. A cropping system that keeps crops, grass, or crop residue on the surface helps to control soil blowing

and water erosion and conserves moisture. Returning crop residue to the soils and applying feedlot manure increase the organic matter content.

If these soils are used as range or native hayland, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on this soil.

Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Libory soil is dominantly big bluestem, little bluestem, switchgrass, plains bluegrass, and indiagrass. These species make up 85 percent or more of the total annual forage on this soil. Sedges and other annual and perennial grasses, forbs, and shrubs make up the remaining 15 percent. Under continuous heavy grazing, sand bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the initial stocking rate, in animal unit months per acre, is 0.9 on the Valentine soil and 1.0 on the Libory soil. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized

in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs grown as windbreaks. Irrigation is needed during dry periods. Soil blowing and water erosion can be controlled by strips of sod or other vegetation between the tree rows. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Weeds and undesirable grasses in the rows can be controlled by timely cultivation and by applications of approved herbicide.

If the Libory soil is used as a site for septic tank absorption fields, sewage lagoons, dwellings, or other buildings, well compacted fill material is needed to increase the depth to the seasonal high water table. These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored. The Libory soil should be excavated during dry periods because of the wetness.

The Valentine soil generally is suitable as a site for dwellings and roads, but buildings should be designed so that they conform to the natural slope of the land or the site should be graded. Constructing roads on suitable, well compacted fill material, establishing adequate roadside ditches, and installing culverts help to prevent the road damage caused by wetness in the Libory soil.

The capability units are VIe-5, dryland, and IVe-11, irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Libory soil is in the Sandy Lowland range site and windbreak suitability group 5.

**VpD—Valentine-Pivot complex, 0 to 9 percent slopes.** These deep, nearly level to strongly sloping soils are on uplands. The Valentine soil formed in sandy eolian material. The Pivot soil formed in 20 inches of sandy eolian material overlying coarse sand or gravelly coarse sand. The Valentine soil is excessively drained. It is in convex hummocky areas. It is gently sloping to strongly sloping. The Pivot soil is somewhat excessively drained. It is on foot slopes and in swales. It is nearly level and very gently sloping. Areas range from 10 to 1,600 acres in size. They are 45 to 65 percent Valentine soil and 25 to 40 percent Pivot soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable fine sand about 5 inches thick. Below this is a transition layer of grayish brown, loose fine sand about 7 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand. In places the surface layer is loamy fine sand, loamy sand, or sand.

Typically, the Pivot soil has a surface layer of very dark grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 3 inches thick. Below this is a transition layer of brown, very friable loamy fine sand about 10 inches thick. The underlying material extends to a depth of more than 60 inches. It is light yellowish brown sand in the upper part and light gray coarse sand and gravelly coarse sand in the lower part. In some places the surface layer is loamy sand or sandy loam. In other places it is dark and is less than 10 inches thick. In a few areas fine sand is in the underlying material.

Included with these soils in mapping are small areas of Meadin and O'Neill soils. Meadin soils are on side slopes. They have gravelly coarse sand at a depth of 8 to more than 20 inches. O'Neill soils are well drained and are on side slopes and upland divides. They have a subsoil that is finer textured than that of the Valentine and Pivot soils. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. It is rapid in the upper part of the Pivot soil and very rapid in the lower part. Available water capacity is low in both soils. The rate of water intake is very high. Organic matter content is low in the Valentine soil and moderately low in the Pivot soil. Runoff is slow on the Valentine soil and very slow on the Pivot soil.

Nearly all of the acreage supports native grasses and is used for grazing or hay. Some areas were previously used for dryland farming but have been reseeded to cool-season grasses and alfalfa or allowed to return to native vegetation. A few areas are used as irrigated

cropland. These soils generally are unsuitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. They are unsuited to gravity irrigation systems because of the hummocky topography and the very high rate of water intake. Soil blowing is a severe hazard in unprotected areas. Water erosion also is a hazard. Establishing crops is difficult because of soil blowing. Planting close-growing crops and winter cover crops and leaving crop residue on the surface help to prevent excessive soil blowing and water erosion. Incorporating crop residue and feedlot manure into the soil increases the organic matter content. Applications of nitrogen, phosphorus, and lime are needed for maximum crop production. Irrigation water should be applied often because of the low available water capacity. If excessive amounts of water are applied, plant nutrients may be leached below the root zone.

If these soils are used as range or native hayland, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on this soil. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Pivot soil is dominantly needleandthread, sand bluestem, prairie junegrass, blue grama, prairie sandreed, and little bluestem. These species make up 55 percent or more of the total annual forage on this soil. Sand dropseed, sedges, common pricklypear, and other annual and perennial grasses, forbs, and shrubs make up the remaining 45 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie junegrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the initial

stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs grown as windbreaks. Irrigation is needed during dry periods. Soil blowing and water erosion can be controlled by strips of sod or other vegetation between the tree rows. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Weeds and undesirable grasses in the rows can be controlled by timely cultivation and by applications of approved herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

These soils generally are suitable as sites for dwellings and roads. On the Valentine soil, buildings should be designed so that they conform to the natural slope of the land or the site should be graded.

The capability units are Vle-5, dryland, and IVe-14, irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Pivot soil is in the Sandy range site and windbreak suitability group 5.

**VrD—Valentine-Sandose loamy fine sands, 0 to 9 percent slopes.** These deep, nearly level to strongly sloping soils are on uplands. The Valentine soil is excessively drained and is gently sloping to strongly sloping. The Sandose soil is well drained and is nearly level and very gently sloping. The Valentine soil formed in sandy eolian material. The Sandose soil formed in sandy eolian material overlying loamy sediment. The Valentine soil is in convex hummocky areas. The Sandose soil is on the concave lower side slopes and in swales. Areas range from 10 to about 700 acres in size. They are 35 to 65 percent Valentine soil and 20 to 50 percent Sandose soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of grayish brown, very friable loamy fine sand about 7 inches thick. Below this is a transition layer of brown, very friable loamy fine sand about 3 inches thick. The underlying material to a depth of more than 60 inches is pale brown and light yellowish brown fine sand. In places the dark surface layer is more than 10 inches thick.

Typically, the Sandose soil has a surface layer of dark grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is about 14 inches thick. It is grayish brown, very friable loamy fine sand in the upper part and pale brown fine sand in the lower part. The subsoil is about 20 inches thick. It is brown, friable very fine sandy loam in the upper part and light olive brown, firm sandy clay loam in the lower part. The underlying material to a depth of more than 60 inches is light yellowish brown very fine sandy loam. In some places the sandy material is less than 20 inches or more than 40 inches deep over the loamy material. In other places the loamy material is at the surface. In some areas the dark surface layer is less than 10 inches thick.

Included with these soils in mapping are areas of Anselmo, Jansen, and Pivot soils. Anselmo soils have a surface layer that is finer textured than that of the Valentine and Sandose soils. They do not have loamy underlying material. They are on the lower side slopes between the Valentine and Sandose soils. Jansen and Pivot soils have coarse textured underlying material at a depth of 20 to 40 inches. They have a surface layer and subsoil that are finer textured than those of the Valentine and Sandose soils. They are on the lower side slopes. Pivot soils are in positions on side slopes

and in swales similar to those of the Valentine and Sandose soils. Included soils make up about 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. It is rapid in the upper part of the Sandose soil and moderate in the lower part. Available water capacity is low in the Valentine soil and high in the Sandose soil. Organic matter content is low in the Valentine soil and moderately low in the Sandose soil. The rate of water intake is very high in the Valentine soil and high in the Sandose soil. Runoff is slow on both soils.

Many areas formerly were used for dryland farming but have been reseeded to cool-season grasses and alfalfa or allowed to return to native vegetation. These areas, and the other areas of native vegetation, are used for grazing or hay. A few areas are used as irrigated cropland. These soils generally are unsuited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated, these soils are poorly suited to corn, alfalfa, and introduced grasses. They are unsuited to gravity irrigation systems because of the hummocky topography and the very high or high rate of water intake. Soil blowing is the most serious hazard. Water erosion also is a hazard. Management of irrigation water and tillage practices are very important in controlling soil blowing and water erosion. A cropping system that keeps crops, grass, or crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Returning crop residue to the soil increases the organic matter content.

If these soils are used as range or native hayland, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on this soil. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Sandose soil is dominantly little bluestem, prairie sandreed, needleandthread, and blue grama. These species make up 65 percent or more of the total annual forage on this soil. Sand bluestem, sedges, and other annual and perennial grasses, forbs, and shrubs make up the

remaining 35 percent. Under continuous heavy grazing, sand bluestem and little bluestem decrease in abundance. Initially, these plants are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If these soils are used as hayland, the forage should be harvested only every other year. During the following year, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. The resulting plant cover helps to hold snow on the surface and thus increases the moisture supply. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs grown as windbreaks. Irrigation is needed during dry periods. Soil blowing and water erosion can be controlled by strips of sod or other vegetation between the tree rows. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Weeds and undesirable grasses in the rows can be controlled by timely cultivation and by applications of approved herbicide.

These soils readily absorb but do not adequately

filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can slough or cave in unless they are temporarily shored.

These soils generally are suitable as sites for dwellings without basements and for roads. On the Sandose soil, the foundations of dwellings with basements should be strengthened and backfilled with coarse textured material. These measures help to prevent the structural damage caused by shrinking and swelling. On the Valentine soil, buildings should be designed so that they conform to the natural slope of the land or the site should be graded.

The capability units are Vle-5, dryland, and IVe-11, irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Sandose soil is in the Sandy range site and windbreak suitability group 5.

**VsG2—Valentine-Simeon complex, 9 to 40 percent slopes, eroded.** These deep, excessively drained soils are on upland breaks and on side slopes in the dissected uplands. They are erosive and are dissected by many small gullies. The strongly sloping to very steep Valentine soil formed in sandy eolian material. The strongly sloping to steep Simeon soil formed in alluvium that in some areas has been reworked by the wind. The Simeon soil is on the upper side slopes and on ridgetops. The Valentine soil is mainly on the middle and lower side slopes. Areas range from about 40 to 1,000 acres in size. They are 45 to 65 percent Valentine soil and 20 to 40 percent Simeon soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of grayish brown, loose fine sand about 6 inches thick. Below this is a transition layer of brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is fine sand. It is light yellowish brown in the upper part and very pale brown in the lower part. In places soft sandstone is at a depth of more than 40 inches.

Typically, the Simeon soil has a surface layer of grayish brown, very friable loamy sand about 7 inches thick. Below this is a transition layer of brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown sand in the upper part; very pale brown coarse sand in the next part; and white, very pale brown, and light gray sand in the lower part. In some areas layers of gravelly coarse sand are in the

underlying material. In a few places shale is at a depth of more than 40 inches.

Included with these soils in mapping are small areas of Anselmo, Brunswick, Meadin, Pivot, and Tassel soils. Anselmo soils are finer textured than the Valentine and Simeon soils. They are on side slopes. Brunswick and Tassel soils are on the upper side slopes. Brunswick soils are moderately deep over sandstone. Tassel soils are shallow over sandstone. Meadin and Pivot soils have a dark surface layer that is thicker than that of the Valentine and Simeon soils. They are in the higher areas on the upper side slopes. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils have gravelly coarse sand or coarse sand at a depth of 20 to 40 inches. Included soils make up 10 to 15 percent of the map unit.

Permeability is rapid in the Valentine and Simeon soils. Available water capacity is low. Organic matter content also is low. Runoff is slow on the Valentine soil and very slow on the Simeon soil.

All of the acreage supports native grasses and is used for grazing. These soils are unsuitable for cultivated crops because of the slope and severe hazards of soil blowing and water erosion.

If these soils are used as range, the climax vegetation on the Valentine soil is dominantly prairie sandreed, sand bluestem, little bluestem, switchgrass, and needleandthread. These species make up 75 percent or more of the total annual forage on this soil. Sand lovegrass, blue grama, sandhill muhly, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Simeon soil is dominantly blue grama, prairie sandreed, needleandthread, sand bluestem, little bluestem, and clubmoss. These species make up 80 percent or more of the total annual forage on this soil. Hairy grama, sand dropseed, and other annual and perennial grasses, forbs, and shrubs make up the remaining 20 percent. Under continuous heavy grazing, sand bluestem, little bluestem, and prairie sandreed decrease in abundance. Initially, these species are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama,

blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate, in animal unit months per acre, is 0.9 on the Valentine soil and 0.6 on the Simeon soil. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. A planned short period of heavy grazing during the grazing season or deferment of grazing in 2 years out of 3 helps to retain little bluestem and prairie sandreed in the plant community. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling water erosion and soil blowing. Because of the low available water capacity, the soils are droughty. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range.

These soils generally are not suited to the trees and shrubs grown as windbreaks because they are too droughty, too sandy, and too steep. Some areas can be used for water-tolerant trees and shrubs if they are hand planted or other special management is applied. Onsite investigation is needed to identify the areas best suited to windbreaks.

In areas where slopes are more than 15 percent, these soils are not suitable as sites for sanitary facilities. A suitable alternative site is needed. In areas where slopes are less than 15 percent, installing septic tank absorption fields on the contour and land shaping help to ensure that the fields function properly. The soils readily absorb but do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The sides of shallow excavations can slough or cave in unless they are temporarily shored. Dwellings and other buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads.

The capability unit is V1e-5, dryland; windbreak suitability group 10. The Valentine soil is in the Sands range site, and the Simeon soil is in the Shallow to Gravel range site.

**VtE—Valentine-Tassel complex, 3 to 17 percent slopes.** These gently sloping to moderately steep soils are on uplands. The deep, excessively drained Valentine soil formed in sandy eolian material. The shallow, well drained Tassel soil formed in material weathered from sandstone. The Valentine soil is on dunes and rolling hills. The Tassel soil generally is on the smoother, lower side slopes. Areas range from 30 to more than 400 acres in size. They are about 40 to 60 percent Valentine soil and 25 to 45 percent Tassel soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable fine sand about 7 inches thick. Below this is a transition layer of brown, very friable fine sand about 8 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and pale brown fine sand. In some areas a buried surface layer is at a depth of more than 40 inches.

Typically, the Tassel soil has a surface layer of dark gray, very friable fine sandy loam about 6 inches thick. The underlying material is grayish brown and light brownish gray fine sandy loam about 7 inches thick. Light gray, soft sandstone is at a depth of about 13 inches. In some places the surface layer is loamy fine sand. In other places it is dark and is more than 7 inches thick. In some areas the sandstone is calcareous.

Included with these soils in mapping are small areas of Dunday and Ronson soils and outcrops of sandstone. Dunday soils are deep and sandy. They have a dark surface layer that is more than 10 inches thick. They are on the lower side slopes. Ronson soils are moderately deep over sandstone. They generally are on the smoother, lower side slopes. The sandstone outcrops generally are on the steeper, convex side slopes. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Valentine soil and moderately rapid in the Tassel soil. Available water capacity is low in the Valentine soil and very low in the Tassel soil. Organic matter content is low in both soils. Runoff is slow on the Valentine soil and medium or rapid on the Tassel soil.

All of the acreage supports native grasses and is used for grazing. These soils are unsuitable for dryland and irrigated crops because of the slope, the low or very low available water capacity, and a shallow root zone in the Tassel soil.

If these soils are used as range, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or

more of the total annual forage on this soil. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Tassel soil is dominantly little bluestem, sand bluestem, prairie sandreed, and sideoats grama. These species make up 70 percent or more of the total annual forage on this soil. Needleandthread, threadleaf sedge, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. Under continuous heavy grazing, little bluestem and sand bluestem decrease in abundance. Initially, these species are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, annual grasses, and forbs. If overgrazing continues for many years, less desirable woody plants, including sumac and small soapweed, increase in abundance.

If the range is in excellent condition, the initial stocking rate, in animal unit months per acre, is 0.9 on the Valentine soil and 0.7 on the Tassel soil. A planned grazing system that includes proper grazing use and timely deferment of grazing or haying helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

The Valentine soil is suited to the trees and shrubs grown as windbreaks. The Tassel soil generally is not suited because of a shallow root zone and the very low

available water capacity. Before a windbreak is planned, onsite investigation is needed. The Valentine soil is so loose that the trees should be planted in shallow furrows with as little disturbance of the surface as possible. Young seedlings can be damaged by sand blasting or covered with drifting sand during periods of high winds. Strips of sod or other vegetation between the tree rows help to control soil blowing and water erosion and conserve moisture by controlling weeds and undesirable grasses. Weeds in areas near the trees can be controlled by timely cultivation and by applications of approved herbicide. Irrigation is needed during dry periods.

The Valentine soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. If the Tassel soil is used as a site for septic tank absorption fields, building up or mounding the site with suitable fill material improves the filtering capacity of the fields. Lining or sealing sewage lagoons on these soils helps to prevent seepage. Grading is required to modify the slope and shape the lagoon. On the Valentine soil, the sides of shallow excavations can slough or cave in unless they are temporarily shored. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded. Cutting and filling generally are needed to provide a suitable grade for roads.

The capability unit is Vle-5, dryland. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**VwE—Valentine-Tryon complex, 0 to 17 percent slopes.** These deep soils are on dunes and in areas between the dunes. The excessively drained, gently sloping to moderately steep Valentine soil is on the dunes. The very poorly drained, nearly level Tryon soil is in narrow valleys between the dunes. It is subject to rare flooding. The Valentine soil formed in sandy eolian material. The Tryon soil formed in eolian and alluvial sediment. Areas range from 10 to several thousand acres in size. They are about 50 to 70 percent Valentine soil and 20 to 35 percent Tryon soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Valentine soil has a surface layer of grayish brown, very friable fine sand about 4 inches thick. Below this is a transition layer of brown, loose fine sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and pale brown fine sand.

Typically, the Tryon soil has a surface layer of dark gray, very friable loamy fine sand about 6 inches thick.



Figure 8.—An area of Valentine-Tryon complex, 0 to 17 percent slopes, used as range. The Valentine soil is on ridges, and the Tryon soil is in swales.

The underlying material to a depth of 60 inches or more is light brownish gray and light gray, mottled fine sand. In some places the surface layer is fine sandy loam. In other places the soil is dark to a depth of more than 10 inches.

Included with these soils in mapping are small areas of Els, Elsmere, lpage, and Marlake soils. Els, Elsmere, and lpage soils are in nearly level and very gently sloping areas between the Valentine and Tryon soils. Els and Elsmere soils are somewhat poorly drained. lpage soils are moderately well drained. Elsmere soils have a dark surface layer that is more than 10 inches thick. Marlake soils are in the lowest depressions in swales. They have a seasonal water table that is higher than that of the Tryon soil. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Valentine and Tryon soils. Available water capacity is low. Organic matter content is low in the Valentine soil and high in the Tryon soil. Runoff is slow on the Valentine soil and ponded on the Tryon soil. The seasonal high water table in the Tryon soil is about 0.5 foot above the surface in wet years and 1.0 foot below the surface in dry years. Water ponds on the surface for a week or more in the spring and during other wet periods.

All of the acreage supports native grasses and is

used for grazing (fig. 8). These soils are unsuited to dryland and irrigated crops because of the wetness in the Tryon soil and the hazard of soil blowing on the Valentine soil.

If these soils are used as range or hayland, the climax vegetation on the Valentine soil is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage on this soil. Needleandthread, sand lovegrass, blue grama, and other annual and perennial grasses, forbs, and shrubs make up the remaining 25 percent. Under continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, sedges, sandhill muhly, annual grasses, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, excessive soil blowing and blowouts are common.

The climax vegetation on the Tryon soil is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and various rushes. These species make up 65 percent or more of the total annual forage on this soil. Slender wheatgrass and other annual and

perennial grasses, forbs, and sedges make up the remaining 35 percent. Under continuous heavy grazing or improper haying, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, plains bluegrass, green muhly, and various sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. When the surface is wet, overgrazing or using heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the initial stocking rate, in animal unit months per acre, is 0.9 on the Valentine soil and 2.1 on the Tryon soil. The Tryon soil can produce high yields, but the forage is of low quality. The forage is of higher quality early in the growing season. A planned grazing system that includes proper grazing use, timely deferment of grazing or haying, and restricted use during wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails and areas on gentle slopes. The areas away from the watering facilities may be underused. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil blowing and water erosion on the Valentine soil. Abandoned cropland should be reseeded to a suitable grass mixture if it is to be used as range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. A proper mowing height helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches. In some years hay cannot be harvested because of excessive wetness in the Tryon soil. When this soil is frozen, livestock can graze without damaging the meadows. They should be removed from the meadows before the soil thaws in the spring and the water table reaches a high level.

The Valentine soil is suited to the trees and shrubs

grown as windbreaks, but the Tryon soil generally is unsuited because of the wetness. Onsite investigation is needed when suitable sites for trees and shrubs are selected. Soil blowing, water erosion, and drought are hazards on the Valentine soil. The trees should be planted in a shallow furrow with as little disturbance of the surface as possible. Maintaining strips of sod or other vegetation between the tree rows helps to control soil blowing and water erosion. Irrigation is needed during dry periods. Weeds and undesirable grasses that compete for moisture can be controlled by timely cultivation and by applications of approved herbicide.

The Valentine soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Lining or sealing sewage lagoons on these soils helps to prevent seepage. Grading is required to modify the slope and shape the lagoon. The Tryon soil is not suitable as a site for sanitary facilities or dwellings because of the ponding. A suitable alternative site is needed. The sides of shallow excavations in these soils can slough or cave in unless they are temporarily shored. Also, excavations in the Tryon soil should be shored during dry periods.

Dwellings and other buildings constructed on the Valentine soil should be designed so that they conform to the natural slope of the land, or the site should be graded. On the Tryon soil, constructing the buildings on raised, well compacted fill material helps to prevent the structural damage caused by floodwater and ponding and increases the depth to the seasonal high water table. Roads on the Tryon soil should be constructed on suitable, well compacted fill material above the level of ponding. Establishing adequate roadside ditches and installing culverts help to prevent the road damage caused by ponding. Cutting and filling generally are needed to provide a suitable grade for roads on the Valentine soil. Onsite investigation is needed before any engineering practices are applied.

The capability unit is Vle-5, dryland. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Tryon soil is in the Wetland range site and windbreak suitability group 10.

**VxB—Vetal loam, 1 to 3 percent slopes.** This deep, very gently sloping, well drained soil is in swales on uplands and on foot slopes. It formed in loamy material of alluvial or eolian origin. Areas range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 16 inches thick. The subsurface layer also is dark grayish brown, very friable loam. It is about 15 inches thick. Below this is a transition layer of brown, very friable loam about 25 inches thick. The

underlying material to a depth of more than 60 inches is light gray, calcareous loamy fine sand. In places the dark surface soil is less than 20 inches thick.

Included with this soil in mapping are small areas of Dunday and O'Neill soils on the slightly higher side slopes. These soils have a dark surface soil that is less than 20 inches thick. Dunday soils are sandier than the Vetal soil. O'Neill soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Vetal soil. Available water capacity is high. Organic matter content is moderate. The rate of water intake also is moderate. Runoff is slow or medium.

Most of the acreage is cultivated. The rest supports native grasses and is used for grazing. About two-thirds of the cropland is irrigated.

If used for dryland farming, this soil is suited to wheat and alfalfa. Soil blowing is the main hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that keeps all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil increases the organic matter content.

If irrigated, this soil is suited to corn, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suitable. Some land leveling generally is needed if gravity systems are used. Timely applications of water and carefully selected application rates are needed. Excessive irrigation leaches plant nutrients below the root zone. Soil blowing is a serious hazard. Stubble mulch tillage and a cropping system that keeps crops or crop residue on the surface most of the time help to control soil blowing and conserve moisture. Applications of feedlot manure increase the organic matter content.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing. The climax vegetation is dominantly little bluestem, needleandthread, prairie sandreed, blue grama, sideoats grama, and big bluestem. These species make up 75 percent or more of the total annual forage. Switchgrass, western wheatgrass, and other perennial grasses and forbs make up the remaining 25 percent. If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. Under continuous heavy grazing, little bluestem, big bluestem, and switchgrass decrease in abundance. Initially, these species are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the

site. As a result, the hazard of soil blowing is increased.

This soil is suited to the trees and shrubs grown as windbreaks. Irrigation is needed during periods of low rainfall. Growing cover crops between the tree rows helps to control soil blowing. Competition for moisture from grasses and weeds is a management concern. Weeds and undesirable grasses can be controlled by timely cultivation or by applications of approved herbicide.

This soil generally is suitable as a site for septic tank absorption fields, dwellings, and other buildings. Lining or sealing sewage lagoons helps to prevent seepage. The road damage caused by frost action can be minimized by establishing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to provide the needed surface drainage.

The capability units are 11e-1, dryland, and 11e-6, irrigated; Silty range site; windbreak suitability group 5.

## Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the

criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 51,000 acres in the survey area, or nearly 7 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in the north-central part, mainly in associations 6 and 7, which are described under the heading "General Soil Map Units."

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use.

The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that receive an inadequate amount of rainfall qualify for prime farmland only in areas where this limitation has been overcome by irrigation. The need for irrigation is indicated after all of the map unit names in table 5. Onsite evaluation is needed to determine whether or not a specific area is irrigated.

# Use and Management of the Soils

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This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

## Crops and Pasture

William E. Reinsch, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Cropland makes up approximately 9 percent of the total farmland in Brown County. Nearly 50 percent of the cultivated cropland is irrigated. Corn and hay are the main crops.

## Dryland Farm Management

Although dryland crops are grown in scattered areas throughout the county, the greatest concentration of dryland and irrigated cropland is in the north-central part. Dryland crops are grown mainly on the Johnstown-Jansen and Jansen-O'Neill-Meadin associations, which are described under the heading "General Soil Map Units." These crops are used mainly as forage for livestock. Over 90 percent of the acreage of dryland crops is used for hay.

In Brown County low rainfall commonly is a limiting factor affecting crop production. Water and wind are erosive factors that should be controlled if crop production is to be maximized. Erosion is the major problem on nearly all of the soils used as cropland and on overgrazed pasture. All of the soils that have slopes of more than 4 percent and are loamy sand or lighter textured in the surface layer are susceptible to soil blowing and water erosion.

Soil blowing is a major problem in Brown County. It can be controlled by conservation tillage practices that leave crop residue on the surface throughout the winter

or until spring planting. The overall hazard of erosion can be reduced by using areas of the more productive soils for row crops and areas of the steeper, more erodible soils for close-grown crops, such as small grain, or for hay and pasture.

Contour stripcropping helps to control soil blowing and water erosion. Strips of meadow crops are maintained in a short-term rotation. The areas between the strips are cultivated, and row crops are planted on the contour. The grass or grass-legume strips usually are used for hay.

Loss of the surface layer through erosion is damaging for two reasons. Firstly, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Secondly, soil erosion on farmland results in the sedimentation of streams, lakes, and ponds. Erosion control minimizes this pollution. It thus prolongs the life of ponds and lakes and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

The cropping system and management practices that help to control erosion should be planned so that they are effective on the soil in each field. This planned management is known as a resource management system. Resource management systems in areas of dryland crops help to preserve soil tilth and fertility, maintain a surface cover that protects the soil from erosion, and control weeds, insects, and diseases.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth. Growing legumes, such as alfalfa, also improves tilth by adding nitrogen to the soil.

Tillage is sometimes needed to prepare a seedbed and control weeds. Excessive tillage, however, reduces the extent of the protective plant cover and increases the hazard of erosion. Steps in the tillage process should be limited to those that are essential. Various conservation tillage practices can be used in Brown County. No-till planting, till-plant, disk-plant, and chisel-plant are well suited to soils used for row crops. Grasses and legumes can be planted by drilling into a cover of stubble without further seedbed preparation.

Soil fertility is naturally lower in most eroded soils and in moderately deep soils than in uneroded, deep soils. All soils, however, require additional plant nutrients for optimum production. The kind and amount of fertilizer to be applied should be based on the results of soil tests. Nitrogen and phosphorus are the elements added to most cultivated areas. In some areas trace elements are needed.

Some soils in Brown County are somewhat poorly

drained because of a moderately high water table. Open drainage ditches and underground tile systems can be used to lower the water table if suitable outlets can be located at low elevations. If the water table cannot be sufficiently lowered, crops that are tolerant of wetness can be planted.

### **Irrigation Management**

About 43 percent of the cropland in Brown County is irrigated. Corn is grown on 76 percent of the irrigated cropland. A smaller acreage is used for alfalfa hay or soybeans. Irrigation water is obtained from wells and the Ainsworth Irrigation Project. Gravity or sprinkler irrigation systems are suited to the areas used for row crops. Alfalfa is generally irrigated by border or sprinkler systems.

A cropping sequence on soils that are well suited to irrigation consists mainly of row crops. If it includes different crops, such as alfalfa and corn, the common diseases and insects are better controlled than if the same crop is grown year after year.

Many areas of the Valentine-Els-Ipage, Simeon-Valentine, and Valentine associations have been developed for row crop irrigation. A large portion of these associations is poorly suited to row crops because of wetness, low fertility, a low available water capacity, the hazard of soil blowing, a low content of organic matter, and the leaching of plant nutrients below the root zone. Irrigating the sandy soils in the Valentine-Els-Ipage association that have a high water table can cause losses of nitrogen through deep percolation and, consequently, the pollution of ground water.

Soil blowing in irrigated areas of the Valentine, Els, and Elsmere soils is a serious hazard unless a large amount of crop residue is left on the surface. Crop residue must be left standing on the northwest-facing knolls during the critical period of March through May. A no-till conservation tillage system may be the only way to protect the sandy Valentine soils from soil blowing.

Land leveling increases the efficiency of irrigation by providing an even distribution of water. The efficiency of a furrow irrigation system can be improved by installing a tailwater recovery system. Gently sloping soils, such as Jansen loam, 2 to 6 percent slopes, are subject to water erosion if they are furrow irrigated up and down the slope. If furrow irrigated, these soils should be contour bench leveled or contour furrows and a ridge-till conservation system should be used.

Contour farming and conservation tillage practices that keep crop residue on the surface help to control water erosion on soils irrigated by a sprinkler system. When water is applied by the sprinklers at a controlled rate, it is absorbed by the soil and does not run off the

surface. Sprinklers can be used on the more sloping soils and on the nearly level ones. Some soils, such as Valentine loamy fine sand, 3 to 9 percent slopes, are suited to sprinkler irrigation only if erosion is controlled. Because the application of water can be carefully regulated, sprinklers can be used for special purposes, such as establishing a new pasture on moderately steep soils. The most common types of sprinkler irrigation in Brown County are the center-pivot and towline systems.

Furrow irrigation is most efficient if it is started after the plants have used about half of the available water in the soil. Thus, if a soil holds 8 inches of available water, irrigation should be started when about 4 inches has been removed by the crop.

A recovery pit can be installed to trap excess irrigation tailwater. This water can be pumped back onto the field and used again. This practice increases the efficiency of the irrigation system and conserves the water supply.

All of the soils in Nebraska are assigned to irrigation design groups. These groups are described in the an irrigation guide that is part of the technical specifications for conservation in Nebraska (12). If applicable, an irrigation capability unit is specified at the end of the map unit descriptions under the heading "Detailed Soil Map Units." The Arabic number at the end of the irrigation capability unit indicates the irrigation design group to which the soil is assigned.

Assistance in planning and designing an irrigation system can be obtained from the local office of the Soil Conservation Service. Estimates of the cost of irrigation equipment can be obtained from local dealers and manufacturers.

### **Weed Control**

A suitable cropping sequence or herbicides can control weeds. Rotating different crops in a planned sequence not only helps to control weeds but also increases the productivity of the soil and the content of organic matter. The kind and amount of herbicide applied to the soil should be carefully controlled. The colloidal clay and humus fractions of the soil are responsible for most of the chemical activity in the soil. Applications of some herbicides can damage crops on Dunday and other sandy soils that have a low content of colloidal clay. They can also damage soils that are low in content of organic matter, such as Valentine soils.

### **Management of Pasture and Hayland**

Hayland or pasture should be managed for maximum forage production. After a pasture is established, the

grasses should be kept productive. In Brown County pastures of introduced grasses consist mainly of cool-season grasses, which start to grow early in spring and reach their peak growth in May or June. These grasses are dormant during July and August and start to grow again in the fall unless the pasture is irrigated. For this reason, additional pastures of warm-season grasses or temporary pastures of sudangrass, which attains its peak growth during July and August, are desirable. A combination of cool- and warm-season grasses provides forage during the entire growing season.

Grasses and legumes used for pasture should be grazed in a rotation that allows for plant regrowth. A planned grazing system in which pastures of cool-season grasses are grazed in rotation extends the grazing season and increases forage production. The most commonly grown introduced grasses on cool-season pastures are smooth brome grass and intermediate wheatgrass. Other suitable cool-season grasses and legumes in Brown County are orchardgrass, creeping foxtail, meadow brome grass, reed canarygrass, alfalfa, and cicer milkvetch. If planted as a single species on nonirrigated land, some native, warm-season grasses can be grown along with cool-season grasses. Switchgrass, indiagrass, and big bluestem are native, warm-season grasses that can be used in a planned system of grazing to provide high-quality forage during the summer.

Introduced pasture grasses can be grazed in the spring and fall after they reach a height of 5 or 6 inches. Until they reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in spring or too late in fall weakens the plants.

### **Yields Per Acre**

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of

weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, feedlot manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

### Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

*Capability classes*, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the

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

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

*Capability subclasses* are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained, *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage), *s* shows that the soil is limited mainly because it is shallow or droughty, and *c* shows that the chief limitation is climate that is very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IVe-5 and IIIe-11.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units," in the yields table, and in the section "Interpretive Groups," which follows the tables at the back of this survey.

### Rangeland

Kenneth L. Hladek, range conservationist, Soil Conservation Service, helped prepare this section.

Rangeland makes up approximately 83 percent of the land in Brown County. It is in scattered areas throughout the county. The largest acreages, however, are in the Valentine, Valentine-Els-Ipage, and Valentine-Els-Tryon associations in the Sandhills. These

associations, which make up most of the southern two-thirds of the county, are used dominantly for large ranching enterprises. The Simeon-Valentine, Loup-Els-Tryon, Jansen-O'Neill-Meadin, and Valentine-O'Neill-Pivot associations also are important areas of rangeland. The farms and ranches in areas of these associations, which are in the northern third of the county, typically are smaller livestock and cash-grain enterprises. The rangeland throughout the county is used primarily for grazing by livestock, but a fairly large acreage is used for native hay.

The raising of livestock, mainly cow-calf herds, is the most important agricultural enterprise in the county. The calves are sold in the fall as feeders. The range is generally grazed from late in spring to early in fall. Livestock graze the corn residue on irrigated cropland and the regrowth of native meadows in fall. Many ranchers keep livestock on winter pastures near their headquarters until the end of the year. Alfalfa and native hay are fed to the livestock during the winter and early spring months. The forage produced on rangeland also is supplemented with protein in fall and winter.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 8 shows, for nearly all the soils in the county, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 8 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

*Total production* is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre

of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

*Dry weight* is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

*Characteristic vegetation*—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Some of the rangeland in Brown County is producing less than half of its potential because of continuous overgrazing. Poor grazing distribution and some brush encroachment also have reduced forage production.

The goal of range management is an excellent range condition. Proper management of rangeland is the most important factor affecting the conservation of soil, water, and plant resources in Brown County. Proper range management and improvement practices, such as proper grazing use, planned grazing systems, range seeding, and brush control, increase the productivity of the range. Besides improving the yields of desirable forage plants, they reduce soil losses to an acceptable

level and thereby increase the potential for producing livestock.

This section can help ranchers and conservationists to plan range management in Brown County. It describes range condition, planned grazing systems, and other management practices that help to achieve sustained forage production.

### Proper Grazing Use

Proper grazing use is grazing at an intensity that maintains enough plant cover to protect the soil and that maintains or improves the quantity and quality of desirable vegetation. It is the first and most important step in successful range management. It increases the vigor and reproductive capacity of desirable plants, leaves enough accumulated litter and mulch on the surface to control erosion, and increases forage production. The proper intensity of grazing on rangeland used during the entire growing season removes one-half of the current year's growth, by weight.

Proper grazing use is determined by the degree to which desirable species are grazed in key areas. It is affected by stocking rates, the distribution of livestock, the kinds and classes of livestock, and the length of the grazing season.

The stocking rate is the number of grazing animals in a particular pasture. It is based on animal units and animal unit months. An animal unit is generally considered to be one mature cow of approximately 1,000 pounds and a calf as much as 4 months old, or their equivalent. An animal unit month is the amount of forage or feed necessary to sustain an animal unit for 1 month. The range site and range condition are used to determine animal unit months for each pasture. Suggested initial stocking rates can then be calculated. The proper stocking rates for range sites in excellent condition are given for each soil under the heading "Detailed Soil Map Units." The rates are lower for range sites in less than excellent condition.

The suggested initial stocking rate is easy to calculate for any given soil or range site. For example, in an area of Valentine fine sand, rolling, which is in the Sands range site, the suggested initial stocking rate is about 0.9 animal unit month per acre if the range is in excellent condition. Thus, a 640-acre pasture in excellent condition can carry 576 animal units for 1 month. If the pasture is to be grazed for 5 months, the suggested initial stocking rate would be 576 divided by 5, or 115 animal units. The rate is based on the existing plant community and the average annual forage production of each site. Because of weather conditions, forage production varies. The suggested rate is intended as an initial stocking rate and should be

adjusted to changes in forage production or the management system.

The proper distribution of livestock throughout a pasture requires planning. Livestock tend to graze in areas near water, roads, and trails and in the more gently sloping areas. Distant corners of the pasture and steep areas are often undergrazed.

Poor grazing distribution may result from too few watering sites or from poorly distributed salt, shade, supplemental feed, and water. A continued concentration of livestock causes severe overuse in local parts of a pasture, leaving other parts underused, and often creates an erosion hazard. Carefully locating fences and salting and watering facilities and using a planned grazing system help to achieve a uniform distribution of grazing.

Fences help to distribute grazing in a more uniform pattern. Also, they can divide pastures into sections used in a planned grazing system and can isolate blowouts and reseeded areas. Cross fences should be located so that they follow natural land features and range site boundaries as much as possible. The potential stocking rate should be similar throughout a given pasture, although this similarity is not essential. Generally, the smaller pastures are grazed more efficiently than the larger ones. This efficiency should to be considered along with convenience when pasture size is determined.

Properly locating salt and minerals is one of the easiest and most economical methods of achieving a more uniform distribution of grazing in a pasture. Salt and minerals should be located away from watering facilities. Cattle do not need to drink immediately after consuming salt or minerals. The salt and mineral stations can be easily moved to areas that are undergrazed and can be relocated periodically during the grazing season. On Valentine soils relocating these stations each time that salt and minerals are provided lessens the hazard of soil blowing.

Properly locating watering facilities also can improve the distribution of grazing. In Brown County most livestock water is obtained from perennial streams and from wells that are pumped by windmills. A few stock-water dams are in areas of the Jansen-O'Neill-Meadin and McKelvie-Tassel-Ronson associations. Regardless of the source, watering facilities should be spaced at varying distances, depending on topography. In rough or hilly areas, the distance between facilities should not be over 0.5 mile. In the more nearly level areas, it should be about 1 mile. If the distance between watering facilities is too far, the cattle tend to graze close to the water sources rather than throughout the pasture.

Range management is dependent on the kinds and classes of livestock grazing the pasture. Cattle, sheep, and horses have different grazing habits and nutritional needs that affect how the range can best be managed.

Cattle are the principal kinds of livestock raised in Brown County and are well suited to grazing its predominate range sites. Horses and sheep are also raised in the county but are few in number. The general management techniques outlined in this section and under the heading "Detailed Soil Map Units" apply principally to cattle production. Where different kinds of livestock are raised, adjustments in management may be needed.

Grazing habits differ among classes of cattle. Yearlings tend to travel farther within a pasture than cow-calf pairs. They also tend to graze the steeper areas and use a pasture more uniformly. Their tendency to trail along fence lines, however, can result in erosion. Cow-calf pairs graze for longer periods on the gentler slopes and stay close to watering facilities. As a result, poor grazing distribution may be more of a problem in pastures stocked with cow-calf pairs than in those stocked with yearlings.

### Range Condition

The range condition for any range site is the existing state of vegetation compared to its potential, or climax vegetation. Climax vegetation is a stable plant community that represents the furthest point of plant succession. It is the most productive combination of forage plants and represents the highest potential in kind and amount of vegetation for a given range site. It reproduces itself and changes little as long as the climate and soil remain stable.

Determining the range condition provides an approximate measure of the overall health of the plant community. More importantly, it provides a basis for predicting the degree of improvement possible under different kinds of management. There are four range condition classes that express the degree to which the composition of the present plant community differs from that of the climax vegetation. These classes are excellent, good, fair, and poor.

All food that green plants use for growth, maintenance, and reproduction is manufactured in their leaves. The excessive removal of leaves during the growing season drastically affects the growth of both roots and shoots. Livestock graze selectively, removing more leaves from some plants than from others. This selective grazing varies according to the season and the degree of use. Various plants respond to continuous heavy grazing in different ways. Some plants decrease in abundance, some increase, and others invade. These

plant responses are used to classify range condition.

The *decreaser species* on a site are those in the original plant community that decrease in abundance when grazed closely and continuously during the growing season. The *increaser species* are those in the original community that normally increase in abundance under continuous heavy grazing. They decrease in abundance if the pasture is severely overgrazed. *Invader species* are not part of the original plant community. They begin growing in an area after the decreasers and increasers have been weakened or eliminated. Once range condition has been determined, it is important to know whether the range is improving or deteriorating in order to plan adjustments in grazing use and management. Important factors affecting trends in the plant community are the vigor and reproductive capacities of both the desirable and undesirable species.

The goal of range management should be an excellent range condition. The greatest forage yields may be obtained on a sustained basis when the range is in excellent condition and is improving. Under these circumstances, soil blowing and water erosion are naturally reduced to an acceptable level and plants can make optimum use of precipitation.

The range sites given in table 8 and at the end of each map unit description are determined according to the kinds and amounts of vegetation that can be expected when the sites are in excellent condition.

### Deferred Grazing

Deferred grazing allows plants a rest period during critical times in their growth stages. This period allows grasses to become vigorous and to produce a mulch at the surface, thus increasing the rate of water infiltration. The mulch also reduces the susceptibility to erosion. Deferred grazing allows the desirable grasses to mature, flower, and seed naturally.

The need for deferment is based on the range condition and range trend. To be beneficial, deferment should be for a minimum of 3 consecutive months and should coincide with the food storage period of the key forage plants. This period varies, depending on the grass species. The food storage period of native, warm-season grasses occurs from late July to early October. On some sites a short deferment of 3 months is all that is needed, while on other sites a deferment of two complete growing seasons may be needed. Generally, however, some grazing during the year is more beneficial than a year-long deferment. If pastures are grazed in winter, protein supplements are needed to meet the nutritional needs of the cattle.

Where overgrazing has eliminated the native

grasses, reseeding the range to adapted native grasses is the best method of restoration. Native range should be reseeded only after the kinds and amounts of existing grasses are carefully evaluated.

### **Planned Grazing Systems**

Planned grazing systems are effective in achieving higher forage production and livestock quality while controlling erosion. In a planned grazing system, two or more pastures are alternately rested and grazed in a planned, but flexible, sequence over a period of years. The rest periods are planned for sometime during the growing season. All livestock should be removed from the pastures being rested. The same pasture is not grazed during the same period 2 years in a row. Therefore, the plants are not close-cropped by livestock at the same stage of development every year. This grazing system improves plant vigor, forage production, and the plant community and thus results in a better range condition. Planned grazing systems permit maximum and uniform use of forage, while maintaining rangeland productivity over a period of years.

To be effective, planned grazing systems must be flexible and adapted to the needs of an individual rancher. Fences, watering facilities, range condition, range sites, kinds or classes of grazing animals, and economic factors are all important considerations in determining the best system for a particular ranch. Grazing systems should be modified over a period of time because of improved plant vigor, increased forage production, or changes in management needs.

Planned grazing systems can increase stocking rates through an increase in forage production and improved forage quality. They also can help to control blowouts and can control parasites and disease among cattle by resulting in cleaner pastures.

### **Range Seeding**

In some areas range management alone cannot restore a satisfactory cover of native vegetation. Some of these areas are formerly cultivated fields, "go-back" areas, and abandoned farmsteads. Range seeding, rather than range management, may be needed in these areas and in severely overgrazed areas where the native vegetation does not respond to management practices.

Good stands of native grasses can be reestablished if the seedbed is properly prepared, adapted species of native grasses are planted, the correct seeding practices are employed, and careful management is applied after seeding.

Range seeding is most successful when the seedbed is firm and has a cover of mulch. A firm seedbed helps

to ensure good soil-seed contact, which is essential for seedling development. The cover of mulch helps to keep the soil moist, lowers the surface soil temperature, and reduces the hazard of erosion. It can be provided by planting a temporary crop, such as sudangrass or grain sorghum. Tillage should be avoided because of the need for a firm seedbed. The grass should be seeded directly into the stubble the following fall, winter, or spring. On soils that have a coarse textured surface layer and are subject to soil blowing, seedbed preparation and seeding should be done in narrow strips over a period of several years.

Seeding mixtures should be of adapted native grasses that are present on the range site when it is in excellent condition. Consequently, the appropriate mixtures vary according to range sites and range sites vary according to the soils. Use of a grassland drill with depth bands ensures proper placement of seeds at a uniform depth. On soils in the Sands and Choppy Sands range sites and on other soils in areas where tillage during seedbed preparation causes a severe hazard of soil blowing, a low-till drill capable of seeding native grasses should be used. This drill places seeds in the center of a shallow furrow without disturbing the vegetation between the furrows. As a result, seeding with this kind of drill greatly reduces the hazard of erosion.

Newly seeded areas should not be fully grazed until after the grass is established. Establishment may take from 2 to 3 years, depending on the grass species, the range site, the method of planting, and the weather. Initial grazing in these areas should be light. Limited grazing in spring or in late fall and winter is desirable until the grass is established. Proper grazing use and a planned grazing system can help to keep the range productive after the grass is established.

Additional information about grass mixtures, grassland drills, and range seeding dates can be obtained from the local office of the Soil Conservation Service.

### **Control of Blowouts**

Blowouts form on sandy soils, mainly in areas of the Valentine association where the vegetation has been removed. Many blowouts form in areas of the Sandhills that have been subject to continuous heavy grazing. Formation of the larger blowouts generally begins in areas near wells, where livestock tend to concentrate. The smaller blowouts commonly form along trails or fence lines. Drought increases the likelihood that blowouts will form.

Unless stabilized, blowouts are likely to enlarge. Windblown sand covers the bordering areas and

smothers the vegetation. The result is an expanding area that is subject to severe soil blowing. A planned grazing system is the most effective way to control and stabilize blowouts. It can stabilize many blowouts in 4 to 5 years. Locating salt and mineral stations away from the blowouts helps to prevent the concentration of livestock near the blowouts. Feeding livestock native hay with seed over winter has also proven to be effective in stabilizing blowouts. This method should be tried before a full-fledged reseeding program is undertaken.

If a planned grazing system is not feasible, reseeding may be necessary. If blowouts are reseeded, steep banks around the blowouts should be reshaped into a stable slope. If a fast-growing summer cover crop is planted in the spring, an adapted native grass mixture can be drilled into the stubble left from the crop. The cover crop helps to protect the surface from soil blowing, lowers the soil temperature, and creates a firm seedbed. If a cover crop is not practical, a mulch of native hay can be spread over the surface and worked into the sand after seeding. Mulching helps to prevent the damage caused by windblown sand while the grasses become established. Fencing blowout areas helps to keep out livestock until a desirable stand is established. Proper grazing use and a planned grazing system help to prevent the reactivation of stabilized blowouts after the grasses are established.

### **Brush Control**

Small soapweed, western snowberry, eastern redcedar, and smooth sumac are the main brush species in Brown County. Although these plants are not a major range problem, they are invading and increasing in abundance on range that is subject to continuous heavy grazing. The result is reduced forage production and a reduced carrying capacity.

Small soapweed or yucca is a problem mainly in areas of the Valentine association. The largest concentration is in the northern half of the county. Using cottonseed cake as a protein supplement increases the amount of small soapweed that cattle consume. If grazed during winter, the plants lose vigor and may be broken off below the root crown. Approved herbicides are not effective in controlling small soapweed.

Western snowberry, smooth sumac, and eastern redcedar are a problem in areas of the Simeon-Valentine and McKelvie-Tassel-Ronson associations. They are invading prairie uplands in fairly large numbers along Lone Pine Creek and Plum Creek.

Western snowberry and smooth sumac are best controlled by applications of approved herbicide. Repeated applications for several consecutive years

may be needed to control western snowberry. Herbicide recommendations can be obtained from the county extension agent or the local office of the Soil Conservation Service.

Eastern redcedar is best controlled by cutting the trees at ground level. The trees can be cut by hand or by earthmoving equipment where the slopes and topography are suitable. Followup treatment generally is not necessary. Approved herbicides can be effective in controlling eastern redcedar. Deferment of grazing after treatment helps to restore plant vigor and forage quality.

### **Managing Native Hayland**

A large acreage of rangeland in Brown County is used for the production of native hay. A considerable amount of hay is cut in areas of soils that have a seasonal high water table and are in the Wetland, Wet Subirrigated, and Subirrigated range sites. These soils are in the Valentine-Els-Ipage, Valentine-Els-Tryon, and Loup-Els-Tryon associations.

Wet meadows can be maintained or improved by proper hayland management. Timely mowing is needed to maintain strong plant vigor and a high quality and quantity of forage. Mowing the grasses between the boot stage and the emergence of the seed heads allows for adequate regrowth and carbohydrate storage in the plant before the first frost. A mowing height of 3 inches or more helps to maintain plant vigor and promotes rapid regrowth. Large meadows can be divided into three sections and mowed in rotation. One third of the meadow should be mowed about 2 weeks before plants reach the boot stage, one third at the boot stage, and one third in the early flowering period. The order in which the sections are mowed should be rotated in following years.

Meadows should not be grazed or harvested for hay when the surface is wet or the water table is within a depth of 6 inches. Grazing or using heavy machinery at these times results in the formation of small bogs, ruts, and mounds, which can hinder mowing in later years. After the soil is frozen, meadows can be moderately grazed without damage.

A fairly large acreage in the Valentine association on uplands is used for native hay, particularly in the northern half of the county. The range sites in areas of this association are generally Sandy Lowland, Sands, and Sandy.

Hay grown in these areas should be harvested only every other year. During the following year, grazing only in fall or winter allows the warm-season grasses to gain vigor and decreases the abundance of cool-season grasses and weeds. Regulating mowing allows the desirable grasses to remain vigorous and healthy. Early



Figure 9.—An area of native woodland along Bone Creek.

mowing and cutting at the proper height allow for adequate plant regrowth. The regrowth helps to hold snow on the surface and thus increases the supply of soil moisture.

Technical assistance in managing range and hayland can be obtained from the local office of the Soil Conservation Service or the Upper Loup or Middle Niobrara Natural Resources District.

### Native Woodland

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Native woodland in Brown County occurs along the major streams and rivers (fig. 9). Approximately 18,000 acres, or less than 2.5 percent of the county, is forest

land. The wooded areas are confined mostly to narrow bands or strips. Some fairly large stands, however, occur on steep breaks in the northern part of the county. The acreage of woodland is increasing. Much of the ponderosa pine is just beginning to reach a harvestable size. A small lumber industry currently is in operation. As more of the trees reach commercial size, the woodland will become better suited to commercial production. Proper harvesting methods, thinning, controlled grazing, and other forest management practices can improve the woodland.

The greatest concentration of woodland is in areas of the McKelvie-Tassel-Ronson and Labu-Sansarc-Almeria associations on steep breaks along the Niobrara River and the major tributaries of Plum Creek and Long Pine Creek. Nearly pure stands of ponderosa pine are on the

upper part of the steep breaks. Bur oak is the dominant species on the lower part of the slopes. Other species include eastern redcedar, green ash, American elm, hackberry, boxelder, gray dogwood, mulberry, black walnut, American basswood, eastern hophornbeam, paper birch, quaking aspen, western snowberry, sand cherry, American plum, common chokecherry, golden currant, gooseberry, smooth sumac, and silver buffaloberry. Also, willow and cottonwood trees grow in the bottom of the draws and along the edge of streams. The stands of ponderosa pine do not extend very far from the Niobrara River. Bur oak, eastern redcedar, and associated species extend upward from the draws to the adjacent rangeland.

Areas along Sand Draw and Bone Creek are lightly wooded. The dominant species are eastern cottonwood, black willow, peachleaf willow, and sandbar willow. Other species are American plum, common chokecherry, and eastern redcedar.

Areas along the Calamus River and the wet areas in the Valentine-Els-Ipage, Valentine-Els-Tryon, and Loup-Els-Tryon associations are interspersed with a few cottonwood and willow trees. There is an abundance of indigobush along the edges of streams and ponds.

The county has a few blocks of woodland remaining from the Timber Claim Act. These generally consist of pure stands of eastern cottonwood.

## Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Windbreaks and environmental plantings have been established at various times on most ranch headquarters and farmsteads in Brown County. In addition, numerous windbreaks are established for livestock protection in the county. Only a few field windbreaks have been established.

Eastern redcedar is the most common species on the ranch headquarters and Siberian elm the second most common. Because several ranch headquarters are in or near subirrigated areas, eastern cottonwood trees also are numerous. Ponderosa pine, honeylocust, black locust, northern catalpa, Scotch pine, Russian mulberry, black willow, green ash, boxelder, American plum, lilac, and Russian olive are some of the other species grown as windbreaks.

Planting trees is a continuing process because old trees, such as Siberian elm and eastern cottonwood, pass maturity and deteriorate. Some trees are destroyed by insects or disease or by storms, and new plantings are needed on expanding ranches. Many old

windbreaks that are predominantly Siberian elm and eastern cottonwood require supplemental plantings to maintain their effectiveness.

Windbreaks that protect livestock, or "outdoor barns," are used extensively in the livestock industry. Outdoor barns generally occur as several windbreaks consisting of eight or more rows of trees. Eastern redcedar is planted in most of them.

A majority of the field windbreaks are in areas of the Valentine-Els-Ipage association near the center of the county. Many of these windbreaks consist of single or multiple rows of eastern cottonwood.

The species of trees and shrubs grown as windbreaks should be those that are suited to the soils on the selected site. Choosing the proper species is the first step in ensuring plant survival and a maximum growth rate. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate.

Trees and shrubs generally are difficult to establish in Brown County because of a low moisture supply during the growing season and hot, drying winds. Dry conditions and competition from weeds and grasses cause most of the failures of windbreaks or environmental plantings. Proper site preparation before planting and control of vegetation after planting are important in establishing and maintaining windbreaks. Supplemental watering is needed during dry periods, and cover crops may be needed to provide protection from hot winds and windblown soil particles.

Windbreaks protect livestock, buildings, and yards from wind and snow (fig. 10). They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings



Figure 10.—A farmstead windbreak of eastern redcedar and Siberian elm on Valentine loamy fine sand, 3 to 9 percent slopes.

that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

At the end of each map unit description under the heading "Detailed Soil Map Units," the soil has been assigned to a windbreak suitability group. These groups are based primarily on the suitability of the soil for the locally adapted species, as is indicated by their growth and vigor. Detailed interpretations for each windbreak suitability group in the county are provided by the Technical Guide, which is available in the local office of the Soil Conservation Service.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

## Recreation

Robert O. Koerner, biologist, Soil Conservation Service, helped prepare this section.

In a 1967 publication, many kinds of recreational areas in Brown County were evaluated by representatives of county, state, and federal agencies as well as local private organizations (10). The potential for vacation cabins, cottages and homesites, camping areas, and vacation farms and ranches was rated as high. The potential for fishing waters, hunting areas, and historic and natural scenic areas was rated as medium. The potential for picnic areas, sports areas and golf courses, preserves for shooting, and riding stables was rated as low. Areas for water sports and other sports activities were not rated.

A number of private and municipal vacation areas have been developed in Brown County. The Ainsworth Golf Course includes a driving range and picnic areas. Two city parks in Ainsworth offer picnic areas, children's playgrounds, a museum, swimming facilities, a sports area, and overnight camping grounds. The Pines and Nebraska Hidden Paradise offer a combination of camp grounds, picnic areas, swimming facilities, children's playgrounds, and places for fishing on scenic Long Pine Creek (10).

The primary recreational activity in Brown County is hunting for big and small game, including waterfowl during the regular seasons. Prairie chicken, sharp-tailed grouse, ring-necked pheasant, bobwhite quail, cottontail rabbit, coyote, raccoon, and fox squirrel are the major small game species. Mourning dove are common throughout the county and can be hunted early in the hunting season. White-tailed deer, mule deer, pronghorn antelope, and wild turkey are the big game species that can be hunted during regular seasons in public areas and on private lands with permission of the landowner.

Prairie grouse populations are subject to significant fluctuations. In most years, however, grouse hunting is a major recreational activity. Pheasants are primarily limited to areas that have significant acres of cropland and adjacent woodland or wetland. In most years quail are rare but are occasionally sighted in areas consisting of very dense woody cover and cropland.

The waterfowl in the county includes numerous species of ducks and geese. Hunting for waterfowl is successful early in the season, and it usually ends before the marshes freeze over.

The potential for wildlife habitat has been improved by center-pivot irrigation systems. Many irrigated, highly erodible areas can be reseeded to grass and thus can provide habitat for increasing populations of small and big game.

Areas along the Niobrara River offer excellent deer and turkey habitat. The marsh areas in the southwestern part of the county are suitable as habitat for waterfowl and shore birds as well as furbearers, such as mink, muskrat, weasel, and beaver.

The Niobrara River, the Calamus River, Plum Creek, Long Pine Creek, Goose Creek, Long Lake, Upper Twin Lake, Fairfield Creek, and several private lakes and ponds provide opportunities for fishing.

Because they are undisturbed by human activity for long periods of the year, many areas in Brown County are conducive to wildlife. The Nebraska Game and Parks Commission controls all hunting and game populations and manages several public recreation areas.

Long Pine State Recreation Area consists of 154

acres of land and 1 acre of a stream. The stream is stocked with trout on a regular basis and provides good opportunities for fishing. Several picnic tables and grills and a few picnic shelters are available. The area offers many nondesignated campsites and a few camping pads. Located along Long Pine Creek, it provides an esthetic atmosphere for families and individuals.

Pine Glen, in an area in the northern part of the county along Long Pine Creek, provides opportunities for trout fishing, hunting, backpacking, geological study, nature study, photography, and hiking. This area is designated as a wildlife management area. It includes 960 acres of wildlife habitat on both sides of Long Pine Creek. Only primitive camping is possible in this area.

American Game Marsh is a wildlife management area in the southwestern part of the county. It is 161 acres in size. Of this acreage, 120 acres is marsh. Because no facilities are provided, only primitive camping is possible. Opportunities for hunting, hiking, nature study, and photography are available. This area provides excellent habitat for waterfowl as well as other wetland wildlife.

Keller Park State Recreation Area has recently been added to the Nebraska Game and Parks Recreation system. This area was dedicated on June 7, 1986. It includes 197 acres and is 5 miles east and 9 miles north of Ainsworth. It is along Bone Creek, near U.S. Highway 183. It offers opportunities for photography, nature study, hiking, fishing, camping, and other recreational activities. The area has five ponds. One of the spring-fed ponds is regularly stocked with rainbow trout of catchable size. A current trout stamp is required to fish the pond. The other ponds are stocked with different species of fish, such as perch, catfish, bass, bluegill, and walleye.

The area has all-weather access roads, many all-weather pads complete with electrical hookups, and a sanitary trailer dump station. Each site is equipped with a fire grate and a picnic table. A large picnic shelter along with sufficient parking space is also available. Water faucets and pumps and vault latrines are provided for both campers and other park visitors. A valid Nebraska park entry permit is required for use of the park. Situated on a stream terrace overlooking Bone Creek, the camping area offers a splendid view of the stream corridor and the adjacent woods.

In the southwestern part of the county, several other marshes on both private and public lands are available for hunting waterfowl. The Nature Conservancy owns and manages several thousand acres of land in an area north of Johnstown and adjacent to the Niobrara River. This land is open to the public, by appointment, for hunting or nature study (fig. 11).

The soils of the survey area are rated in table 10



Figure 11.—A scenic recreational area along the Niobrara River.

according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations

are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

*Camp areas* require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface absorbs rainfall readily but remains firm and is not dusty when

dry. Strong slopes can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is firm after rains and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or gravelly coarse sand should be considered.

*Paths and trails* for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Technical assistance in designing recreation facilities is available at the local office of the Soil Conservation Service in Ainsworth.

## Wildlife Habitat

Brown County offers a wide variety of habitat types for openland, wetland, woodland, and rangeland wildlife. The wooded drainageways and the bottom land along the Niobrara River and its tributaries provide ideal habitat for wild turkey, white-tailed deer, mule deer, bobwhite quail, tree squirrel, fox, coyote, bobcat, cottontail rabbit, opossum, and ring-necked pheasant. During periods of migration, shore birds, songbirds, hawks, owls, eagles, and waterfowl also inhabit the county.

Tree, shrub, and vine species in the Niobrara River Valley and in drainageways flowing into the river include bur oak, boxelder, green ash, hackberry, eastern redcedar, cottonwood, willow, American linden, elm, American plum, chokecherry, coralberry, sumac, silver buffaloberry, ponderosa pine, Russian olive, mulberry, black walnut, wild grape, woodbine, Virginia creeper, and poison ivy. The vegetation in these areas influences the quality and diversity of wildlife habitat.

Wooded areas, including shelterbelts, farm windbreaks, and low areas where a high water table favors cottonwoods, are throughout the county. These areas, as well as plum and chokecherry thickets along roadsides and fence lines, provide cover for quail, rabbit, deer, and pheasant. Wild turkeys, which are increasing in number, inhabit most areas that have

stands of trees. Some of the areas that have thin stands of trees cannot provide a great deal of cover, but they can provide den trees for raccoons and woodpeckers and perches for hawks, owls, and eagles.

The area around Ainsworth in the north-central part of the county is a tableland. The soils in this area have a silty or loamy surface layer and are nearly level to gently sloping. They generally are irrigated. The main crops are corn and alfalfa. This area does not provide adequate winter or nesting cover. As a result, the populations of upland game birds and other wildlife are limited. Farmstead, feedlot, and field windbreaks provide some cover and food for deer, pheasants, cottontail rabbits, songbirds, and other openland wildlife. The main species of trees in these windbreaks are green ash, Siberian elm, hackberry, eastern redcedar, pine, common chokecherry, and Russian olive. Areas where crop residue is left on the surface, weedy fence rows, and small uncultivated areas in the corners of fields irrigated by center-pivot systems and along irrigation ditches provide winter cover. This area provides adequate cover in the summer. Because of irrigation, water is in good supply most of the year.

The rangeland throughout much of the county occurs as nearly level to hilly, sandy soils covered by grasses and forbs. The vegetation includes sand bluestem, little bluestem, big bluestem, sideoats grama, indiagrass, prairie cordgrass, leadplant, sand cherry, sumac, and plum bushes. Willow grows in low areas. The rangeland provides cover for mule deer, pronghorn antelope, coyotes, badgers, prairie grouse, meadowlarks, and jackrabbits.

Wetlands are throughout the county. They occur as marshes or shallow lakes in areas where a seasonal high water table is at or near the surface. The vegetation in these areas includes cattails, rushes, sedges, willows, smartweed, duckweed, wild rice, and ferns. The areas provide cover, food, and water for waterfowl, shore birds, muskrats, mink, pheasant, and deer.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation (fig. 12), by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that



Figure 12.—A wildlife planting in an area of Valentine-Libory complex, 0 to 9 percent slopes. The species planted include eastern redcedar, ponderosa pine, Russian olive, chokeberry, and skunkbush sumac.

are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

*Grain and seed crops* are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops

are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, soybeans, and grain sorghum.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, intermediate wheatgrass, smooth brome, clover, and alfalfa.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are big bluestem, little bluestem, goldenrod, beggarweed, western wheatgrass, and blue grama.

*Hardwood trees* and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage.

Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are bur oak, cottonwood, green ash, hackberry, elm, American basswood, gray dogwood, eastern hophornbeam, and willow. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, American plum, and common chokecherry.

*Coniferous plants* furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are ponderosa pine, spruce, eastern redcedar, and juniper.

*Shrubs* are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are western snowberry, American plum, common chokecherry, smooth sumac, sand cherry, golden currant, and gooseberry.

*Wetland plants* are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, and slope. Examples of wetland plants are smartweed, cattails, wildrice, prairie cordgrass, rushes, sedges, and reeds.

*Shallow water areas* have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

*Habitat for openland wildlife* consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, skunk, and badger.

*Habitat for woodland wildlife* consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey (fig. 13), songbirds, woodpeckers, squirrels, raccoon, white-tailed deer, porcupine, bobcat, hawks, and owls.

*Habitat for wetland wildlife* consists of open, marshy

or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, beaver, blackbirds, and snakes.

*Habitat for rangeland wildlife* consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, mule deer, sharp-tailed grouse, meadowlark, prairie chicken, curlew, coyote, prairie dog, rattlesnake, and jackrabbit.

Technical assistance in improving wildlife habitat is available in the local office of the Soil Conservation Service in Ainsworth.

## Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

*Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.*

*The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and



Figure 13.—Wild turkeys feeding in an area of Inavale loamy fine sand, 0 to 3 percent slopes, along Long Pine Creek.

other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil

maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

### Building Site Development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to

overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, gravel content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

*Dwellings and small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts and sodium affect plant

growth. Flooding, wetness, slope, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

### Sanitary Facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

*Septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Bedrock interferes with installation. The caving of cutbanks is a hazard in areas of sandy soils.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

*Sewage lagoons* are shallow ponds constructed to

hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and gravel can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

*Daily cover for landfill* is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported

to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

### Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good*, *fair*, or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 feet.

*Roadfill* is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by a high water table and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable

material, a low shrink-swell potential, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential or slopes of 15 to 25 percent. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, or slopes of more than 25 percent. They are wet, and depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

*Sand and gravel* are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that has no more than 12 percent fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They have little or no gravel and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

### Water Management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment.

Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of organic matter or of salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*Aquifer-fed excavated ponds* are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

*Drainage* is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic

substances in the root zone, such as salts or sodium. Availability of drainage outlets is not considered in the ratings.

*Irrigation* is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

*Terraces and diversions* are embankments or a combination of channels and ridges constructed across a slope to control water erosion and conserve moisture by intercepting runoff. Slope, wetness, gravel content, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

*Grassed waterways* are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

# Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

## Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 14). "Loam," for example, is soil that is

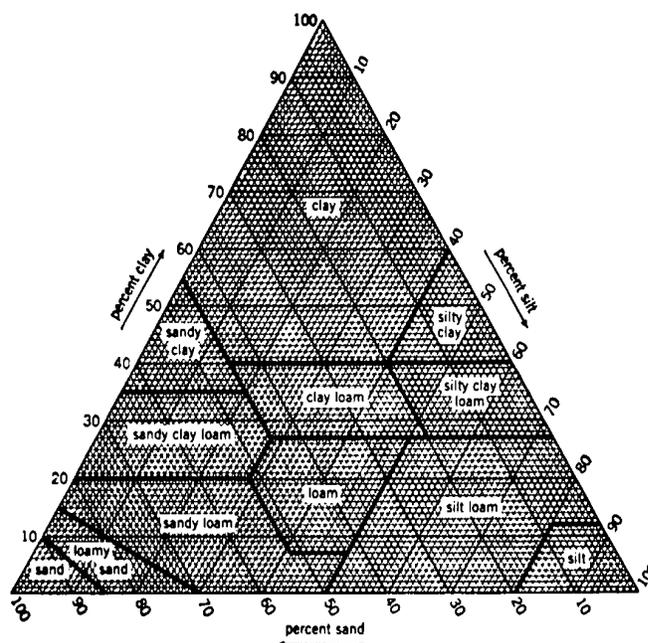


Figure 14.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

*Classification* of the soils is determined according to the Unified soil classification system (3) and the system adopted by the American Association of State Highway and Transportation Officials (2).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering

properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. In Nebraska, group index numbers range from -4 for the best subgrade material to 32 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 19.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

## Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the

ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

*Moist bulk density* is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at  $\frac{1}{3}$  bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

*Permeability* refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

*Available water capacity* refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

*Soil reaction* is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

*Salinity* is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at

25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

- 4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## Soil and Water Features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning

that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or of soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of

distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

*Depth to bedrock* is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

*Potential frost action* is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very

gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

### Physical and Chemical Analyses of Selected Soils

Samples from some soil profiles were collected and sent to the Soil Conservation Service, Soil Survey Investigations Staff, in Lincoln, Nebraska, for physical and chemical analyses. Brocksburg, Dunday, Jansen, Johnstown, and Valentine soils were sampled in Brown

County during the course of the survey. Brunswick, Elsmere, Loup, McKelvie, Simeon, and Vetal soils were sampled in nearby counties. These data and other information about the soils in the county can be obtained from the Soil Survey Investigations Staff.

The laboratory methods of both the Soil Survey Investigations Staff and the Nebraska Department of Roads were used in determining soil properties. The Soil Survey Investigations Staff develops data on properties relevant to the classification and agricultural management of soils. The Nebraska Department of Roads develops engineering test data. Much of the data can be extrapolated from one use to the other.

### Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Specific gravity—T 100 (AASHTO). The group index number that is part of the AASHTO classification is computed by the Nebraska Modified System.



# Classification of the Soils

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The system of soil classification used by the National Cooperative Soil Survey has six categories (11). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

**ORDER.** Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

**SUBORDER.** Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

**GREAT GROUP.** Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Fluvaquents (*Fluv*, meaning flood plain, plus *aquent*, the suborder of the Entisols that has an aquic moisture regime).

**SUBGROUP.** Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Fluvaquents.

**FAMILY.** Families are established within a subgroup

on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy, mixed, mesic Typic Fluvaquents.

**SERIES.** The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

## Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (9). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (11). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

### Almeria Series

The Almeria series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on bottom land along the major streams and tributaries.

These soils formed in stratified, loamy and sandy alluvium. Slopes range from 0 to 2 percent.

Almeria soils are commonly adjacent to Bolent and Inavale soils, to Fluvaquents, sandy, and to Histosols. Bolent and Inavale soils are better drained than the Almeria soils and are on the higher parts of the bottom land. Fluvaquents and Histosols are very poorly drained and are along oxbows and on low bottom land adjacent to streams.

Typical pedon of Almeria fine sandy loam, in an area of Almeria-Histosols complex, channeled, 200 feet east and 2,500 feet south of the northwest corner of sec. 35, T. 26 N., R. 22 W.

A—0 to 5 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak medium granular structure; soft, very friable; slightly acid; abrupt smooth boundary.

Cg1—5 to 12 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; many medium distinct yellowish brown (10YR 5/6 moist) mottles; single grain; loose; neutral; abrupt smooth boundary.

Cg2—12 to 28 inches; grayish brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

Cg3—28 to 42 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; single grain; loose; neutral; clear smooth boundary.

Cg4—42 to 54 inches; light gray (10YR 7/2) sand, light brownish gray (10YR 6/2) moist; single grain; loose; mildly alkaline; diffuse smooth boundary.

Cg5—54 to 60 inches; white (10YR 8/1) sand, light brownish gray (10YR 6/2) moist; single grain; loose; neutral.

The A horizon has value of 3 to 6 (2 to 5 moist) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes loamy fine sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 8 (2 to 7 moist), and chroma of 1 to 3. It has faint or distinct yellowish or brownish mottles. It is commonly fine sand or sand, but the range includes loamy fine sand. Also, this horizon has strata of very fine sandy loam or fine sandy loam  $\frac{1}{8}$  inch to 16 inches thick. Some pedons have thin strata of finer or coarser textured material. Some have sandstone fragments.

### Anselmo Series

The Anselmo series consists of deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in loamy and sandy eolian material. Slopes range from 0 to 30 percent.

Anselmo soils are commonly adjacent to Brunswick, Dunday, O'Neill, Ronson, Valentine, and Vetal soils. Brunswick and Ronson soils are moderately deep to soft sandstone. Brunswick soils are not mollic. They are on side slopes. Ronson and O'Neill soils are on divides and side slopes. O'Neill soils are moderately deep to coarse sand and gravel. Dunday soils have a control section that is sandier than that of the Anselmo soils. They are on divides and the higher side slopes. Valentine soils are sandy and are not mollic. They are generally on hummocky uplands. Vetal soils have a mollic epipedon that is more than 20 inches thick. They are in upland swales and on foot slopes.

Typical pedon of Anselmo fine sandy loam, 0 to 2 percent slopes, 1,500 feet north and 50 feet east of the southwest corner of sec. 4, T. 31 N., R. 23 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; few very fine and fine roots; slightly acid; abrupt smooth boundary.

A—7 to 18 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; few very fine and fine roots; neutral; gradual smooth boundary.

Bw—18 to 33 inches; brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; few very fine and fine roots; neutral; clear smooth boundary.

C1—33 to 42 inches; light yellowish brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure; soft, very friable; few very fine and fine roots; neutral; clear smooth boundary.

C2—42 to 49 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; weak coarse prismatic structure; soft, very friable; few very fine roots; neutral; clear smooth boundary.

C3—49 to 60 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; single grain; loose; neutral.

The thickness of the solum ranges from 24 to 40 inches. The mollic epipedon ranges from 11 to 20 inches in thickness. It includes the upper part of the B horizon in some pedons.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 to 3. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to

4. It is typically fine sandy loam, but the range includes loam and sandy loam. Some pedons have a BC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is typically loamy fine sand, but the range includes fine sandy loam and fine sand. Some pedons have loamy or silty strata below a depth of 40 inches.

### Barney Series

The Barney series consists of deep, poorly drained soils on low bottom land. These soils formed in 7 to 20 inches of stratified, loamy alluvium over sandy alluvium. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Barney soils are commonly adjacent to Bolent and Inavale soils on the higher parts of the bottom land. Bolent soils are somewhat poorly drained. Inavale soils are somewhat excessively drained.

Typical pedon of Barney fine sandy loam, channeled, 150 feet west and 780 feet north of the southeast corner of sec. 14, T. 30 N., R. 22 W.

Oe—1 inch to 0; partially decomposed organic material.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, black (10YR 2/1) moist; weak medium granular structure; slightly hard, very friable; many fine and medium roots; mildly alkaline; clear smooth boundary.

A2—7 to 10 inches; stratified grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) and black (10YR 2/1) moist; weak medium subangular blocky structure; slightly hard, very friable; many fine and medium roots; mildly alkaline; clear smooth boundary.

ACg—10 to 13 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/4 moist) mottles; weak fine and medium subangular blocky structure; slightly hard, very friable; many fine and medium roots; mildly alkaline; gradual smooth boundary.

Cg—13 to 20 inches; light gray (10YR 7/2) sand, light brownish gray (10YR 6/2) moist; common medium distinct yellowish brown (10YR 5/6 moist) mottles; single grain; loose; few thin strata of grayish brown (10YR 5/2) loam; mildly alkaline; clear smooth boundary.

2Cg—20 to 60 inches; light brownish gray (10YR 6/2) coarse sand, grayish brown (10YR 5/2) moist; single grain; loose; mildly alkaline.

The solum is 7 to 10 inches thick. Depth to the 2C horizon ranges from 7 to 20 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes loam and loamy fine sand finely stratified with coarser textured material. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. It has faint to prominent brownish or grayish mottles. It is commonly sand, but the range includes loamy sand and loamy fine sand finely stratified with finer or coarser textured material. The 2C horizon is dominantly coarse sand, gravelly coarse sand, or sand. It is less commonly fine sand. It has mottles similar to those of the C horizon.

The Barney soil in Inavale-Barney complex, channeled, has an epipedon that is too thin to meet the requirements of the mollic subgroup. This difference, however, does not affect the use or behavior of the soil.

### Bolent Series

The Bolent series consists of deep, somewhat poorly drained, rapidly permeable soils on bottom land. These soils formed in sandy alluvium. Slopes range from 0 to 2 percent.

Bolent soils are commonly adjacent to Almeria, Barney, and Inavale soils and to Fluvaquents, sandy. Almeria and Barney soils are on the lower parts of the bottom land. Almeria soils are poorly drained or very poorly drained. Barney soils are poorly drained. Fluvaquents are very poorly drained and are on the lowest bottom land adjacent to the stream channels. Inavale soils are somewhat excessively drained and are on the higher parts of the bottom land.

Typical pedon of Bolent fine sandy loam, 0 to 2 percent slopes, 2,800 feet north and 3,000 feet west of the southeast corner of sec. 31, T. 33 N., R. 23 W.

A—0 to 5 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, friable; common medium and fine roots; mildly alkaline; clear smooth boundary.

C1—5 to 8 inches; light gray (2.5Y 7/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; single grain; soft, very friable; few fine and medium roots; mildly alkaline; clear smooth boundary.

C2—8 to 15 inches; white (2.5Y 8/2) fine sand, light brownish gray (2.5Y 6/2) moist; few fine prominent strong brown (7.5YR 5/6 moist) mottles; single grain; loose; mildly alkaline; gradual smooth boundary.

C3—15 to 40 inches; white (2.5Y 8/2) fine sand, light

brownish gray (2.5Y 6/2) moist; few fine distinct yellow (2.5Y 7/6 moist) mottles; single grain; loose; few very thin strata of light brownish gray (2.5Y 6/2) very fine sandy loam; mildly alkaline; gradual smooth boundary.

C4—40 to 60 inches; white (2.5Y 8/2) fine sand, light brownish gray (2.5Y 6/2) moist; few fine distinct pale yellow (2.5Y 7/4 moist) mottles; single grain; loose; mildly alkaline.

The A horizon has value of 4 to 6 (2 to 4 moist) and chroma of 1 to 3. Some pedons have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 to 8 (4 to 7 moist), and chroma of 1 to 3. It has brown, reddish brown, or yellow mottles. It is loamy fine sand, loamy sand, fine sand, or sand. It is typically stratified with lighter and darker material, which may be coarser or finer textured.

## Brocksburg Series

The Brocksburg series consists of deep, well drained soils on uplands. These soils formed in 20 to 40 inches of loamy sediment or loess overlying alluvial sand and coarse sand. Permeability is moderate in the solum and very rapid in the underlying material. Slopes are 0 to 1 percent.

Brocksburg soils are commonly adjacent to Jansen, Johnstown, Meadin, O'Neill, and Sandose soils. The adjacent soils are in positions on broad uplands similar to those of the Brocksburg soils. Jansen, Meadin, O'Neill, and Sandose soils have a mollic epipedon less than 20 inches thick. Johnstown soils have a subsoil that is finer textured than that of the Brocksburg soils. They are more than 40 inches deep to sandy or gravelly material. Meadin soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. O'Neill soils do not have an argillic horizon. They have more sand in the control section than the Brocksburg soils. Sandose soils are sandy in the upper part and loamy in the underlying material.

Typical pedon of Brocksburg loam, 0 to 1 percent slopes, 2,150 feet west and 105 feet south of the northeast corner of sec. 34, T. 30 N., R. 22 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

A—6 to 16 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; slightly acid; clear smooth boundary.

Bt1—16 to 23 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm; neutral; clear smooth boundary.

Bt2—23 to 31 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to moderate coarse subangular blocky; very hard, firm; dark coatings on faces of peds; neutral; clear smooth boundary.

Bt3—31 to 36 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm; dark coatings on faces of peds; neutral; abrupt smooth boundary.

2C1—36 to 44 inches; light yellowish brown (2.5Y 6/4) sand, light olive brown (2.5Y 5/4) moist; single grain; loose; neutral; clear wavy boundary.

2C2—44 to 60 inches; light gray (10YR 7/2) coarse sand, brown (10YR 5/3) moist; single grain; loose; neutral.

The solum is 20 to 38 inches thick. The mollic epipedon is 20 to 34 inches thick. Sand, coarse sand, or gravelly coarse sand is at a depth of 24 to 40 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 2 to 4. It is dominantly clay loam, but the range includes loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is typically coarse sand, but the range includes sand and gravelly coarse sand. It contains as much as 35 percent gravel by volume.

## Brunswick Series

The Brunswick series consists of moderately deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from soft sandstone bedrock (fig. 15). Slopes range from 3 to 30 percent.

The Brunswick soils in Brown County are in a drier climate than is typical for the series. This difference, however, does not significantly affect the use or management of the soils.

Brunswick soils are commonly adjacent to Anselmo, McKelvie, Meadin, Ronson, Tassel, and Valentine soils. Anselmo soils are deep and have a mollic epipedon. They are on the higher side slopes. McKelvie soils are sandy. They are on the lower side slopes of breaks. Meadin soils have a mollic epipedon and have gravelly



Figure 15.—Profile of Brunswick fine sandy loam. This soil is moderately deep over soft sandstone bedrock. The arrow marks the lower boundary of the surface layer. The scale is in feet.

coarse sand at a depth of 8 to 20 inches. They are higher on upland ridgetops and side slopes than the Brunswick soils. Ronson soils have a mollic epipedon. They are in landscape positions similar to those of the Brunswick soils. Tassel soils are in positions on upland ridges and on side slopes similar to those of the Brunswick soils. They have weakly cemented sandstone at a depth of 6 to 20 inches. Valentine soils are sandy. They are on hummocky uplands.

Typical pedon of Brunswick fine sandy loam, in an area of Anselmo-Brunswick fine sandy loams, 11 to 30 percent slopes, 200 feet west and 1,650 feet north of

the southeast corner of sec. 19, T. 31 N., R. 21 W.

- A—0 to 4 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable; many fine roots; slightly acid; clear smooth boundary.
- Bw1—4 to 11 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; many fine roots; slightly acid; clear smooth boundary.
- Bw2—11 to 16 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; many fine roots; neutral; clear smooth boundary.
- BC—16 to 26 inches; very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; common fine roots; neutral; gradual smooth boundary.
- C—26 to 33 inches; very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) moist; massive; soft, very friable; common fine roots; neutral; clear smooth boundary.
- Cr1—33 to 43 inches; white (2.5Y 8/2), soft sandstone, light brownish gray (2.5Y 6/2) moist; mildly alkaline; clear wavy boundary.
- Cr2—43 to 60 inches; pale yellow (5Y 7/3), soft sandstone, pale olive (5Y 6/3) moist; mildly alkaline.

The thickness of the solum ranges from 12 to 28 inches. The depth to soft sandstone bedrock ranges from 20 to 40 inches.

The A horizon has value of 4 or 5 (3 or 4 moist) and chroma of 1 or 2. The Bw horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is typically fine sandy loam, but the range includes loam that averages less than 18 percent clay. The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 6 to 8 (5 or 6 moist); and chroma of 2 or 3. It is typically fine sandy loam or loamy fine sand, but the range includes sandy loam. The Cr horizon has colors similar to those of the C horizon.

### Dunday Series

The Dunday series consists of deep, somewhat excessively drained, rapidly permeable soils in enclosed sandhill valleys and on uplands. These soils formed in sandy eolian material. Slopes range from 0 to 9 percent.

Dunday soils are commonly adjacent to Anselmo, Pivot, Ronson, Sandose, and Valentine soils. Anselmo soils contain less sand than the Dunday soils. They are on divides or on the lower side slopes. Pivot soils have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. They are on the slightly lower side slopes and in swales. Ronson soils have sandstone at a depth of 20 to 40 inches. They are in swales and in positions on side slopes similar to those of the Dunday soils. Sandose soils have loamy underlying material. They are in the slightly lower positions in swales. Valentine soils are in positions on side slopes similar to those of the Dunday soils or are higher on ridges and dunes. They do not have a mollic epipedon.

Typical pedon of Dunday loamy fine sand, 0 to 3 percent slopes, 1,600 feet north and 350 feet west of the southeast corner of sec. 19, T. 32 N., R. 21 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; slightly acid; clear smooth boundary.

AC—7 to 18 inches; brown (10YR 4/3) loamy fine sand, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable; common fine and very fine roots; slightly acid; clear smooth boundary.

C1—18 to 30 inches; pale brown (10YR 6/3) fine sand, brown (10YR 4/3) moist; single grain; loose; few very fine roots; neutral; gradual smooth boundary.

C2—30 to 60 inches; very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; single grain; loose; few very fine roots; neutral.

The thickness of the solum ranges from 14 to 26 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is fine sand, loamy fine sand, or loamy sand. Buried loamy layers are in the lower part of this horizon in some pedons.

## Els Series

The Els series consists of deep, somewhat poorly drained, rapidly permeable soils in depressions and valleys in the Sandhills. These soils formed in a mixture of eolian and alluvial sandy material. Slopes range from 0 to 3 percent.

Els soils are commonly adjacent to Elsmere, Ipage, Loup, Tryon, and Valentine soils. Elsmere soils have a mollic epipedon. They are in positions on bottom land similar to those of the Els soils and are in depressions

in sandhill valleys. Ipage soils are on small hummocks or low ridges in the slightly higher areas in sandhill valleys. They are moderately well drained. Loup and Tryon soils are in the slightly lower areas of bottom land in sandhill valleys. They are poorly drained and very poorly drained. Valentine soils are on the higher hummocks and are excessively drained.

Typical pedon of Els loamy sand, 0 to 2 percent slopes, 2,650 feet north and 2,200 feet east of the southwest corner of sec. 30, T. 30 N., R. 24 W.

A—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many very fine and fine roots; slightly acid; clear smooth boundary.

AC—6 to 11 inches; brown (10YR 5/3) loamy sand, dark grayish brown (10YR 4/2) moist; single grain; loose; common very fine and fine roots; neutral; clear smooth boundary.

C—11 to 19 inches; pale brown (10YR 6/3) fine sand, brown (10YR 4/3) moist; single grain; loose; common very fine and fine roots; neutral; clear smooth boundary.

Cg1—19 to 32 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few fine distinct brownish yellow (10YR 6/6 moist) mottles; single grain; loose; few very fine roots; neutral; clear smooth boundary.

Cg2—32 to 60 inches; white (10YR 8/2) fine sand, light gray (10YR 7/2) moist; few fine distinct brownish yellow (10YR 6/6 moist) mottles; single grain; loose; neutral.

The thickness of the solum ranges from 6 to 19 inches. The A horizon has value of 4 or 5 (3 moist) and chroma of 1 or 2. It is loamy sand, fine sand, or loamy fine sand. The AC horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1 to 3. It is mottled in some pedons. It is loamy sand, fine sand, sand, or loamy fine sand. The C horizon has hue of 10YR or 2.5Y, value of 5 to 8 (4 to 7 moist), and chroma of 2 or 3. It has brownish yellow, yellowish brown, or strong brown mottles. It is typically fine sand, but in some pedons it is sand or loamy sand.

## Elsmere Series

The Elsmere series consists of deep, somewhat poorly drained, rapidly permeable soils in depressions and in valleys in the Sandhills. These soils formed in a mixture of eolian and alluvial sandy material. Slopes range from 0 to 2 percent.

Elsmere soils are commonly adjacent to Els,

Gannett, Ipage, Loup, and Tryon soils. Els soils do not have a mollic epipedon. They are in positions on bottom land similar to those of the Elsmere soils and are in depressions in sandhill valleys. Gannett soils are poorly drained and are in the lower depressions in sandhill valleys. Ipage soils are higher on the low hummocky slopes in valleys than the Elsmere soils. They are moderately well drained. Loup and Tryon soils are on the slightly lower parts of valleys. They are poorly drained or very poorly drained.

Typical pedon of Elsmere loamy fine sand, 0 to 2 percent slopes, 1,150 feet east and 125 feet north of the southwest corner of sec. 22, T. 27 N., R. 22 W.

A1—0 to 6 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many very fine and fine roots; neutral; clear smooth boundary.

A2—6 to 14 inches; very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many very fine and fine roots; neutral; clear smooth boundary.

AC—14 to 23 inches; light brownish gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; common very fine roots; neutral; clear wavy boundary.

Cg—23 to 60 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few fine distinct dark yellowish brown (10YR 3/4 moist) mottles; single grain; loose; few very fine roots; neutral.

The thickness of the mollic epipedon ranges from 10 to 19 inches. The thickness of the solum ranges from 10 to 30 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The AC horizon has value of 4 to 6 (2 to 4 moist) and chroma of 1 or 2. It is fine sand, loamy sand, or loamy fine sand. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It has few to many, faint to prominent, yellowish brown, strong brown, or dark reddish brown mottles. It is typically fine sand. It is less commonly loamy sand, loamy fine sand, or sand.

### Gannett Series

The Gannett series consists of deep, poorly drained soils in depressions in sandhill valleys. These soils formed in eolian or water-worked sandy and silty material. Permeability is moderately rapid in the solum and rapid in the underlying material. Slopes range from 0 to 2 percent.

Gannett soils are commonly adjacent to Elsmere, Loup, and Marlake soils. The adjacent soils are sandier throughout than the Gannett soils. Elsmere soils are somewhat poorly drained and are in the higher positions in sandhill valleys. Loup soils are slightly lower on bottom land than the Gannett soils. Marlake soils are very poorly drained and are in ponded depressions.

Typical pedon of Gannett fine sandy loam, 0 to 2 percent slopes, 800 feet east and 1,500 feet south of the northwest corner of sec. 13, T. 27 N., R. 24 W.

Oi—2 inches to 0; partly decomposed organic material.

A1—0 to 6 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, friable; mildly alkaline; clear smooth boundary.

A2—6 to 19 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; slightly hard, friable; mildly alkaline; clear smooth boundary.

ACg—19 to 23 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak coarse subangular blocky structure; slightly hard, friable; mildly alkaline; clear smooth boundary.

Cg1—23 to 45 inches; light gray (10YR 6/1) loamy sand, gray (10YR 5/1) moist; single grain; loose; mildly alkaline; gradual smooth boundary.

Cg2—45 to 60 inches; light gray (10YR 7/1) fine sand, light gray (10YR 6/1) moist; single grain; loose; mildly alkaline.

The thickness of the solum ranges from 16 to 24 inches. It commonly is the same as the thickness of the mollic epipedon.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The C horizon has value of 6 or 7 (5 or 6 moist) and chroma of 1 or 2. It has distinct or prominent mottles. Typically, it is fine sand or loamy sand.

### Inavale Series

The Inavale series consists of deep, somewhat excessively drained, rapidly permeable soils on bottom land. These soils formed in sandy alluvium. Slopes range from 0 to 3 percent.

Inavale soils are commonly adjacent to Almeria, Barney, and Bolent soils and to Fluvaquents, sandy. Almeria and Barney soils are on the lower bottom land and are poorly drained or very poorly drained. Bolent soils are somewhat poorly drained and are on the slightly lower bottom land. Fluvaquents are very poorly drained and are in the lowest positions on bottom land adjacent to the stream channels.

Typical pedon of Inavale loamy fine sand, 0 to 3

percent slopes, 1,300 feet east and 700 feet north of the southwest corner of sec. 26, T. 33 N., R. 24 W.

A—0 to 8 inches; gray (10YR 5/1) loamy fine sand, very dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, very friable; few fine and very fine roots; neutral; abrupt smooth boundary.

AC—8 to 20 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grain; loose; few very fine roots; few thin strata of grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) very fine sandy loam; neutral; abrupt smooth boundary.

C—20 to 60 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; single grain; loose; few thin strata of light brownish gray (10YR 6/2) fine sandy loam; neutral.

The thickness of the solum ranges from 8 to 20 inches. The A horizon has value of 4 to 6 (3 to 5 moist) and chroma of 1 to 3. It is loamy fine sand, sand, fine sandy loam, or loamy sand. The AC and C horizons have value of 5 to 7 (4 to 6 moist) and chroma of 2 or 3. They are typically fine sand, but the range includes sand, loamy fine sand, and loamy sand. Also, strata of coarser or finer textured material are common in the C horizon (fig. 16).

### Ipague Series

The Ipague series consists of deep, moderately well drained, rapidly permeable soils formed in sandy eolian and alluvial material. These soils are in sandhill valleys. Slopes range from 0 to 3 percent.

Ipague soils are commonly adjacent to Els, Elsmere, Tryon, and Valentine soils. Els and Elsmere soils are on the slightly lower parts of sandhill valleys and are somewhat poorly drained. Elsmere soils have a mollic epipedon. Tryon soils are in the lower areas in sandhill valleys. They are poorly drained and very poorly drained. Valentine soils are on the higher, nearly level to hilly uplands and sandhills. They are excessively drained.

Typical pedon of Ipague fine sand, 0 to 3 percent slopes, 1,900 feet east and 2,600 feet south of the northwest corner of sec. 27, T. 26 N., R. 22 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

AC—7 to 13 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grain; loose; neutral; gradual smooth boundary.

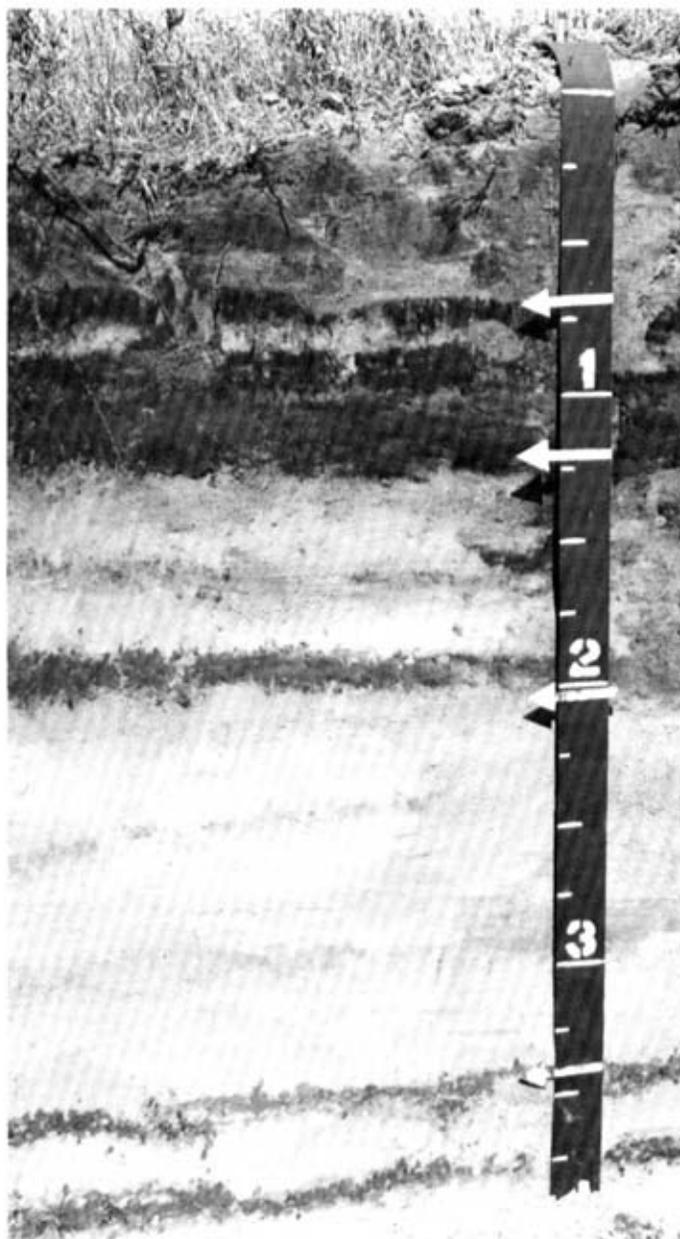


Figure 16.—Profile of Inavale loamy fine sand. The arrows mark different strata. The scale is in feet.

C1—13 to 31 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; single grain; loose; neutral; gradual smooth boundary.

C2—31 to 60 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; common fine and medium distinct yellowish brown (10YR 5/6 moist) mottles; single grain; loose; neutral.

The thickness of the solum ranges from 4 to 20 inches. The A horizon has value of 4 to 6 (3 or 4 moist)

and chroma of 1 or 2. It is fine sand or loamy sand. The AC horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 or 3. It is fine sand, sand, loamy fine sand, or loamy sand. The C horizon has value of 6 to 8 (4 to 6 moist) and chroma of 2 or 3. It has few or common, distinct or prominent, gray to yellowish brown mottles within a depth of 40 inches. It is typically fine sand or sand. It is less commonly loamy fine sand or loamy sand. Also, coarse sand is below a depth of 40 inches in some pedons.

### Jansen Series

The Jansen series consists of well drained soils on uplands. These soils formed in 20 to 36 inches of loamy sediment or loess overlying sand, coarse sand, and gravelly coarse sand. Permeability is moderate in the solum and very rapid in the underlying material. Slopes range from 0 to 6 percent.

Jansen soils are commonly adjacent to Brocksburg, Johnstown, Meadin, O'Neill, and Sandose soils. The adjacent soils are in positions on broad uplands similar to those of the Jansen soils. Brocksburg soils have a mollic epipedon that is more than 20 inches thick. Johnstown soils have a subsoil that is finer textured than that of the Jansen soils. They are deep over sandy or gravelly material. Meadin soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. O'Neill soils have more sand in the upper part of the control section than the Jansen soils. Sandose soils are sandy in the upper part and loamy in the underlying material. They are on the slightly higher ridgetops.

Typical pedon of Jansen loam, 0 to 2 percent slopes, 400 feet east and 1,200 feet south of the northwest corner of sec. 16, T. 30 N., R. 23 W.

- Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; slightly acid; abrupt smooth boundary.
- BA—8 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; neutral; clear smooth boundary.
- Bt1—13 to 20 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm; dark coatings on faces of peds; neutral; clear smooth boundary.
- Bt2—20 to 30 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate coarse prismatic

structure parting to moderate medium subangular blocky; hard, firm; dark coatings on faces of peds; neutral; gradual wavy boundary.

2C1—30 to 42 inches; pale brown (10YR 6/3) coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; neutral; clear wavy boundary.

2C2—42 to 60 inches; light gray (10YR 7/2) sand, pale brown (10YR 6/3) moist; single grain; loose; neutral.

The thickness of the solum and the depth to sand, coarse sand, or gravelly coarse sand range from 20 to 38 inches. In some pedons pebbles are on the surface and are mixed throughout the profile. The mollic epipedon ranges from 7 to 19 inches in thickness.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is loam or fine sandy loam. The Bt horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 to 4. It is loam, clay loam, or sandy clay loam. The content of clay in this horizon ranges from 18 to 32 percent. The 2C horizon is coarse sand, gravelly coarse sand, or sand. It contains as much as 35 percent gravel by volume.

### Johnstown Series

The Johnstown series consists of deep, well drained soils on uplands. These soils formed in loamy and silty sediment or loess. Permeability is moderate in the solum and rapid or very rapid in the sandy or gravelly underlying material. Slopes range from 0 to 6 percent.

Johnstown soils are commonly adjacent to Brocksburg, Jansen, Meadin, and Sandose soils. Brocksburg soils formed in 20 to 40 inches of loamy sediment overlying sand and coarse sand. They are in positions on upland divides similar to those of the Johnstown soils. Jansen, Meadin, and Sandose soils have a mollic epipedon that is less than 20 inches thick. Jansen soils formed in 20 to 36 inches of loamy sediment or loess overlying alluvial sand, coarse sand, or gravelly coarse sand. They are in positions on uplands similar to those of the Johnstown soils. Meadin soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand. They are on upland breaks, ridgetops, and side slopes. Sandose soils are sandy in the upper part and loamy in the underlying material. They are on the slightly higher upland divides, in swales, and on side slopes.

Typical pedon of Johnstown loam, 0 to 1 percent slopes, 500 feet east and 100 feet south of the northwest corner of sec. 14, T. 30 N., R. 21 W.

- Ap—0 to 8 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak medium platy structure parting to weak fine granular; slightly hard,

very friable; few fine and very fine roots; medium acid; abrupt smooth boundary.

A—8 to 21 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few fine and very fine roots; slightly acid; clear smooth boundary.

Bt—21 to 27 inches, grayish brown (10YR 5/2) clay loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, firm; few fine and very fine roots; very dark grayish brown (10YR 3/2 moist) coatings on faces of peds; neutral; clear smooth boundary.

Btb1—27 to 36 inches; very dark grayish brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, firm; few fine and very fine roots; shiny films on faces of peds; neutral; clear smooth boundary.

Btb2—36 to 44 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; few very fine roots; grayish brown (10YR 5/2) wormcasts; neutral; clear smooth boundary.

BCb—44 to 50 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable; few very fine roots; few fine soft accumulations of carbonate; slight effervescence; mildly alkaline; abrupt wavy boundary.

2C—50 to 60 inches; light yellowish brown (10YR 6/4) coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; neutral.

The thickness of the solum ranges from 36 to 55 inches. The depth to sand, coarse sand, or gravelly coarse sand ranges from 40 to 60 inches. The mollic epipedon ranges from 20 to 44 inches in thickness. The depth to a buried soil ranges from 14 to 36 inches. The depth to carbonates ranges from 36 to more than 60 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but the range includes fine sandy loam. The Bt horizon has hue of 10YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. The Btb horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 5 moist), and chroma of 2 to 4. The Bt and Btb horizons are typically clay loam, but the range includes silty clay loam. The content of clay in these horizons ranges from 27 to 35 percent. The BCb

horizon and the C horizon, if it occurs, have hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. They are clay loam, loam, very fine sandy loam, silt loam, or silty clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is typically coarse sand, gravelly coarse sand, or sand, but the range includes fine sand, loamy fine sand, and loamy sand. This horizon contains 0 to 35 percent gravel by volume.

## Labu Series

The Labu series consists of moderately deep, well drained, slowly permeable soils on dissected upland breaks to the Niobrara River. These soils formed in material weathered from clayey shale (fig. 17). Slopes range from 11 to 30 percent.

Labu soils are commonly adjacent to Sansarc, Simeon, Tassel, and Valentine soils. Sansarc soils are on the upper, steeper sides and tops of ridges on the river breaks. They are less than 20 inches deep over bedded shale. Simeon and Valentine soils are deep and sandy. They are generally on the sides of river breaks above the Labu soils. Tassel soils are shallow over weathered sandstone. They are on the higher ridges and side slopes.

Typical pedon of Labu silty clay, in an area of Labu-Sansarc silty clays, 11 to 40 percent slopes, 2,450 feet north and 2,350 feet east of the southwest corner of sec. 23, T. 32 N., R. 21 W.

A—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, firm; many fine to coarse roots; neutral; clear smooth boundary.

Bw1—5 to 9 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; very hard, very firm; common fine to coarse roots; mildly alkaline; clear smooth boundary.

Bw2—9 to 13 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; very hard, very firm; common fine to coarse roots; tongues of grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; mildly alkaline; clear smooth boundary.

Bw3—13 to 18 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium and fine subangular blocky structure; hard, firm; common fine to coarse roots; few fine masses

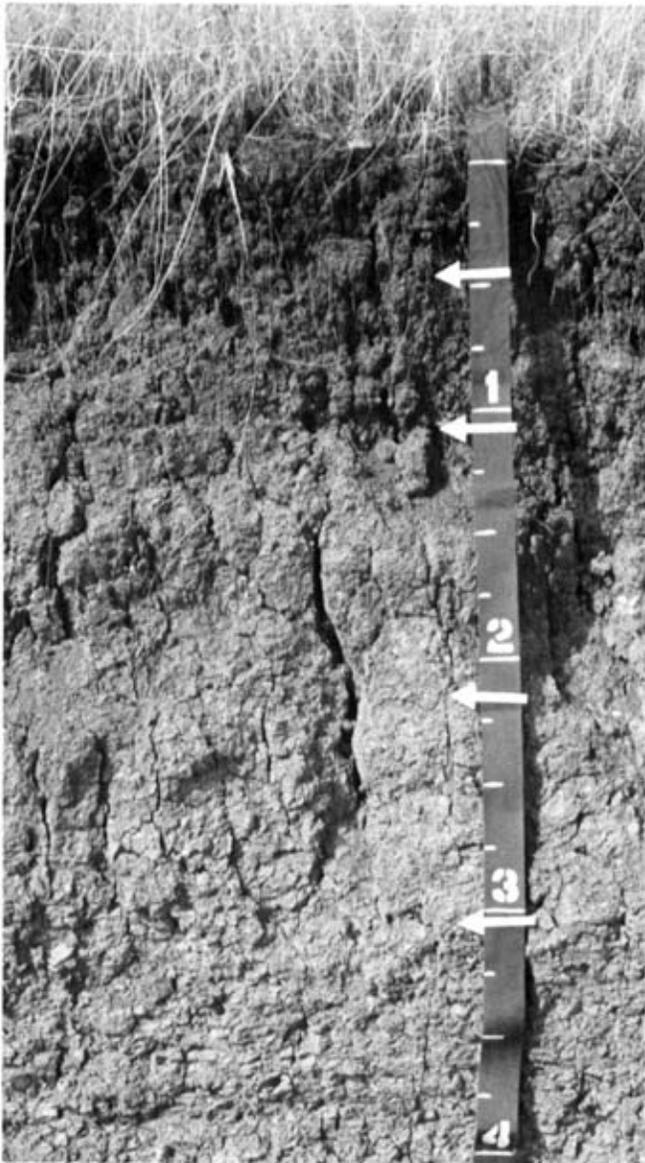


Figure 17.—Profile of Labu silty clay, which formed in shale residuum. The lower arrow marks the upper boundary of the bedded shale. The scale is in feet.

and concretions of calcium carbonate; violent effervescence; mildly alkaline; clear wavy boundary.  
 C—18 to 23 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; massive in the fine-earth fraction; about 30 percent partially weathered shale fragments, which are fine or medium and platy; very hard, very firm; few fine to coarse roots; common oxidized iron stains; many fine masses and concretions of calcium carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

Cr—23 to 60 inches; light brownish gray (2.5Y 6/2), bedded, calcareous shale, dark grayish brown (2.5Y 4/2) moist.

The thickness of the solum ranges from 18 to 28 inches. The depth to bedded shale ranges from 20 to 40 inches. Cracks as much as 1½ inches wide and several feet long commonly extend throughout the solum when the soils are dry.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2. The Bw horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6 (4 or 5 moist); and chroma of 2 to 4. It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. The Cr horizon has hue of 2.5Y or 5Y, value of 6 or 7 (4 to 6 moist), and chroma of 2 to 4.

### Libory Series

The Libory series consists of deep, moderately well drained soils on uplands. These soils formed in sandy eolian material over loamy and silty alluvium. Permeability is rapid in the upper part of the profile and moderate in the lower part. Slopes range from 0 to 3 percent.

Libory soils are commonly adjacent to Dunday, Els, Elsmere, and Valentine soils. Dunday soils are in the higher positions in sandhill valleys and on upland side slopes. They are somewhat excessively drained. Els and Elsmere soils are sandy and somewhat poorly drained. They are on the slightly lower parts of sandhill valleys. Valentine soils are deep, sandy, and excessively drained. They are on the highest hummocks and dunes.

Typical pedon of Libory loamy fine sand, in an area of Valentine-Libory complex, 0 to 9 percent slopes, 2,450 feet west and 2,100 feet north of the southeast corner of sec. 19, T. 27 N., R. 20 W.

A1—0 to 5 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable; many fine roots; neutral; clear smooth boundary.

A2—5 to 10 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many fine roots; neutral; clear smooth boundary.

Bw1—10 to 24 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; common fine roots;

neutral; abrupt wavy boundary.

2Bw2—24 to 31 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many fine prominent dark brown (7.5YR 3/4 moist) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; neutral; clear smooth boundary.

2Bw3—31 to 40 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2) moist; few fine prominent strong brown (7.5YR 5/8 moist) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; mildly alkaline; gradual smooth boundary.

2C—40 to 60 inches; light gray (5Y 7/2) silty clay loam, light olive gray (5Y 6/2) moist; few fine prominent strong brown (7.5YR 5/8 moist) mottles; massive; hard, firm; few fine roots; many fine and medium soft masses of calcium carbonate; violent effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 17 inches in thickness. Depth to the silty 2Bw horizon ranges from 20 to 36 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 to 3. The Bw horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 or 3. It is typically loamy fine sand, but the range includes loamy sand and fine sand. The 2Bw horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6 (3 to 5 moist); and chroma of 2 or 3. It has few to many, distinct or prominent mottles. It is typically silty clay loam, but the range includes very fine sandy loam, loam, and silt loam. The 2C horizon has hue of 2.5Y, 5Y, or 10YR; value of 4 to 7 (3 to 6 moist); and chroma of 2 or 3. It is typically silty clay loam, but the range includes silt loam and very fine sandy loam.

## Loup Series

The Loup series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on bottom land and the floors of valleys in the Sandhills. These soils formed in loamy and sandy alluvium. Slopes range from 0 to 2 percent.

Loup soils are commonly adjacent to Els, Elsmere, Gannett, Ipage, and Marlake soils. Els and Elsmere soils are on the slightly higher parts of the sandhill valleys and are somewhat poorly drained. Gannett soils have a control section that is finer textured than that of the Loup soils. They are slightly higher on bottom land than the Loup soils. Ipage soils are on low hummocky slopes or low ridges in the higher areas in sandhill valleys. They are moderately well drained. Marlake soils do not have a mollic epipedon. They have a seasonal high water table that is closer to the surface than that of

the Loup soils. They are in the lowest depressional areas in sandhill valleys.

Typical pedon of Loup fine sandy loam, 0 to 2 percent slopes, 1,000 feet south and 300 feet west of the northeast corner of sec. 8, T. 29 N., R. 22 W.

Oe—1 inch to 0; partially decomposed organic material; slight effervescence.

A—0 to 10 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; neutral; clear wavy boundary.

AC—10 to 15 inches; gray (10YR 5/1) fine sand, very dark grayish brown (10YR 3/2) moist; few fine distinct grayish brown (2.5Y 5/2 moist) mottles; weak fine granular structure; soft, very friable; common fine and very fine roots; neutral; clear smooth boundary.

Cg1—15 to 25 inches; light gray (10YR 6/1) fine sand, gray (10YR 5/1) moist; few fine distinct grayish brown (2.5Y 5/2 moist) mottles; single grain; loose; few very fine roots; neutral; clear smooth boundary.

Cg2—25 to 48 inches; light gray (10YR 7/2) sand, light brownish gray (10YR 6/2) moist; few fine distinct yellowish brown (10YR 5/4 moist) mottles; single grain; loose; few very fine roots; neutral; clear smooth boundary.

Ab—48 to 60 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; massive; soft, very friable; few very fine roots; neutral.

The thickness of the solum ranges from 10 to 22 inches. The mollic epipedon ranges from 7 to 20 inches in thickness. Some pedons have carbonates near the surface.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. The Cg horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 7 moist), and chroma of 1 or 2. It is fine sand, sand, loamy fine sand, or loamy sand.

## Marlake Series

The Marlake series consists of deep, very poorly drained, rapidly permeable soils in depressions in sandhill valleys. These soils formed in sandy alluvium. Because of a high water table, they are covered with water for most of the growing season. Slopes are 0 to 1 percent.

Marlake soils are commonly adjacent to Els, Gannett, Ipage, Loup, and Tryon soils. Els soils are in the higher areas in sandhill valleys and are somewhat poorly drained. Gannett, Loup, and Tryon soils are on the slightly higher bottom land and in low areas in sandhill valleys. Gannett and Loup soils have a mollic epipedon.

Tryon soils are less stratified than the Marlake soils. Ipage soils are on low hummocky slopes or low ridges in the higher areas in sandhill valleys. They are moderately well drained.

Typical pedon of Marlake fine sandy loam, 0 to 1 percent slopes, 1,800 feet west and 900 feet north of the southeast corner of sec. 26, T. 28 N., R. 24 W.

Oe—4 inches to 0; very dark grayish brown (10YR 3/2), moderately decomposed organic material, very dark brown (10YR 2/2) moist; clear wavy boundary.

A—0 to 6 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

Cg1—6 to 21 inches; gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; stratified with thin layers of light gray (10YR 6/1) fine sandy loam; neutral; gradual smooth boundary.

Cg2—21 to 34 inches; gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; stratified with thin layers of fine sandy loam; neutral; gradual smooth boundary.

Cg3—34 to 60 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; few medium distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; stratified with thin layers of fine sandy loam; neutral.

The thickness of the solum ranges from 6 to 25 inches. Snail shells are common in these soils.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically fine sandy loam, but the range includes loamy fine sand and loamy sand. Some pedons have an AC horizon. The C horizon is typically loamy fine sand, but the range includes fine sand and strata of finer or coarser textured material. Dark colored buried layers are common. The AC horizon, if it occurs, and the C horizon typically have few or common, faint to prominent, yellowish brown to reddish brown mottles.

### McKelvie Series

The McKelvie series consists of deep, excessively drained, rapidly permeable soils on upland breaks. These soils formed in sandy eolian material and in sandy material weathered from sandstone. Slopes range from 15 to 70 percent.

McKelvie soils are commonly adjacent to Meadin, Ronson, Simeon, Tassel, and Valentine soils. The

adjacent soils are generally in the higher positions on uplands and on breaks to the Niobrara River and its tributaries. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Ronson soils have a mollic epipedon and have sandstone at a depth of 20 to 40 inches. Simeon soils have a control section that is more than 35 percent medium and coarse sand. Tassel soils have sandstone at a depth of 6 to 20 inches. Valentine soils formed in sandy eolian material. They do not contain sandstone fragments.

Typical pedon of McKelvie loamy fine sand, in an area of McKelvie-Tassel-Ronson complex, 15 to 70 percent slopes, 1,300 feet north and 1,200 feet east of the southwest corner of sec. 33, T. 33 N., R. 23 W.

A—0 to 6 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; few  $\frac{1}{16}$ - to 2-inch calcareous sandstone fragments; mildly alkaline; clear smooth boundary.

AC—6 to 13 inches; light brownish gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, very friable; common fine and very fine roots; common  $\frac{1}{16}$ - to 2-inch calcareous sandstone fragments; mildly alkaline; clear smooth boundary.

C—13 to 60 inches; light gray (2.5Y 7/2) fine sand, light brownish gray (2.5Y 6/2) moist; single grain; loose; few fine roots; many  $\frac{1}{16}$ - to  $\frac{1}{2}$ -inch calcareous sandstone fragments; mildly alkaline.

Some pedons do not have an AC horizon. Few to many  $\frac{1}{16}$ - to 3-inch sandstone fragments are throughout the lower part of the profile. The sandstone fragments are calcareous or noncalcareous.

The A horizon has value of 4 and 5 (3 or 4 moist) and chroma of 2 or 3. It is dominantly loamy fine sand, but the range includes loamy sand, fine sand, and sand. The AC horizon has value of 5 or 6 (3 to 5 moist) and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 6 to 8 (5 to 7 moist), and chroma of 2 to 4. The AC and C horizons are similar in texture to the A horizon. Soft sandstone is typically below a depth of 60 inches but is at a depth of 40 to 60 inches in some pedons.

### Meadin Series

The Meadin series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in 8 to 20 inches of sandy and loamy material overlying gravelly coarse sand (fig. 18). Slopes range from 0 to 30 percent.

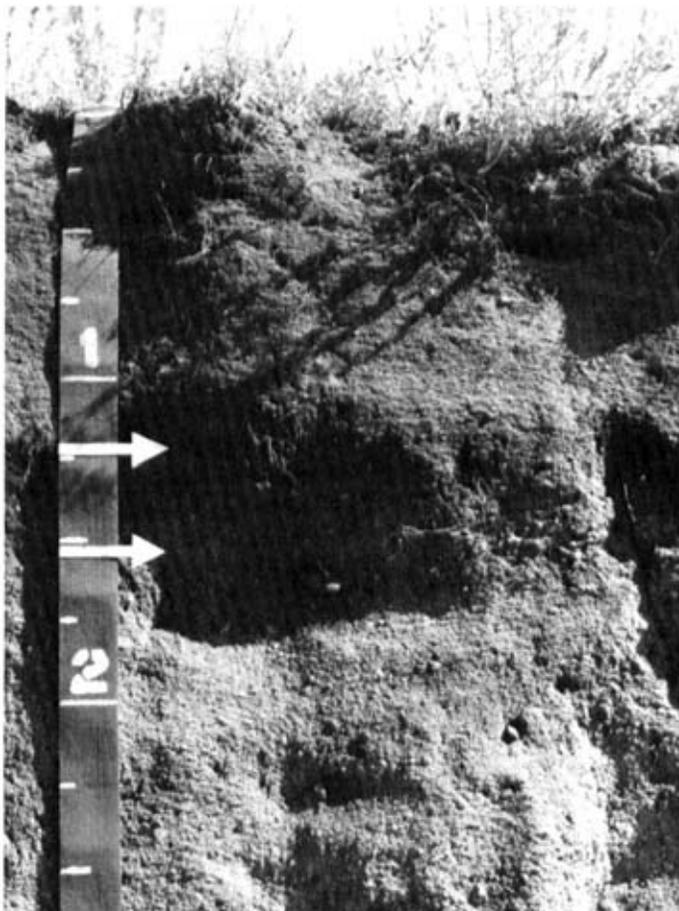


Figure 18.—Profile of Meadin sandy loam. The lower arrow marks the contact between the loamy material and the underlying gravelly coarse sand. The scale is in feet.

Meadin soils are commonly adjacent to Jansen, O'Neill, Pivot, Simeon, and Valentine soils. Jansen, O'Neill, and Pivot soils are more than 20 inches deep to sand, coarse sand, or gravelly coarse sand. Jansen and O'Neill soils are in positions on upland divides and side slopes similar to those of the Meadin soils or are in the slightly higher areas. Pivot soils are in positions on uplands similar to those of the Meadin soils or are in the slightly higher areas. Simeon and Valentine soils do not have a mollic epipedon. Simeon soils are in positions on breaks similar to those of the Meadin soils or are on side slopes. Valentine soils are on the higher dunes, ridges, and side slopes in the uplands.

Typical pedon of Meadin sandy loam, 3 to 30 percent slopes, 300 feet west and 150 feet south of the center of sec. 23, T. 30 N., R. 21 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist;

weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

AC—7 to 12 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure parting to weak fine granular; soft, very friable; neutral; clear wavy boundary.

2C1—12 to 24 inches; pale brown (10YR 6/3) gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; about 30 percent gravel by volume; neutral; gradual wavy boundary.

2C2—24 to 60 inches; light gray (10YR 7/2) gravelly coarse sand, pale brown (10YR 6/3) moist; single grain; loose; about 20 percent gravel by volume; neutral.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The depth to gravelly coarse sand, gravelly sand, or very gravelly coarse sand ranges from 8 to 20 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. The AC horizon has value of 4 to 6 (3 or 4 moist) and chroma of 2 to 4. It is sandy loam, gravelly sandy loam, loamy sand, or gravelly loamy sand. The 2C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is typically gravelly coarse sand or gravelly sand, but the range includes very gravelly coarse sand. The content of gravel in this horizon generally is 20 to 35 percent by volume, but it can be as much as 55 percent.

## O'Neill Series

The O'Neill series consists of deep, well drained soils on uplands. These soils formed in 20 to 40 inches of loamy material overlying sand, coarse sand, or gravelly coarse sand. Permeability is moderately rapid in the solum and very rapid in the underlying material. Slopes range from 0 to 11 percent.

O'Neill soils are commonly adjacent to Anselmo, Jansen, Meadin, Pivot, and Simeon soils. Anselmo soils do not have coarse sand or gravelly coarse sand in the control section. Jansen soils have more clay in the subsoil than the O'Neill soils. Anselmo and Jansen soils are in positions on broad upland divides similar to those of the O'Neill soils. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are in positions on upland divides similar to those of the O'Neill soils or are in the lower positions on side slopes in the uplands. Pivot soils are sandier than the O'Neill soils and are somewhat excessively drained. They are in positions on uplands similar to those of the O'Neill soils. Simeon soils do not have a mollic epipedon. They are sandy and excessively drained. They are in positions on side

slopes similar to those of the O'Neill soils.

Typical pedon of O'Neill fine sandy loam, 0 to 2 percent slopes, 1,840 feet north and 50 feet west of the southeast corner of sec. 5, T. 30 N., R. 22 W.

Ap—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure parting to weak fine granular; slightly hard, friable; few fine and very fine roots; slightly acid; abrupt smooth boundary.

A—5 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable; few fine and very fine roots; slightly acid; clear smooth boundary.

Bw1—8 to 16 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable; slightly acid; clear smooth boundary.

Bw2—16 to 26 inches; brown (10YR 5/3) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; slightly acid; clear smooth boundary.

2C1—26 to 32 inches; pale brown (10YR 6/3) gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; neutral; clear smooth boundary.

2C2—32 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; neutral.

The mollic epipedon ranges from 10 to 20 inches in thickness. It extends into the Bw horizon in some pedons. The thickness of the solum ranges from 20 to 40 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly fine sandy loam or sandy loam, but the range includes loam. The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 to 4. It is fine sandy loam or sandy loam. In some pedons clay has accumulated in the lower part of the Bw horizon, so that the layer is noticeably finer textured than the layer above or below. The 2C horizon has value of 6 or 7 (5 or 6 moist) and chroma of 3 or 4. It is gravelly coarse sand, coarse sand, or sand.

## Pivot Series

The Pivot series consists of deep, somewhat excessively drained soils in dry sandhill valleys and on uplands. These soils formed in 20 to 40 inches of sandy eolian material and sandy alluvium overlying coarse

sand or gravelly coarse sand. Permeability is rapid in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 3 percent.

Pivot soils are commonly adjacent to Dunday, Meadin, O'Neill, Simeon, and Valentine soils. Dunday soils are on the slightly higher side slopes in the uplands. They do not have gravelly coarse sand or coarse sand in the underlying material. Meadin soils are in positions on uplands similar to or slightly lower than those of the Pivot soils. They have gravelly coarse sand at a depth of 8 to 20 inches. O'Neill soils have a solum that is finer textured than that of the Pivot soils. They are in positions on uplands similar to those of the Pivot soils. Simeon and Valentine soils do not have a mollic epipedon. Simeon soils are in positions on upland side slopes similar to those of the Pivot soils. Valentine soils are on the higher ridges and dunes on uplands.

Typical pedon of Pivot loamy sand, 0 to 3 percent slopes, 2,550 feet north and 1,430 feet west of the southeast corner of sec. 8, T. 31 N., R. 23 W.

A1—0 to 9 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many very fine and fine roots; neutral; clear smooth boundary.

A2—9 to 16 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; common very fine and fine roots; neutral; gradual smooth boundary.

AC—16 to 22 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; common very fine and fine roots; about 1 percent gravel by volume; neutral; gradual smooth boundary.

C1—22 to 27 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grain; loose; few very fine roots; about 3 percent gravel by volume; neutral; clear smooth boundary.

2C2—27 to 50 inches; very pale brown (10YR 7/3) coarse sand, pale brown (10YR 6/3) moist; single grain; loose; about 5 percent gravel by volume; neutral; diffuse smooth boundary.

2C3—50 to 60 inches; very pale brown (10YR 7/3) gravelly coarse sand, pale brown (10YR 6/3) moist; single grain; loose; about 25 percent gravel by volume; neutral.

The mollic epipedon ranges from 10 to 18 inches in thickness. It includes the AC horizon in some pedons. Depth to the 2C horizon is 20 to 32 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically loamy sand, but the

range includes loamy fine sand. The AC horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is typically loamy sand or sand, but the range includes loamy fine sand and fine sand. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 to 4. It is sand or coarse sand. The 2C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is coarse sand or gravelly coarse sand. The content of gravel in this horizon ranges from 5 to 25 percent by volume.

### Ronson Series

The Ronson series consists of moderately deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from calcareous, weakly cemented sandstone. Slopes range from 0 to 30 percent.

Ronson soils are commonly adjacent to Anselmo, Brunswick, Dunday, McKelvie, Tassel, and Valentine soils. Anselmo soils do not have calcareous sandstone within a depth of 60 inches. Brunswick soils do not have a mollic epipedon. Anselmo and Brunswick soils are on side slopes in the uplands and in canyons. Dunday, McKelvie, and Valentine soils are sandy and do not have sandstone within a depth of 60 inches. Dunday soils are in positions on side slopes similar to those of the Ronson soils. McKelvie soils are on the mid and lower slopes of the breaks to the Niobrara River. Valentine soils are on the higher hummocks and on dunes. Tassel soils are on knolls, the upper ridges, and side slopes in the uplands. They have sandstone at a depth of less than 20 inches.

Typical pedon of Ronson fine sandy loam, in an area of Ronson-Tassel fine sandy loams, 3 to 6 percent slopes, 50 feet south and 500 feet east of the northwest corner of sec. 5, T. 31 N., R. 21 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; common fine roots; neutral; abrupt smooth boundary.

A—6 to 13 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure parting to weak fine granular; soft, very friable; common fine roots; neutral; clear smooth boundary.

AC—13 to 18 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable; common fine roots; mildly alkaline; clear smooth boundary.

C1—18 to 28 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; soft, very friable; few fine roots; common fine soft fragments of weathered sandstone; mildly alkaline; clear smooth boundary.

C2—28 to 37 inches; light gray (2.5Y 7/2) sandy loam, light brownish gray (2.5Y 6/2) moist; massive; soft, very friable; many fine soft fragments of weathered sandstone; mildly alkaline; clear smooth boundary.

Cr—37 to 60 inches; pale yellow (5Y 8/3), weakly cemented sandstone, pale olive (5Y 6/3) moist; violent effervescence; moderately alkaline.

The mollic epipedon is 8 to 19 inches thick. Sandstone is at a depth of 20 to 40 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The AC horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 or 3. It is fine sandy loam or sandy loam. The C horizon has value of 5 to 8 (4 to 7 moist) and chroma of 2 to 4. It is sandy loam or fine sandy loam.

### Sandose Series

The Sandose series consists of deep, well drained soils on uplands and in the Sandhills. These soils formed in sandy eolian material over loamy sediment (fig. 19). Permeability is rapid in the upper part of the profile and moderate in the lower part. Slopes range from 0 to 3 percent.

Sandose soils are commonly adjacent to Anselmo, Dunday, Jansen, and Valentine soils. Anselmo soils have less sand in the upper part than the Sandose soils. They are on the higher side slopes and upland divides. Dunday and Valentine soils are on the higher side slopes. They are sandy throughout. Jansen soils formed in 20 to 36 inches of loamy sediment or loess overlying gravelly coarse sand, coarse sand, or sand. They are on the slightly lower upland side slopes.

Typical pedon of Sandose loamy fine sand, 0 to 3 percent slopes, 330 feet west and 150 feet north of the center of sec. 15, T. 27 N., R. 22 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

A—10 to 15 inches; brown (10YR 4/3) loamy fine sand, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

Bw1—15 to 26 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse

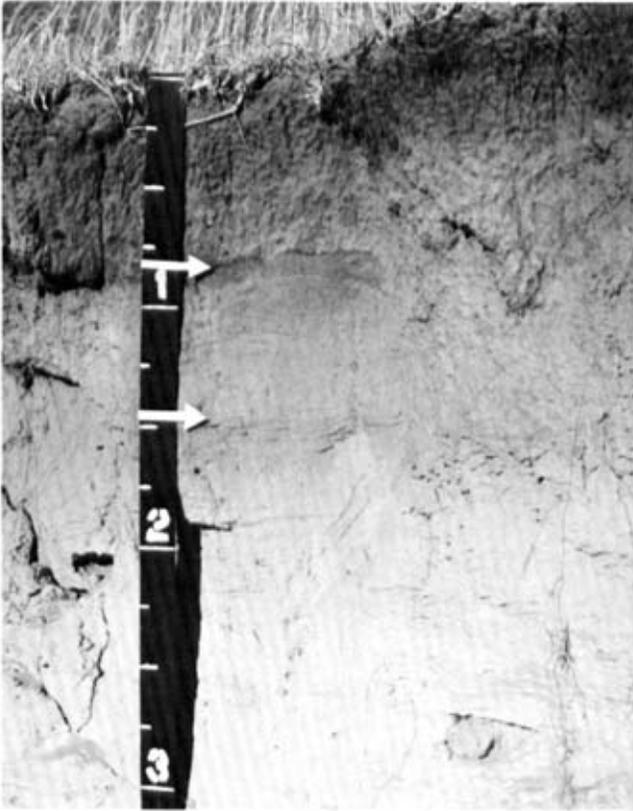


Figure 19.—Profile of Sandose loamy fine sand. The upper arrow marks the lower boundary of the surface layer. The lower arrow marks the contact between sandy material and the underlying loam. The scale is in feet.

subangular blocky; slightly hard, very friable; neutral; abrupt wavy boundary.

2Bw2—26 to 39 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm; neutral; clear smooth boundary.

2Bw3—39 to 46 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm; violent effervescence; mildly alkaline; clear smooth boundary.

2C—46 to 60 inches; light gray (2.5Y 7/2) very fine sandy loam, light brownish gray (2.5Y 6/2) moist; massive; slightly hard, firm; violent effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. Depth to the loamy 2Bw horizon ranges from 20 to 36 inches. The thickness of the solum ranges from 35 to 55 inches. The depth to free

carbonates ranges from 38 to more than 60 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 to 3. The Bw horizon has value of 4 to 6 (3 or 4 moist) and chroma of 2 or 3. It is dominantly loamy fine sand or loamy sand. The 2Bw horizon has value of 5 to 7 (3 to 5 moist) and chroma of 2 to 4. It is typically loam or clay loam, but the range includes sandy clay loam and very fine sandy loam. The 2C horizon has value of 6 or 7 (4 to 6 moist) and chroma of 2 to 4. It is very fine sandy loam or loam.

## Sansarc Series

The Sansarc series consists of shallow, well drained, slowly permeable soils on dissected upland breaks to the Niobrara River. These soils formed in clayey material weathered from shale. Slopes range from 11 to 40 percent.

Sansarc soils are commonly adjacent to Labu, McKelvie, Simeon, Tassel, and Valentine soils. Labu soils have bedded shale at a depth of 20 to 40 inches. They are on the lower, less sloping side slopes of the river breaks. McKelvie, Simeon, Tassel, and Valentine soils are higher on the landscape than the Sansarc soils. McKelvie, Simeon, and Valentine soils are deep and sandy. Tassel soils are shallow over weathered sandstone.

Typical pedon of Sansarc silty clay, in an area of Labu-Sansarc silty clays, 11 to 40 percent slopes, 2,400 feet east and 2,350 feet north of the southwest corner of sec. 23, T. 32 N., R. 21 W.

A—0 to 3 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine to coarse roots; mildly alkaline; clear smooth boundary.

AC—3 to 6 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to moderate thin platy; hard, firm; common fine to coarse roots; about 20 percent partially weathered shale fragments; common oxidized iron stains; few fine masses and concretions of calcium carbonate; violent effervescence; mildly alkaline; gradual wavy boundary.

C—6 to 12 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to strong thin and medium platy; hard, firm; common fine to coarse roots; 40 to 50 percent partially weathered shale fragments; common oxidized iron stains; many fine masses and concretions of calcium carbonate; violent effervescence; moderately

alkaline; gradual wavy boundary.

Cr—12 to 60 inches; light brownish gray (2.5Y 6/2), bedded, calcareous shale, dark grayish brown (2.5Y 4/2) moist.

The depth to bedded shale ranges from 6 to 20 inches. The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It contains, by volume, as much as 50 percent or more partially weathered shale fragments.

### Simeon Series

The Simeon series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in sandy alluvium that in some areas has been reworked by the wind. Slopes range from 0 to 30 percent.

Simeon soils are commonly adjacent to Meadin, O'Neill, Pivot, and Valentine soils. Meadin, O'Neill, and Pivot soils have a mollic epipedon. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. They are on side slopes and ridgetops that are dissected by drainageways. O'Neill soils have a solum that is finer textured than that of the Simeon soils. They are on upland divides, tableland, ridgetops, and side slopes. Pivot soils are on uplands and in dry sandhill valleys. Valentine soils are on the higher side slopes and hummocks. They are less than 35 percent medium and coarse sand.

Typical pedon of Simeon loamy sand, 0 to 3 percent slopes, 2,200 feet north and 1,800 feet east of the southwest corner of sec. 30, T. 32 N., R. 23 W.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many very fine and fine roots; neutral; clear smooth boundary.

AC—5 to 10 inches; brown (10YR 5/3) sand, dark brown (10YR 4/3) moist; single grain; loose; common very fine and fine roots; about 8 percent gravel by volume; slightly acid; clear smooth boundary.

C1—10 to 18 inches; very pale brown (10YR 7/3) coarse sand, pale brown (10YR 6/3) moist; single grain; loose; few very fine roots; about 3 percent gravel by volume; neutral; clear smooth boundary.

C2—18 to 35 inches; very pale brown (10YR 8/3) coarse sand, pale brown (10YR 6/3) moist; single grain; loose; about 10 percent gravel by volume;

neutral; clear smooth boundary.

C3—35 to 47 inches; very pale brown (10YR 7/3) coarse sand, pale brown (10YR 6/3) moist; single grain; loose; about 4 percent gravel by volume; neutral; clear smooth boundary.

C4—47 to 60 inches; very pale brown (10YR 8/3) coarse sand, pale brown (10YR 6/3) moist; single grain; loose; few pebbles; neutral.

The thickness of the solum ranges from 7 to 20 inches. The A horizon has value of 3 to 6 (2 to 5 moist) and chroma of 1 to 3. It typically is loamy sand or sand. The AC horizon has value of 4 to 7 (4 to 6 moist) and chroma of 2 or 3. It is sand, loamy sand, or coarse sand. The C horizon has value of 6 to 8 (5 to 7 moist) and chroma of 2 to 4. It typically is coarse sand or sand, but the range includes loamy sand that has more than 35 percent medium and coarse sand. The content of gravel in this horizon is as much as 15 percent by volume.

### Tassel Series

The Tassel series consists of shallow, well drained and somewhat excessively drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slopes range from 0 to 70 percent.

The Tassel soils in Brown County are in a more humid climate than is typical for the series. This difference, however, does not significantly affect the use or management of the soils.

Tassel soils are commonly adjacent to Brunswick, McKelvie, Ronson, Simeon, and Valentine soils. Brunswick and Ronson soils have weathered sandstone at a depth of 20 to 40 inches. Brunswick soils are on dissected side slopes in the uplands and on the lower side slopes of canyons. Ronson soils are in swales and on the lower side slopes in the uplands. They have a mollic epipedon. McKelvie soils are sandy. They generally are on the mid and lower side slopes of breaks to the Niobrara River. Simeon and Valentine soils are in the higher areas on side slopes in the uplands and are on dunes and hummocks. They are sandy throughout.

Typical pedon of Tassel fine sandy loam, in an area of McKelvie-Tassel-Ronson complex, 15 to 70 percent slopes, 750 feet west and 600 feet north of the southeast corner of sec. 33, T. 33 N., R. 23 W.

A—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many

fine roots; few fine soft calcareous sandstone fragments; mildly alkaline; clear smooth boundary.

C—6 to 10 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; many fine roots; common fine soft calcareous sandstone fragments; violent effervescence; moderately alkaline; clear wavy boundary.

Cr—10 to 60 inches; white (2.5Y 8/2), soft sandstone, light brownish gray (2.5Y 6/2) moist; violent effervescence; strongly alkaline.

The solum is 3 to 9 inches thick. The depth to sandstone bedrock ranges from 6 to 20 inches. The depth to free carbonates ranges from 0 to 10 inches.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 2 or 3. It is dominantly fine sandy loam, but the range includes loamy fine sand. Some pedons have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is dominantly fine sandy loam, but the range includes loamy fine sand and sandy loam.

## Tryon Series

The Tryon series consists of deep, poorly drained and very poorly drained, rapidly permeable soils in low areas in sandhill valleys. These soils formed in eolian and alluvial sediment. Slopes range from 0 to 2 percent.

Tryon soils are commonly adjacent to Els, Elsmere, Ipage, Marlake, and Valentine soils. Els and Elsmere soils are in the higher areas of bottom land in sandhill valleys and are somewhat poorly drained. Ipage soils are higher on the landscape than the Tryon soils and are on hummocky slopes or low ridges. They are moderately well drained. Marlake soils are in the lower depressional areas. They are wet for longer periods than the Tryon soils. Valentine soils are on the steeper hummocks and on dunes. They are excessively drained.

Typical pedon of Tryon loamy fine sand, 0 to 2 percent slopes, 100 feet north and 350 feet west of the southeast corner of sec. 5, T. 29 N., R. 24 W.

Oe—2 inches to 0; partially decomposed organic material; strong effervescence.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; neutral; clear smooth boundary.

Cg1—5 to 10 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; few fine

distinct dark yellowish brown (10YR 3/6 moist) mottles; single grain; loose; common fine and very fine roots; neutral; clear wavy boundary.

Cg2—10 to 20 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few medium prominent strong brown (7.5YR 5/6 moist) mottles; single grain; loose; few very fine roots; neutral; clear smooth boundary.

Cg3—20 to 26 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; many medium and coarse prominent yellowish red (5YR 4/6 moist) mottles; single grain; loose; neutral; clear smooth boundary.

Cg4—26 to 60 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; few fine and medium prominent strong brown (7.5YR 5/6 moist) mottles; single grain; loose; neutral.

The thickness of the solum ranges from 3 to 15 inches. Some pedons have carbonates near the surface.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. Some pedons have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 to 8 (4 to 7 moist), and chroma of 1 to 3. It is dominantly fine sand, sand, or loamy fine sand, but some pedons have layers of finer textured material below a depth of 40 inches.

## Valentine Series

The Valentine series consists of deep, excessively drained, rapidly permeable soils on uplands and in the Sandhills. These soils formed in sandy eolian material (fig. 20). Slopes range from 0 to 60 percent.

Valentine soils commonly are adjacent to Dunday, Els, Ipage, Simeon, and Tryon soils. Dunday soils have a mollic epipedon. They are in positions on side slopes similar to or lower than those of the Valentine soils. Els, Ipage, and Tryon soils are in sandhill valleys and are lower on the landscape than the Valentine soils. Els soils are somewhat poorly drained, Ipage soils are moderately well drained, and Tryon soils are poorly drained and very poorly drained. Simeon soils are more than 35 percent medium and coarse sand and as much as 15 percent gravel. They are in the lower positions in swales, on breaks, and on side slopes.

Typical pedon of Valentine fine sand, rolling, 1,500 feet south and 1,100 feet west of the northeast corner of sec. 9, T. 28 N., R. 22 W.

A—0 to 4 inches; grayish brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) moist; weak

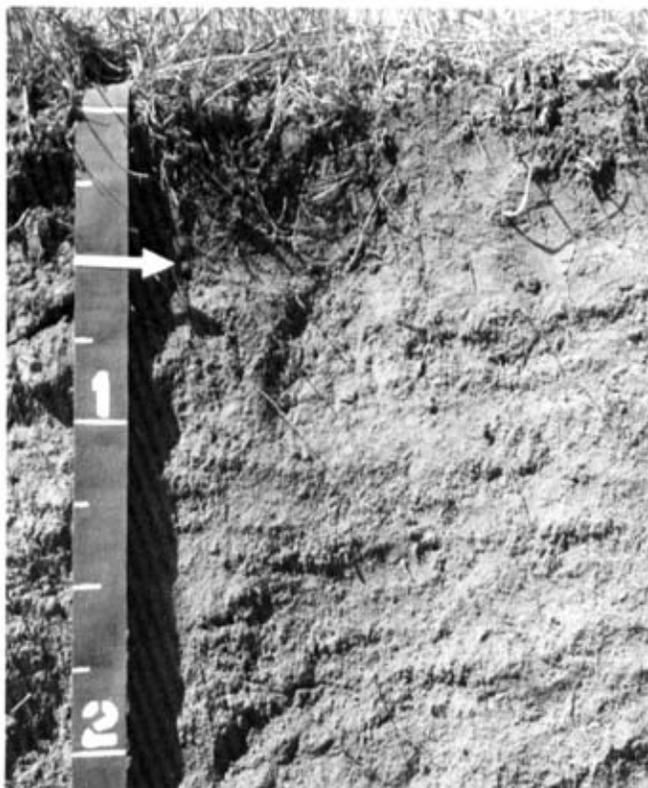


Figure 20.—Profile of Valentine fine sand, which formed in sandy eolian material. The arrow marks the lower boundary of the surface layer. The scale is in feet.

fine granular structure; soft, very friable; many fine and very fine roots; slightly acid; clear smooth boundary.

AC—4 to 8 inches; brown (10YR 5/3) fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; common very fine and fine roots; neutral; clear smooth boundary.

C1—8 to 23 inches; light yellowish brown (10YR 6/4) fine sand, brown (10YR 5/3) moist; single grain; loose; few fine and very fine roots; neutral; clear smooth boundary.

C2—23 to 60 inches; very pale brown (10YR 7/4) fine sand, pale brown (10YR 6/3) moist; single grain; loose; few fine and very fine roots; neutral.

The A horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 or 3. It is dominantly fine sand, but the range includes loamy fine sand. Some pedons do not have an AC horizon. The C horizon has value of 6 or 7 (5 or 6 moist) and chroma of 2 to 4. It is similar in texture to the A horizon. All horizons are less than 35 percent medium sand and less than 10 percent coarse sand.

## Vetal Series

The Vetal series consists of deep, well drained, moderately rapidly permeable soils in upland swales and on foot slopes. These soils formed in loamy material of alluvial or eolian origin. Slopes range from 1 to 3 percent.

Vetal soils are commonly adjacent to Anselmo, O'Neill, and Ronson soils. The adjacent soils have a mollic epipedon that is less than 20 inches thick. Anselmo and O'Neill soils are in the higher positions on divides and side slopes. O'Neill soils have sand, coarse sand, or gravelly coarse sand at a depth of 20 to 40 inches. Ronson soils have soft sandstone at a depth of 20 to 40 inches. They are in the higher swales and on side slopes and ridges.

Typical pedon of Vetal loam, 1 to 3 percent slopes, 400 feet south and 500 feet east of the northwest corner of sec. 18, T. 33 N., R. 24 W.

A1—0 to 16 inches; dark grayish brown (10YR 4/2) loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; neutral; gradual smooth boundary.

A2—16 to 31 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium and coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; neutral; gradual smooth boundary.

AC—31 to 56 inches; brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, very friable; neutral; gradual smooth boundary.

C—56 to 60 inches; light gray (10YR 7/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 60 inches. The mollic epipedon ranges from 20 to 50 inches in thickness. It extends into the AC horizon in some pedons. Most pedons have no free carbonates, but some have free carbonates below a depth of 30 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. The AC horizon has value of 4 to 6 (3 or 4 moist) and chroma of 1 to 3. It is typically loam, but the range includes fine sandy loam and sandy loam. The C horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 or 3. It is typically loamy fine sand but is loamy sand or fine sand in some pedons.

# Formation of the Soils

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Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the processes of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. The length of time required for the development of distinct horizons depends on the other factors involved.

The factors of soil formation are closely interrelated in their effects on the soil. Few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

## Parent Material

Parent material is the unconsolidated mineral material in which a soil forms. It is largely responsible for the chemical and mineralogical composition of the soil. The soils in Brown County formed in material transported by wind and water and in material weathered from the underlying geologic formations.

Pierre Shale is the oldest material exposed in Brown County. It is on the lower side slopes along the Niobrara River. It generally is black to gray, clayey shale that has layers of bentonite, limestone, and chalky shale. The moderately deep Labu and shallow Sansarc soils formed in material weathered from Pierre Shale.

The Ogallala Formation overlies the Pierre Shale. This formation is exposed on terrace remnants and slopes along the Niobrara River and its tributaries. It consists largely of siltstone, sandstone, and fine grained sand. Consolidation of the sediments varies from packed to cemented. Some of the sediments are extremely calcareous. The texture ranges from fine sand to sandy clay loam. Much of this material has a thin mantle of sandy eolian material or loess. The moderately deep Ronson soils formed in material weathered from calcareous, weakly cemented sandstone. The shallow Tassel soils formed in material weathered from bedded sandstone.

Quaternary material consisting mostly of sand and gravel and some soft sandstone is deposited on the Ogallala Formation. The sandstone is exposed on terrace remnants and slopes along the tributaries of the Niobrara River. Brunswick soils formed in material weathered from this soft sandstone. The sand and gravel were deposited by streams during the Pliocene and early Pleistocene. South of the Ainsworth Table, the Quaternary deposits are buried under a thick layer of sandy and loamy alluvium. On the Ainsworth Table, the deposits are covered by thin layers of sandy and silty eolian material and sandy or loamy alluvium. Meadin, O'Neill, Pivot, and Simeon soils formed in these materials.

Alluvium, or water-deposited material, consists of clay, silt, sand, and gravel washed from other areas and deposited on bottom land and stream terraces. The deposits range in thickness from a few to more than 25 feet. Soil formation is slight in the alluvial sediments, and the texture of the soil is closely related to that of the parent material.

Soils in the subirrigated valleys formed mostly in sandy alluvium. Large areas of these soils have ground water close to the surface. This water keeps the underlying material continually wet and in places periodically rises enough to waterlog the entire soil profile. The somewhat poorly drained Elsmere and Els, poorly drained or very poorly drained Tryon and Loup,

and very poorly drained Marlake soils formed in sandy alluvium. In some areas the sandy alluvium has been reworked by the wind. The moderately well drained lpage soils formed in this material. The soils on high bottom land are well drained to excessively drained. The most recent alluvium is on bottom land along drainageways that are occasionally flooded. The poorly drained Almeria and somewhat poorly drained Bolent soils formed in stratified, sandy and loamy alluvium.

Sandy eolian material is the most extensive parent material in the county. It is of mixed mineralogy. Quartz and feldspar are the principal minerals. The material ranges from a few inches to more than 200 feet in thickness. In places the wind has sorted out the fine soil particles and left mostly fine sand in the form of dunes. Valentine soils formed in sandy eolian material in the Sandhills. They generally are gently rolling to hilly. Dunday soils formed in sandy eolian material. Libory and Sandose soils formed in sandy eolian material that overlies silty or loamy sediments.

There are some large loess deposits on the Ainsworth Table. In most places the loess occurs only as a thin layer and generally overlies Pliocene and early Pleistocene sand and gravel, Ogallala sediments, or alluvium. Johnstown soils formed in deposits of loess.

## Climate

The climate in Brown County is continental and subhumid. There are wide seasonal variations in temperature and moisture. The mean annual temperature is about 49 degrees F, and the average annual rainfall is about 22 inches. The average growing season is about 145 days.

Rainfall, changes in temperature, and the wind directly affect soil formation. As rainwater moves through the soil, it carries nutrients, clay, and organic matter from the surface layer to the subsoil or underlying material. As soils form, precipitation infiltrating the soil leaches lime from the profile. The soil material is shifted, sorted, and reworked by running water. Temperature and moisture affect the speed of chemical weathering. Alternating periods of freezing and thawing and of wetting and drying speed the chemical and mechanical weathering processes. They also improve the physical condition of the soil by loosening and mixing the material.

Wind transfers soil material from one place to another. The extensive deposits of sandy eolian material in the Sandhills and the loess on the tablelands exemplify the importance of the wind as an agent in the deposition of soil material. The hummocky topography

of Valentine soils can be attributed to wind activity. The wind mixes and sorts the surface layer, causing changes in physical properties of the soil. Hot winds in the summer have a drying effect on soils.

The amount and kind of vegetation and animal life that the climate sustains directly affect soil formation. Biological activity increases when temperature and moisture are favorable. The accumulation of organic matter and the darkening of the surface layer are increased by the decomposition of vegetation. This decomposition is brought about by the animal and biological activity in the soil, which helps to convert plant remains into humus.

## Plant and Animal Life

When the weathering and deposition processes slow down, grasses and other plants take root. As soon as vegetation is established, many kinds of animals and other organisms inhabit the soil material and make use of the food provided by the plants. Plants and animals live on or in the soil and influence its physical and chemical properties by providing organic matter. The other soil-forming factors affect the kind and amount of vegetation and animal life on and in the soil.

The soils in Brown County formed under mid and tall grasses. The grasses provide organic matter as the plants and their roots decompose. The fibrous roots of the grasses penetrate the soil to a depth of several feet and improve the porosity and structure of the soil. Plant roots remove minerals from the lower part of the soil. Nutrients improve the fertility of the soil as the plants decay. Plants keep the soil porous and open to air and water movement. The improved porosity results in greater activity by bacteria, earthworms, and burrowing animals. Micro-organisms attack dead roots and undecomposed organic material. The resulting humus and other mineral nutrients are available to living plants.

Some bacteria take nitrogen from the air and use it for their own growth. The nitrogen is available for use by plants when the bacteria die. In the well drained soils, the activity of the micro-organisms and animals increases as the content of organic matter increases. The wetter soils are colder and more poorly aerated. Organic matter decays more slowly in these soils because the living organisms are less numerous. Insects, earthworms, and small burrowing animals mix the soil with fresh nutrients. This activity hastens the formation of organic matter.

Human activities greatly affect plant and animal life. They will help to determine the direction and rate of soil formation in the future.

## Relief

Relief, or lay of the land, influences soil formation through its effect on runoff, drainage, and erosion. It controls the movement of water on the surface. The degree of slope, the shape of the surface, and other features of relief affect each soil. Relief influences the moisture content in the soil and the extent of erosion on the surface. Steep soils have a thin surface layer and indistinct horizons. If these soils are clayey or loamy, runoff is rapid. Only a small amount of water enters the soils. As a result, plants grow slowly and soil formation proceeds slowly. If runoff is excessive, erosion removes the surface layer almost as fast as this layer forms.

In the Sandhills, little or no runoff occurs because of a rapid rate of water intake. The soils are excessively drained and have indistinct horizons. The coarse sandy material is highly resistant to chemical weathering.

The nearly level and gently sloping soils generally have horizons that are more distinct than those in similar soils on the steeper slopes. The less sloping soils absorb more moisture and are affected by percolation to a greater depth. Extra moisture is added to the soils in low areas. As a result, these soils have a thick, dark surface layer and are characterized by more horizon development. Also, they are leached of lime to a greater depth than other soils. As the slope increases, the thickness of the soil profile generally decreases. In nearly level areas and in depressions where little or no water runs off the surface, a claypan may develop in the subsoil.

Soils on bottom land and stream terraces have very low relief. Some of the soils on bottom land have a seasonal high water table, which affects the decay of organic matter, the soil temperature, and the degree of alkalinity. Other soils on bottom land are subject to flooding and thus to a periodic deposition of sediment.

## Time

The length of time needed for a soil to form depends on the influence of the other four soil-forming factors, especially the parent material. Soils that have been in place only a short time show little or no evidence of horizon development. Soils that have been in place for a long time have well expressed horizons. Mature soils have reached an equilibrium with their environment. If land use, irrigation, or other factors change the environment, a new equilibrium is established.

Soils form more slowly in residuum than in unconsolidated parent material. The weathering of the residuum and the formation of the soil occur simultaneously, but the process is very slow. The soils that formed in material weathered from Pierre Shale and Ogallala sediments are the oldest soils in the county. They have been in place long enough for the formation of mature genetic horizons. The alluvium and eolian material deposited on the Pliocene and early Pleistocene sand and gravel on the Ainsworth Table are among the older kinds of parent material in the county. The soils that formed in these materials have been in place long enough for the formation of genetic horizons and for the horizons to have thickened. Jansen and O'Neill are mature soils in which a subsoil has formed.

The sandy eolian material and the more recent alluvium have not been in place long enough for the formation of mature soils. Soils that formed in these deposits are young, immature soils that are characterized by little or no subsoil development because of the brief time that the parent material has been in place. Ipage, Simeon, and Valentine soils are examples. In areas of alluvial soils that are subject to flooding, deposition is still occurring. Almeria and Bolent are examples of these young soils.



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# Glossary

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**ABC soil.** A soil having an A, a B, and a C horizon.

**AC soil.** A soil having only an A and a C horizon.

Commonly, such soil formed in recent alluvium or on steep rocky slopes.

**Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**Alkali (sodic) soil.** A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

**Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.

**Area reclaim** (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

**Association, soil.** A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

**Available water capacity (available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low .....	0 to 3
Low .....	3 to 6
Moderate .....	6 to 9
High .....	9 to 12
Very high .....	more than 12

**Base saturation.** The degree to which material having cation-exchange properties is saturated with

exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

**Bedding planes.** Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Blowout.** A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

**Bottom land.** The normal flood plain of a stream, subject to flooding.

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

**Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

**Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

**Catsteps.** Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

**Chiseling.** Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

**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 oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

**Climax vegetation.** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

**Coarse fragments.** If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

**Coarse textured soil.** Sand or loamy sand.

**Colluvium.** Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

**Complex, soil.** A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

**Conservation tillage.** A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to

pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

*Cemented.*—Hard; little affected by moistening.

**Contour stripcropping.** Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

**Control section.** The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

**Corrosive.** High risk of corrosion to uncoated steel or deterioration of concrete.

**Cover crop.** A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

**Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.

**Decreasers.** The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

**Deferred grazing.** Postponing grazing or resting grazing land for a prescribed period.

**Depth, soil.** The total thickness of weathered soil material over bedrock. In this survey the classes of soil depth are shallow, 0 to 20 inches; moderately deep, 20 to 40 inches; and deep, more than 40 inches.

**Depth to rock** (in tables). Bedrock is too near the surface for the specified use.

**Diversion (or diversion terrace).** A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

**Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

*Excessively drained.*—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

*Somewhat excessively drained.*—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious.

Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.*—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

*Moderately well drained.*—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

*Somewhat poorly drained.*—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.*—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained.*—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

*Erosion (geologic).* Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

*Erosion (accelerated).* Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

**Fallow.** Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

**Fast intake** (in tables). The rapid movement of water into the soil.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Fibric soil material (peat).** The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

**Fine textured soil.** Sandy clay, silty clay, or clay.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Foot slope.** The inclined surface at the base of a hill.

**Forage.** Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

**Forb.** Any herbaceous plant not a grass or a sedge.

**Frost action** (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

**Genesis, soil.** The mode of origin of the soil. Refers

especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

- Gleyed soil.** Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.
- Grassed waterway.** A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.
- Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.
- Gravelly soil material.** Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.
- Green manure crop** (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.
- Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table.
- Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.
- Habitat.** The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.
- Hemic soil material (mucky peat).** Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:
- O horizon.*—An organic layer of fresh and decaying plant residue.
- A horizon.*—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

*E horizon.*—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

*B horizon.*—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

*C horizon.*—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

*Cr horizon.*—Soft, consolidated bedrock beneath the soil.

*R layer.*—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

**Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.

**Hydrologic soil groups.** Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

**Illuviation.** The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

**Increasers.** Species in the climax vegetation that increase in amount as the more desirable plants

are reduced by close grazing. Increases commonly are the shorter plants and the less palatable to livestock.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Intake rate.** The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2 .....	very low
0.2 to 0.4 .....	low
0.4 to 0.75 .....	moderately low
0.75 to 1.25 .....	moderate
1.25 to 1.75 .....	moderately high
1.75 to 2.5 .....	high
More than 2.5 .....	very high

**Invaders.** On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are:  
*Border.*—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

*Basin.*—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

*Controlled flooding.*—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

*Corrugation.*—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

*Drip (or trickle).*—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

*Furrow.*—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

*Sprinkler.*—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

*Subirrigation.*—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

*Wild flooding.*—Water, released at high points, is

allowed to flow onto an area without controlled distribution.

**Leaching.** The removal of soluble material from soil or other material by percolating water.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Loess.** Fine grained material, dominantly of silt-sized particles, deposited by wind.

**Low strength.** The soil is not strong enough to support loads.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

**Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.

**Miscellaneous area.** An area that has little or no natural soil and supports little or no vegetation.

**Moderately coarse textured soil.** Coarse sandy loam, sandy loam, or fine sandy loam.

**Moderately fine textured soil.** Clay loam, sandy clay loam, or silty clay loam.

**Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

**Munsell notation.** A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

**Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper,

boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

**Organic matter.** A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

**Organic matter content.** The amount of organic matter in soil material. The classes used in this survey are very low, less than 0.5 percent; low, 0.5 to 1.0 percent; moderately low, 1.0 to 2.0 percent; moderate, 2.0 to 4.0 percent; and high, 4.0 to 8.0 percent.

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

**Pedon.** The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

**Percolation.** The downward movement of water through the soil.

**Percs slowly** (in tables). The slow movement of water through the soil, adversely affecting the specified use.

**Permeability.** The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow .....	less than 0.06 inch
Slow .....	0.06 to 0.2 inch
Moderately slow .....	0.2 to 0.6 inch
Moderate .....	0.6 inch to 2.0 inches
Moderately rapid .....	2.0 to 6.0 inches
Rapid .....	6.0 to 20 inches
Very rapid .....	more than 20 inches

**Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

**pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

**Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

**Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

**Plastic limit.** The moisture content at which a soil

changes from semisolid to plastic.

**Plowpan.** A compacted layer formed in the soil directly below the plowed layer.

**Ponding.** Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

**Poor filter** (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

**Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Range condition.** The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

**Rangeland.** Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

**Range site.** An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

**Reaction, soil.** A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid .....	below 4.5
Very strongly acid .....	4.5 to 5.0
Strongly acid .....	5.1 to 5.5
Medium acid .....	5.6 to 6.0
Slightly acid .....	6.1 to 6.5
Neutral .....	6.6 to 7.3
Mildly alkaline .....	7.4 to 7.8
Moderately alkaline .....	7.9 to 8.4
Strongly alkaline .....	8.5 to 9.0
Very strongly alkaline .....	9.1 and higher

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Residuum (residual soil material).** Unconsolidated,

weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

**Saline soil.** A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

**Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

**Sandstone.** Sedimentary rock containing dominantly sand-sized particles.

**Sapric soil material (muck).** The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

**Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

**Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

**Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

**Silt.** As a soil separate, individual mineral particles that

range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Siltstone.** Sedimentary rock made up of dominantly silt-sized particles.

**Similar soils.** Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

**Slope.** The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the classes of slope are:

Nearly level.....	0 to 1 percent, 0 to 2 percent
Very gently sloping .....	1 to 3 percent
Gently sloping .....	2 to 6 percent, 3 to 6 percent
Strongly sloping.....	6 to 11 percent
Moderately steep .....	11 to 17 percent
Steep .....	17 to 30 percent
Very steep .....	30 to 70 percent
Rolling .....	9 to 24 percent
Hilly .....	24 to 60 percent

**Slope** (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

**Slow intake** (in tables). The slow movement of water into the soil.

**Small stones** (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

**Soil.** A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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.

**Soil separates.** Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand .....	2.0 to 1.0
Coarse sand.....	1.0 to 0.5
Medium sand .....	0.5 to 0.25
Fine sand .....	0.25 to 0.10
Very fine sand.....	0.10 to 0.05
Silt .....	0.05 to 0.002
Clay .....	less than 0.002

**Solum.** The upper part of a soil profile, above the C horizon, in which the processes of soil formation

are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

- Stripcropping.** Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.
- Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).
- Stubble mulch.** Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.
- Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.
- Subsurface layer.** Any surface soil horizon (A, E, AB, or EB) below the surface layer.
- Surface layer.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."
- Surface soil.** The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.
- Taxadjuncts.** Soils that cannot be classified in a series recognized in the classification system. Such soils

are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

- Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.
- Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.
- Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."
- Thin layer** (in tables). Otherwise suitable soil material too thin for the specified use.
- Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.
- Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.
- Upland** (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.
- Weathering.** All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.