USDA United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with University of Nebraska, Conservation and Survey Division

Soil Survey of Cheyenne County, Nebraska

How To Use This Soil Survey

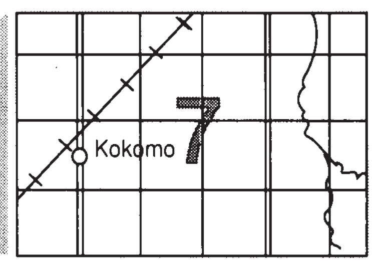
General Soil Map

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.

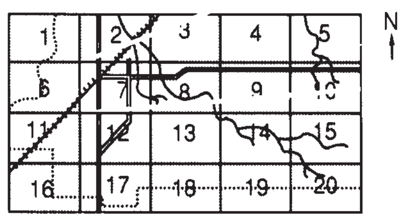
Detailed Soil Maps

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



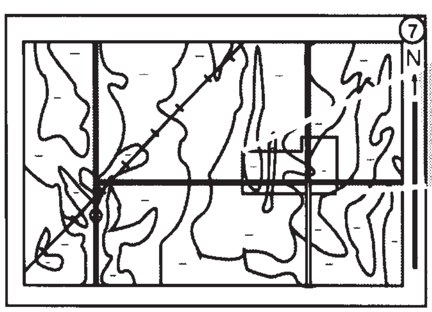
MAP SHEET

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.

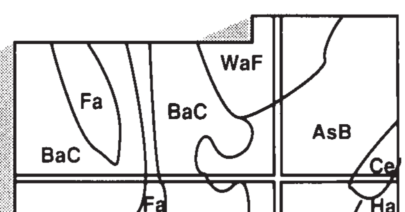


INDEX TO MAP SHEETS

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.



MAP SHEET



AREA OF INTEREST

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.

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 including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1987. Soil names and descriptions were approved in 1990. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. This survey was made cooperatively by the Natural Resources Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the South Platte Natural Resources District. The South Platte Natural Resources District and the Cheyenne County Commissioners provided financial assistance to employ a soil scientist and to purchase aerial photography used in field mapping.

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 Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Windbreaks provide protection for the farmstead and stripcropping provides protection for the soils in the Alliance-Duroc-Kuma association in Cheyenne County.

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Issued November 1997

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Foreword

This soil survey contains information that can be used in land-planning programs in Cheyenne 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, 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 Natural Resources Conservation Service or the Cooperative Extension Service.

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Soil Survey of Cheyenne County, Nebraska

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Technical assistance provided by Norman P. Helzer, state soil scientist, Natural Resources Conservation Service, and Mark S. Kuzila, principal soil scientist, University of Nebraska, Conservation and Survey Division

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

CHEYENNE COUNTY is in the southern part of the Nebraska panhandle (fig. 1). It borders the State of Colorado on the south, Kimball and Banner Counties on the west, Morrill County on the north, and Garden and Deuel Counties on the east. It covers an area of 765,498 acres, or 1,196 square miles. It is about 40 miles from east to west and slightly more than 30 miles from north to south.

Agriculture is the main source of income in the county. Farming, ranching, and related businesses account for most of the employment.

Most of the soils in the county are loamy and silty. They range from nearly level to very steep. Most of the soils in the county formed in material weathered from calcareous sandstone or in loess deposited over this sandstone. Most of the soils in the county are on uplands. Some of the soils in the uplands formed in sandy and gravelly alluvium. In the northern part of the county some soils formed in windblown and redeposited sandy and loamy material. On the side slopes of the major valleys, the soils are steep and formed in calcareous sandstone, calcareous siltstone, or in sandy and gravelly colluvium. The soils in the valleys formed mainly in calcareous alluvium, colluvium, or both. Soil blowing and water erosion are the main hazards affecting the soils on uplands. Occasional flooding is a hazard in some areas of the soils in the valleys. Insufficient rainfall for crops is a management concern in most years. Conserving water and maintaining fertility are major concerns in management. Proper design of irrigation systems and efficient use of water are important concerns.

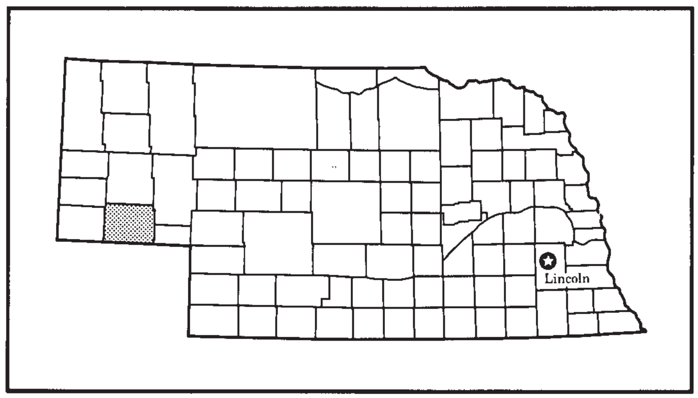

Figure 1.—Location of Cheyenne County in Nebraska.

This soil survey updates the survey of Cheyenne County published in 1920 *(3)*. It gives additional information and has maps that show the soils in greater detail.

General Nature of the County

This section provides general information about Cheyenne County. It briefly describes history and population; transportation; climate; geology; ground water; physiography, relief, and drainage; and trends in agriculture.

History and Population

In 1867, the Union Pacific Railroad reached the area that is now Cheyenne County. About this time, Fort Sidney was established to protect the tracklaying crews from Indians. In 1870, Cheyenne County was organized and included a large part of the Nebraska panhandle. The discovery of gold in the Black Hills in 1874 brought many travelers through the county on the Sidney-Deadwood Trail. Partly because of this, settlers became aware of the agricultural possibilities of the area. Before 1885, most of the settlers in the county were cattlemen who used the open range. In 1885, large numbers of homesteaders began to settle in the county. Cheyenne County attained its present boundaries in 1909.

In 1870, the population of Cheyenne County was 1,032 and was mostly located in the area of present-day Sidney. By 1910, the population was 4,551. In 1980, it was 10,057. Sidney, the largest town and the county seat, has a population of 6,010. The other incorporated towns in the county are Potter (pop. 369), Lodgepole (pop. 413), Dalton (pop. 345), and Gurley (pop. 212). Sidney is a few miles south of the center of the county and about 350 miles west of Lincoln.

Transportation

Interstate Highway 80 and U.S. Highway 30 cross the county generally from east to west. U.S. Highway 385 enters the county from the east and exits in the north-central part. Nebraska Highway 19 runs southwest from Sidney into Colorado. The towns of Potter, Sidney, and Lodgepole are served by the Union Pacific Railroad, which runs from east to west. Dalton, Gurley, and Sidney are served by the Burlington Northern Railroad, which generally runs from north to south. Sidney also has some bus and airport facilities. Rural roads are generally graveled, but a few are paved.

Climate

In Cheyenne County, winters are cold because of incursions of cold, continental air that bring fairly frequent spells of low temperatures. Summers are hot but occasionally are interrupted by 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 Sidney, Nebraska, in the period 1951 to 1984. 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 27 degrees F and the average daily minimum temperature is 14 degrees. The lowest temperature on record, which occurred at Sidney on January 19, 1963, is -30 degrees. In summer, the average temperature is 69 degrees and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred on July 11, 1954, is 107 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 about 19 inches. Of this, more than 14 inches, or about 75 percent, usually falls in April through September. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 4.54 inches at Sidney on June 11, 1970. Thunderstorms occur on about 44 days each year.

The average seasonal snowfall is more than 41 inches. The greatest snow depth at any one time during the period of record was 27 inches. On the average, 20 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 75 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the east-southeast. Average windspeed is highest, 13 miles per hour, in spring.

Severe duststorms occur occasionally in the spring, when strong, dry winds blow across 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. The damage is variable and spotty.

Geology

R.F. Diffendal, Jr., research geologist, Conservation and Survey Division, University of Nebraska, helped prepare this section.

The oldest rock unit exposed in Cheyenne County is the upper part of the Brule Formation, which is the youngest formation of the White River Group of the Oligocene epoch (33-29 million years old). Surface outcrops, road cuts, and railroad cuts through the Brule Formation occur along the sides of valleys along Lodgepole Creek from just east of Sidney westward to the vicinity of Brownson, along the valley sides of Sidney Draw and its tributaries, and along the sides of an unnamed drainageway northwest of Colton. Test drilling and drilling for wells along the floor of Lodgepole Creek have revealed that the alluvial (stream) deposits from the Deuel-Cheyenne County line in the east to the Point of Rocks in the west are also underlain by the Brule Formation.

Much of the Brule Formation is brown to pink siltstone. The silt-sized grains are dominantly made up of volcanic debris erupted from volcanoes that were active in the Rocky Mountains of Colorado, the Great Basin of Nevada and adjoining states, and possibly other areas during the period of Brule deposition. The volcanic debris was transported to Cheyenne County by wind and deposited as an extensive thick blanket of volcanic ash fragments (glass shards and glass mantled crystals). While most of the Brule siltstones are made up of impure volcanic ash, some strata in the Brule Formation are made up of very pure volcanic ash and may be several feet thick.

Some changes occurred in the Brule Formation after its deposition. Clay minerals were deposited in pore spaces between the silt and sand grains. These minerals form cement that bonds the grains together, producing the siltstone. Fractures developed in the Brule siltstones after cementation occurred. The spacing of these fractures varies within the formation and may be related to the weathering of the near-surface layers of the silts during periods when deposition ceased. Calcium carbonate cemented siltstone concretions also formed in some parts of the Brule Formation, probably as a result of changes in included water chemistry or soil-forming processes.

The Ash Hollow Formation of the Ogallala Group is directly above the Brule Formation in the county. This formation is of Miocene age (10.5-5 million years old). It was deposited on the stream eroded surface of the Brule Formation, mainly by rivers draining out of the Rocky Mountains in Wyoming and northern Colorado. The sediments and rocks of the Ash Hollow Formation include sand and gravel, conglomerates, sands, sandstones, silts, siltstones, and diatomites. These kinds of deposits graded laterally and vertically into one another, just as similar deposits of rivers grade into one another today. Streams transported and deposited sediments of the Ash Hollow Formation directly alongside the higher spots where soils were forming on previously deposited sediments. Through time these streams filled their channels with sediments eroded from the granites and other rocks of the Rocky Mountains and then shifted their positions, cut new channels, and filled these in turn.

In contrast to the tremendous volcanic ash deposits that formed the Brule Formation, the volcanic ash deposits of the Ash Hollow Formation are rarely more than 10 feet thick and generally extend over areas of less than 1 square mile. These ash deposits occur in gullies, swales, ponds, and stream channels that must have been topographically low at the time that the ash was deposited. Ash Hollow ash deposits generally have admixtures of non-volcanic sediments and often appear to have been washed off the surrounding land surfaces into the low spots.

The Ash Hollow Formation is typified by hard calcium carbonate or silica-cemented layers of sandstone or siltstone that form gray ledges that are as much as several feet thick and are separated from one another by softer materials. These so-called "mortar beds" are thought to be remnants of soils formed in the higher areas adjacent to streams during the deposition of the formation. Fossil root structures, "seeds," and other plant fossils in these ledges support this idea.

Material that is younger than that in the Ash Hollow Formation in the county includes unconsolidated windblown silt (loess) and sand covering parts of the uplands on either side of Lodgepole Creek and Sidney Draw, stream deposits (alluvium) beneath valley floors and terraces along the sides of valleys, and slope deposits (colluvium) along the sides of valleys. All of these deposits appear to be relatively young, with most of them less than 20,000 years old.

Strata inclined at angles as much as 9 degrees in the area northwest of Colton and along Rush Creek in the northeastern part of the county indicate that some of the Ash Hollow and older rocks of the county have been deformed by folding or faulting. This deformation may have been responsible for the distribution of ground water and hydrocarbons in some parts of the county.

Ground Water

R.F. Diffendal, Jr., research geologist, Conservation and Survey Division, University of Nebraska, helped prepare this section.

The Brule Formation, which underlies all of Cheyenne County, generally yields only small amounts of water to wells. Large initial yields often followed by rapid declines during pumping may come from wells in fractured parts of the Brule Formation. Wells along the eroded valley sides and on the floors of the valley of Lodgepole Creek and Sidney Draw may be supplied by water from this aquifer.

The Ash Hollow Formation (Ogallala Group) underlies the tablelands and the sides of valleys along Lodgepole Creek and Sidney Draw and also underlies the valley floor of Lodgepole Creek west of Point of Rocks. Records of test drilling and drilling for irrigation wells indicate that the formation varies from 0 to more than 500 feet in thickness in the county and is thickest in the northern half of the county.

The Ash Hollow Formation is completely saturated below the water table. The saturated thickness where the formation occurs is known to be from less than 35 to more than 290 feet from one part of the county to another. Potential yields to wells vary from little or no yield to more than 1,000 gallons per minute, depending on the thickness of the formation and the kinds of sediments and rocks encountered.

Unconsolidated silts, sands, and pebbles of Quaternary age (younger than 2.8 million years old) are important sources of ground water in the valleys. Municipal supplies for some farms, ranches, villages, and towns along Lodgepole Creek come from these units at least in part.

Municipalities in the county obtain their water from one or more of these three geologic units. Sidney obtains most or all of its water from fractured zones in the Brule Formation. Potter, Gurley, and Dalton obtain water from the Ash Hollow Formation. Lodgepole's water supply comes from Quaternary alluvium.

New wells drilled for irrigation and municipal and industrial supplies are recorded annually. In 1983 the cumulative total of registered irrigation wells in the county was 444, of which 222 used center-pivot systems for water distribution. Most of these wells are in the northern half of the county and along Lodgepole and Cottonwood Creeks and along Sidney Draw. A cumulative total of 31 municipal wells and 13 industrial wells had been drilled in Cheyenne County through 1983.

The supply of ground water is adequate for the needs of most domestic and livestock users in the county. Reliable supplies are most difficult to obtain from areas where the Brule Formation is near the surface. The depth to water varies greatly across the county. The water table occurs at less than 10 feet beneath the surface in areas on the floor of Lodgepole Creek, while it is more than 300 feet beneath the surface of the tablelands at many places.

Water quality throughout the county is generally good. The water ranges from hard to very hard but otherwise is low in mineralization.

Contamination of water supplies is a potential problem. Chemicals introduced during agricultural activities, human and animal wastes that have been improperly disposed, leaking fuel storage tanks, and commercial and household chemicals that have been carelessly discarded are possible sources of contamination. Water supplies should be checked periodically to determine if a problem is developing, particularly in areas where the sources just mentioned are present.

Physiography, Relief, and Drainage

Cheyenne County is in the High Plains region of the Great Plains. Essentially the county has higher areas to the north and south separated by Lodgepole Creek, which flows from west to east. Other drainageways in the county include Cottonwood and Cow Creeks in the south-central to southeastern part of the county; Rush Creek, which drains the northern third of the county from the northwest to the east; various tributaries of the North Platte River and Pumpkin Creek, which greatly dissect parts of the northern rim of the county; and Sidney and Sand Draws, which drain into Lodgepole Creek in the southwestern part of the county.

In the northwestern tip of the county, the north-central rim, and the northeastern tip are areas of gently sloping to very steep, shallow to very deep, and somewhat excessively drained and well drained soils. These areas include a significant proportion of rock outcrop. Associated with these are areas of soils formed in eolian sediments and loess. These areas are very deep, well drained, and are nearly level to gently sloping.

The high table area in the northern part of the county is the Cheyenne Table. It consists of large areas of very deep, well drained, level to strongly sloping soils. In these areas are some small to large areas of depressional, poorly drained soils. This table is dissected by Rush Creek and tributaries of Lodgepole Creek. Along these drainageways are shallow to very deep soils. These areas are well drained and are nearly level to moderately steep. Along the breaks to the Lodgepole Creek valley are shallow and moderately deep; excessively drained, somewhat excessively drained, and well drained; and gently sloping to very steep areas. The breaks area includes many areas of rock outcrop and gravel and sand knobs.

The Lodgepole Creek valley and Sidney and Sand Draws have very deep and somewhat poorly drained to well drained soils on foot slopes, stream terraces, alluvial fans, and bottom land. These areas are generally nearly level to strongly sloping.

The breaks to Sidney and Sand Draws in the southwest corner of the county are made up of shallow to very deep soils and areas of sandstone and siltstone rock outcrop. These areas are somewhat excessively drained and well drained and are gently sloping to very steep. Above these breaks to the west are small areas of shallow to very deep soils on tables. These areas are well drained and are nearly level to strongly sloping.

A table area of well drained soils is south of Lodgepole Creek above the breaks. These soils are moderately deep to very deep and are nearly level to strongly sloping.

In the southeastern corner of the county along Cottonwood and Cow Creeks are gently sloping to very steep areas. The soils in these areas are shallow and moderately deep to sand and gravel and are excessively drained to well drained.

Throughout the county are small areas of soils on small ridges that are shallow over bedrock. These soils are generally well drained and are on steeper slopes than the soils in surrounding areas.

Lodgepole Creek has cut a channel about 200 feet below the level of the high plain. The elevation of the county ranges from about 3,800 feet near Lodgepole to about 4,400 feet near the western boundary. The average elevation is about 4,100 feet.

Trends in Agriculture

Winter wheat is the main cash crop in Cheyenne County, with 251,000 acres planted in 1984. Other crops grown are corn (18,500 acres), sorghum (6,400 acres), oats (2,600 acres), barley (4,700 acres), dry, edible beans (10,300 acres), sugar beets (170 acres), and hay (17,000 acres).

In 1909, the county had 15,479 acres in wheat, 14,403 acres in corn, 6,750 acres in oats, 688 acres in barley, 3,216 acres in rye, 389 acres in flaxseed, 970 acres in potatoes, and 1 acre in beans. In 1918, the county had 56,965 acres in winter wheat, and the average yield was 15 bushels per acre. In 1984, the average yield was 40.5 bushels per acre. In 1918, corn was grown on 25,354 acres and produced 20 bushels per acre, whereas the yield in 1984 was 112.8 bushels per acre.

About 550,000 acres of the county is used as cropland. Most of this total is either in winter wheat or summer fallow. About 215,000 acres of the county is used as rangeland or for roads, homesites, and other miscellaneous uses.

In January 1985, 444 wells were registered in the county. In 1980, 40,000 acres was irrigated, but by 1984 the acreage had increased to 45,000 acres.

About 740 farms were in the county in 1979, but this number had decreased to an estimated 690 in 1984.

Livestock are an important source of income in the county. In 1970, 25,100 cattle were on feed, but by 1984 their number had increased to 57,000. The number of hogs in the county in 1984 was 19,500. A total of 3,000 sows were farrowed in that year, with 23,400 pigs saved.

The general trend in the county is toward fewer farms and larger acreages.

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; 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. This 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 related to the geology, landforms, relief, climate, and natural vegetation in 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 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 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 U.S.

is based mainly on the kind and character of soil properties and the arrangement of horizons in the profile. After the scientists classified and named the soils in the survey area, they compared the 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 on soil properties and on such variables as climate and biological activity. Soil conditions are predictable over long periods, but they are not predictable from year to year. Thus, 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 two or three 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 named and 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 named and 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

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, different slope groupings, and the application of the latest classification system.

Soil Descriptions

1. Alliance-Duroc-Kuma Association

Deep and very deep, well drained, nearly level to gently sloping, loamy soils formed in loess, alluvial sediment, and eolian material; on uplands

This association consists of soils on upland divides and side slopes and in swales. Slopes range from 0 to 6 percent.

This association has a total area of about 202,800 acres, or about 27 percent of the county. It is about 34 percent Alliance soils, 13 percent Duroc soils, 11 percent Kuma soils, and 42 percent minor soils.

Alliance soils are on divides, side slopes, and ridgetops on uplands and formed in silty loess that overlies weakly cemented, fine grained, limy sandstone. They are nearly level to gently sloping. Typically, the surface layer is grayish brown loam about 6 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is about 20 inches thick. The upper part is brown silty clay loam, and the lower part is pale brown silt loam. The underlying material to a depth of 52 inches is very pale brown, calcareous silt loam. Below this to a depth of 60 inches is very pale brown, weakly cemented, fine grained, limy sandstone bedrock.

Duroc soils are on the slightly concave parts of side slopes near drainageways and in upland swales and formed in alluvial sediment and eolian material. They are nearly level and very gently sloping. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 13 inches thick. The subsoil is about 36 inches thick. It is grayish brown loam in the upper part; grayish brown, calcareous silt loam in the next part; and brown and dark grayish brown, calcareous silt loam in the lower part. The underlying material to a depth of 60 inches is very pale brown, calcareous loam.

Kuma soils are on slightly convex or concave slopes on broad upland flats and formed in loess. They are nearly level. Typically, the surface layer is grayish brown loam about 7 inches thick. The subsoil is about 35 inches thick. The upper part is brown and dark brown silty clay loam, the next part is dark grayish brown silt loam, the next part is brown silt loam, and the lowest part is pale brown silt loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is silt loam, and the lower part is very fine sandy loam.

Of minor extent in this association are Altvan, Canyon, Keith, Rosebud, and Sidney soils. Altvan soils are on side slopes and have gravelly sand at a depth of 20 to 40 inches. Canyon soils are on narrow ridgetops and are shallow to weakly cemented, fine grained, limy sandstone bedrock. Keith soils do not have weakly cemented, fine grained, limy sandstone bedrock and are in landscape positions similar to those of the Alliance soils. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock and are in landscape positions similar to those of the Alliance soils. Sidney soils have less clay in the subsoil than the

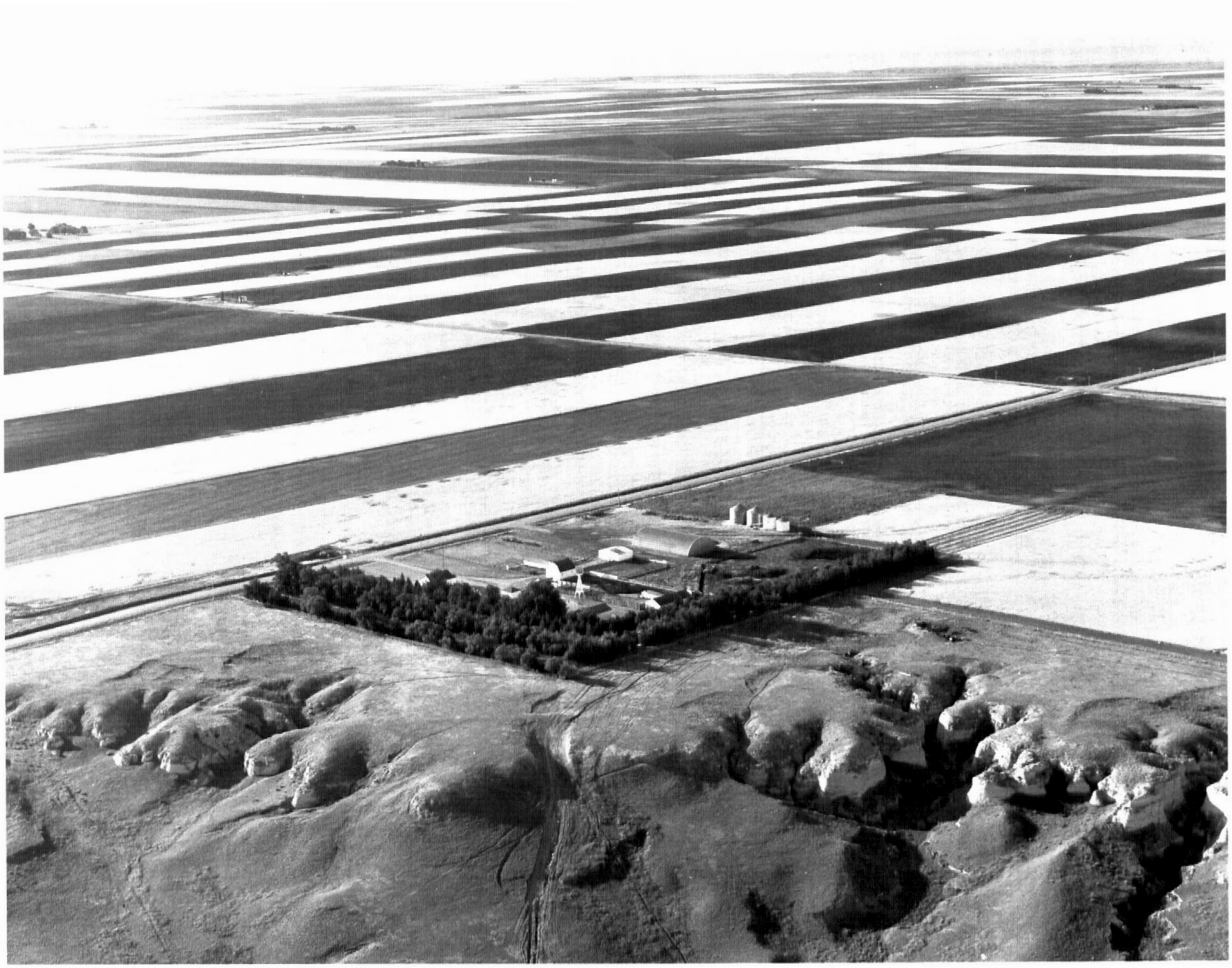

Figure 2.—Stripcropping helps to control soil blowing on the soils in the Alliance-Duroc-Kuma association.

major soils. They are in landscape positions similar to those of the Alliance soils.

Farms in this association are mainly cash-grain enterprises with some livestock grazing. In most areas the soils are used for cultivated crops. A few cultivated areas are irrigated. The main irrigated crops are alfalfa, corn, wheat, and dry, edible beans. The main dryland crops are wheat and millet.

Soil blowing is the main hazard in the less sloping cultivated areas, and water erosion is the main hazard in the more sloping areas. In the areas managed for dryland crops, insufficient rainfall is the main limitation. Stripcropping helps to control soil blowing (fig. 2). A system of conservation tillage, which leaves protective amounts of crop residue on the surface, and the use of cover crops help to control soil blowing and water erosion and conserve moisture.

2. Kuma-Keith-Duroc Association

Very deep, well drained, nearly level to gently sloping, loamy soils formed in loess, eolian material, and alluvial sediment; on uplands

This association consists of soils on broad upland flats, divides, and side slopes and in swales. Slopes range from 0 to 6 percent.

This association has a total area of about 207,498 acres, or about 27 percent of the county. It is about 34 percent Kuma soils, 29 percent Keith soils, 17 percent Duroc soils, and 20 percent minor soils (fig. 3).

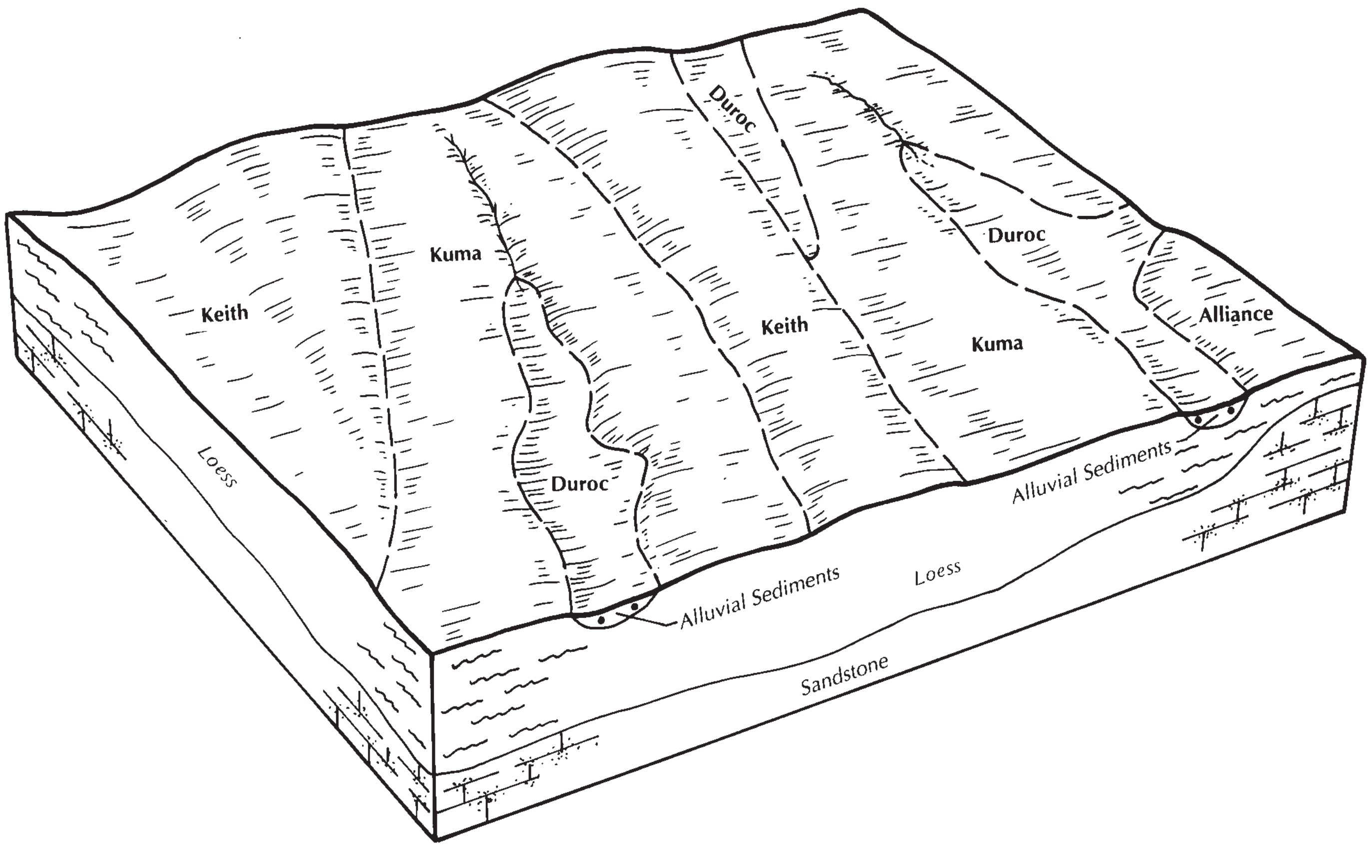

Figure 3.—Typical pattern of soils and parent material in the Kuma-Keith-Duroc association.

Kuma soils are on slightly convex or concave slopes on broad upland flats and formed in loess. They are nearly level. Typically, the surface layer is grayish brown loam about 7 inches thick. The subsoil is about 35 inches thick. The upper part is brown and dark brown silty clay loam, the next part is dark grayish brown silt loam, the next part is brown silt loam, and the lowest part is pale brown silt loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is silt loam, and the lower part is very fine sandy loam.

Keith soils are on slightly convex slopes on broad upland divides, broad summits, and convex side slopes and formed in loess. They are nearly level to gently sloping. Typically, the surface layer is grayish brown loam about 6 inches thick. The subsurface layer is grayish brown loam about 4 inches thick. The subsoil is about 13 inches thick. The upper part is brown silt loam, and the lower part is pale brown silt loam. The underlying material is calcareous to a depth of 60 inches. The upper part is pale brown silt loam, and the lower part is very pale brown very fine sandy loam.

Duroc soils are on slightly concave parts of side slopes near drainageways and in upland swales and formed in alluvial sediment and eolian material. They are nearly level and very gently sloping. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 13 inches thick. The subsoil is about 36 inches thick. It is grayish brown loam in the upper part, grayish brown, calcareous silt loam in the next part, and brown and dark grayish brown, calcareous silt loam in the lowest part. The underlying material to a depth of 60 inches is very pale brown, calcareous loam.

Of minor extent in this association are Alliance, Altvan, Rosebud, and Sidney soils. Alliance and Sidney soils are in landscape positions similar to those of the Keith soils and have weakly cemented, fine grained, limy sandstone bedrock within a depth of 60 inches. Altvan soils are on side slopes and have gravelly sand at a depth of 20 to 40 inches. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock and are in landscape positions similar to those of the Keith soils.

Farms in this association are mainly cash-grain enterprises. Some areas are used for livestock grazing. In most areas the soils are used for cultivated crops. Some of the cultivated areas are irrigated. Deep wells supply the irrigation water. The main irrigated crops are alfalfa; corn; dry, edible beans; and wheat. The main dryland crops are millet and wheat.

Soil blowing is the main hazard in the less sloping cultivated areas, and water erosion is the main hazard in the more sloping areas. In the areas managed for dryland crops, insufficient rainfall is the main limitation. Stripcropping helps to control soil blowing. A system of conservation tillage, which leaves protective amounts of crop residue on the surface, and the use of cover crops help to control soil blowing and water erosion and conserve moisture.

3. Rosebud-Sidney-Canyon Association

Shallow to deep, well drained, nearly level to strongly sloping, loamy soils formed in calcareous residuum and colluvium; on uplands

This association consists of soils on upland divides, summits, ridgetops, and side slopes. Slopes range from 0 to 9 percent.

This association has a total area of about 36,430 acres, or about 5 percent of the county. It is about 36 percent Rosebud soils, 17 percent Sidney soils, 17 percent Canyon soils, and 30 percent minor soils.

Rosebud soils are on upland divides, summits, ridgetops, and side slopes and formed in loamy calcareous residuum of weakly cemented, fine grained, limy sandstone. They are nearly level to strongly sloping. Typically, the surface layer is grayish brown loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark grayish brown clay loam, the next part is brown loam, the next part is light brownish gray loam, and the lowest part is light gray loam. Below a depth of 30 inches is white, weakly cemented, fine grained, limy sandstone bedrock to a depth of 60 inches.

Sidney soils are on side slopes in the uplands and formed in loamy colluvium weathered from weakly cemented, fine grained, limy sandstone. They are gently sloping and strongly sloping. Typically, the surface layer is grayish brown loam about 7 inches thick. The subsoil is light brownish gray loam about 11 inches thick. The underlying material to a depth of 50 inches is loam. The upper part is very pale brown, and the lower part is light gray. Below this to a depth of 60 inches is white, weakly cemented, fine grained, limy sandstone bedrock.

Canyon soils are on narrow ridgetops and convex shoulders of dissected side slopes in the uplands and formed in loamy, calcareous material weathered from weakly cemented, fine grained, limy sandstone. They are gently sloping and strongly sloping. Typically, the surface layer is grayish brown, calcareous fine sandy loam about 6 inches thick. The underlying material is pale brown, calcareous gravelly loam to a depth of 11 inches. To a depth of 60 inches it is white and light gray, weakly cemented, fine grained, limy sandstone bedrock.

Of minor extent in this association are Alliance, Altvan, Dix, Duroc, and Satanta soils. Alliance soils have more silt and less sand and are in landscape positions similar to those of the Rosebud and Sidney soils. Altvan soils are on side slopes and have gravelly sand at a depth of 20 to 40 inches. Dix soils are on the steeper side slopes and have very gravelly sand within a depth of 20 inches. Duroc soils are in swales and along intermittent drainageways. Satanta soils are in landscape positions similar to those of the Rosebud soils and have gravelly sand at a depth of 40 to 60 inches.

Farms in this association are mainly cash-grain enterprises. Some areas are used for livestock grazing. Most of the soils are used for cultivated crops, especially the soils in nearly level to gently sloping areas. The soils in the more sloping areas and along intermittent drainageways support native grasses and may be used for grazing. Some of the cultivated areas are irrigated. Wells supply the irrigation water. The main irrigated crops are alfalfa; corn; dry, edible beans; and wheat. The main dryland crops are millet and wheat.

Soil blowing is the main hazard in the less sloping cultivated areas, and water erosion is the main hazard in the more sloping areas. In areas managed for dryland crops, insufficient rainfall is the main limitation. Stripcropping helps to control soil blowing. Distributing an adequate supply of irrigation water is a concern in managing irrigated areas. A system of conservation tillage, which leaves protective amounts of crop residue on the surface, and the use of cover crops help to control soil blowing and water erosion and conserve moisture.

4. Altvan-Satanta-Johnstown Association

Moderately deep over gravelly sand and very deep, well drained, nearly level to strongly sloping, loamy soils formed in loess, loamy alluvial sediment, and eolian material deposited over gravelly sand; on uplands and stream terraces

This association consists of soils on broad uplands, ridgetops, side slopes, and stream terraces. Slopes range from 0 to 9 percent.

This association has a total area of about 44,690 acres, or about 6 percent of the county. It is about 27 percent Altvan soils, 24 percent Satanta soils, 12 percent Johnstown soils, and 37 percent minor soils.

Altvan soils are on ridgetops and side slopes in the uplands and stream terraces and formed in loamy sediment that has a component of loess over gravelly sand. They are very gently sloping to strongly sloping. Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is dark brown loam about 4 inches thick. The subsoil is about 19 inches thick. It is brown clay loam in the upper part, pale brown, calcareous clay loam in the next part, and very pale brown, calcareous loam in the lower part. The underlying material to a depth of 60 inches is very pale brown, calcareous fine sandy loam in the upper part, very pale brown, calcareous gravelly sand in the next part, and pink gravelly sand in the lower part.

Satanta soils are on broad uplands and side slopes in the uplands and on stream terraces and formed in loamy eolian or alluvial sediments over gravelly loamy sand. They are nearly level to gently sloping. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsurface layer is brown clay loam about 4 inches thick. The subsoil is about 17 inches thick. The upper part is brown clay loam, the next part is pale brown clay loam, and the lower part is very pale brown, calcareous loam. The underlying material is calcareous to a depth of 60 inches. The upper part is very pale brown loam, the next part is very pale brown fine sandy loam, and the lower part is very pale brown gravelly loamy sand.

Johnstown soils are on slightly convex slopes on broad upland flats and formed in loess and loamy sediments. They are nearly level. Typically, the surface layer is grayish brown loam about 5 inches thick. The subsurface layer is grayish brown loam about 4 inches thick. The subsoil is 37 inches thick. The upper part is grayish brown clay loam, the next part is dark grayish brown clay loam, the next part is brown clay loam, the next part is pale brown silt loam, and the lowest part is very pale brown, calcareous silt loam. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand.

Of minor extent in this association are Alliance, Dix, Duroc, Keith, and Kuma soils. Alliance and Keith soils are in landscape positions similar to those of the Satanta soils. They contain more silt and less sand than the major soils. Dix soils are on the steeper landscapes and have very gravelly sand within a depth of 20 inches. Duroc soils are in swales and along drainageways and have a dark upper layer that is more than 20 inches thick. Kuma soils are similar to the Johnstown soils and do not have a gravelly sand substratum.

Farms in this association are mainly cash-grain enterprises. Some areas are used for livestock grazing. In most areas the soils are used for cultivated crops. Some of the cultivated areas are irrigated. Deep wells supply the irrigation water. The main irrigated crops are alfalfa; corn; dry, edible beans; and wheat. The main dryland crops are millet and wheat. The soils in the more sloping areas support native grasses and are used for grazing.

Soil blowing is the main hazard in the less sloping cultivated areas, and water erosion is the main hazard in the more sloping areas. In the areas managed for dryland crops, insufficient rainfall is the main limitation. A system of conservation tillage, which leaves protective amounts of crop residue on the surface, and the use of cover crops help to control soil blowing and water erosion and conserve moisture.

5. Jayem-Duroc-Keith Association

Very deep, well drained, nearly level to gently sloping, loamy soils formed in eolian material, alluvial sediment, and loess; on uplands

This association consists of soils on upland divides, ridgetops, and side slopes and in swales. Slopes range from 0 to 6 percent.

This association has a total area of about 18,130 acres, or more than 2 percent of the county. It is about 45 percent Jayem soils, 16 percent Duroc soils, 9 percent Keith soils, and 30 percent minor soils.

Jayem soils are on convex ridgetops and side slopes in the uplands and formed in eolian material weathered from noncalcareous sandstone. They are very gently sloping and gently sloping. Typically, the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsurface layer is brown fine sandy loam about 14 inches thick. The subsoil is pale brown fine sandy loam about 11 inches thick. The underlying material is fine sandy loam to a depth of 60 inches. It is pale brown and light yellowish brown in the upper part and very pale brown and calcareous in the lower part.

Duroc soils are on slightly concave parts of side slopes near drainageways and in upland swales and formed in alluvial sediment and eolian material. They are nearly level and very gently sloping. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 13 inches thick. The subsoil is about 36 inches thick. It is grayish brown loam in the upper part, grayish brown, calcareous silt loam in the next part, and brown and dark grayish brown, calcareous silt loam in the lower part. The underlying material to a depth of 60 inches is very pale brown, calcareous loam.

Keith soils are on slightly convex slopes on broad upland divides and on convex side slopes. They formed in loess. They are nearly level to gently sloping. Typically, the surface layer is grayish brown loam about 6 inches thick. The subsurface layer is grayish brown loam about 4 inches thick. The subsoil is about 13 inches thick. The upper part is brown silt loam, and the lower part is pale brown silt loam. The underlying material is calcareous to a depth of 60 inches. The upper part is pale brown silt loam, and the lower part is very pale brown very fine sandy loam.

Of minor extent in this association are Alliance, Altvan, Creighton, and Kuma soils. Alliance soils are in landscape positions similar to those of the Keith soils and have weakly cemented, fine grained, limy sandstone bedrock within a depth of 60 inches. Altvan soils are on side slopes and have gravelly sand at a depth of 20 to 40 inches. Creighton soils are in landscape positions similar to those of the Jayem soils and have free carbonates above a depth of 40 inches. Kuma soils have a buried soil and are in landscape positions similar to those of the Keith soils.

Farms in this association are mainly cash-grain enterprises. Some areas are used for livestock grazing. In most areas the soils are used for cultivated crops. Very few of the cultivated areas are irrigated. The main irrigated crops are alfalfa; corn; dry, edible beans; and wheat. The main dryland crops are millet and wheat.

Soil blowing is the main hazard in the less sloping cultivated areas, and water erosion is the main hazard in the more sloping areas. In areas managed for dryland crops, insufficient rainfall is the main limitation. Stripcropping helps to control soil blowing. A system of conservation tillage, which leaves protective amounts of crop residue on the surface, and the use of cover crops help to control soil blowing and water erosion and conserve moisture.

6. Canyon-Bayard-Rosebud Association

Shallow, very deep, and moderately deep, well drained, strongly sloping to very steep, loamy soils formed in calcareous residuum and colluvial and alluvial sediments; on uplands and foot slopes

This association consists of soils on breaks, ridgetops, and side slopes in the uplands and on foot slopes. Slopes range from 6 to 60 percent.

This association has a total area of about 76,590 acres, or about 10 percent of the county. It is about 55 percent Canyon soils, 15 percent Bayard soils, 8 percent Rosebud soils, and 22 percent minor soils (fig. 4).

Canyon soils are on narrow ridgetops, dissected side slopes, and sharp slope breaks on the uplands and formed in loamy, calcareous material weathered from weakly cemented, fine grained, limy sandstone. They are strongly sloping to very steep. Typically, the surface layer is grayish brown, calcareous fine sandy loam about 6 inches thick. The underlying material is pale brown, calcareous gravelly loam to a depth of 11 inches. To a depth of 60 inches it is white and light gray, weakly cemented, fine grained, limy sandstone bedrock.

Bayard soils are on foot slopes and formed in colluvial and alluvial sediments weathered from weakly cemented, fine grained, limy sandstone. They are strongly sloping to steep. Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, calcareous fine sandy loam about 4 inches thick. The transitional layer is light brownish gray, calcareous fine sandy loam about 10 inches thick. The underlying material is calcareous fine sandy loam to a depth of 60 inches. The upper part is light brownish gray, and the lower part is pale brown.

Rosebud soils are on ridgetops and side slopes on the uplands and formed in loamy, calcareous material weathered from weakly cemented, fine grained, limy sandstone. They are strongly sloping. Typically, the surface layer is grayish brown loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark grayish brown clay loam, the next part is brown loam, the next part is light brownish gray loam, and the lowest part is light gray loam. To a depth of 60 inches it is white, weakly cemented, fine grained, limy sandstone bedrock.

Of minor extent in this association are Alliance, Dix, and Sidney soils and areas of Rock outcrop. Alliance soils are in the less sloping areas and have weakly cemented, fine grained, limy sandstone at a depth of 40 to 60 inches. Dix soils are in landscape positions similar to those of the Canyon soils and have very gravelly sand within a depth of 20 inches. Sidney soils are in landscape positions similar to those of the Bayard soils and formed in loamy, calcareous colluvium weathered from weakly cemented, fine grained, limy sandstone bedrock. The areas of Rock outcrop are on narrow ridgetops and on sharp slope breaks and consist of bare sandstone.

The soils in most areas of this association support native grasses and are used as rangeland. Beef cattle is the main livestock enterprise. Some of the strongly sloping areas are cultivated. The main crops are millet and wheat. The steep and very steep slopes and the shallow soil limit the use of most areas to rangeland and wildlife habitat.

Soil blowing, water erosion, and the shallow soil are the main management concerns affecting cultivated areas. The use of these soils as rangeland helps to control soil blowing and water erosion. Maintaining or increasing the productivity of the rangeland is the main

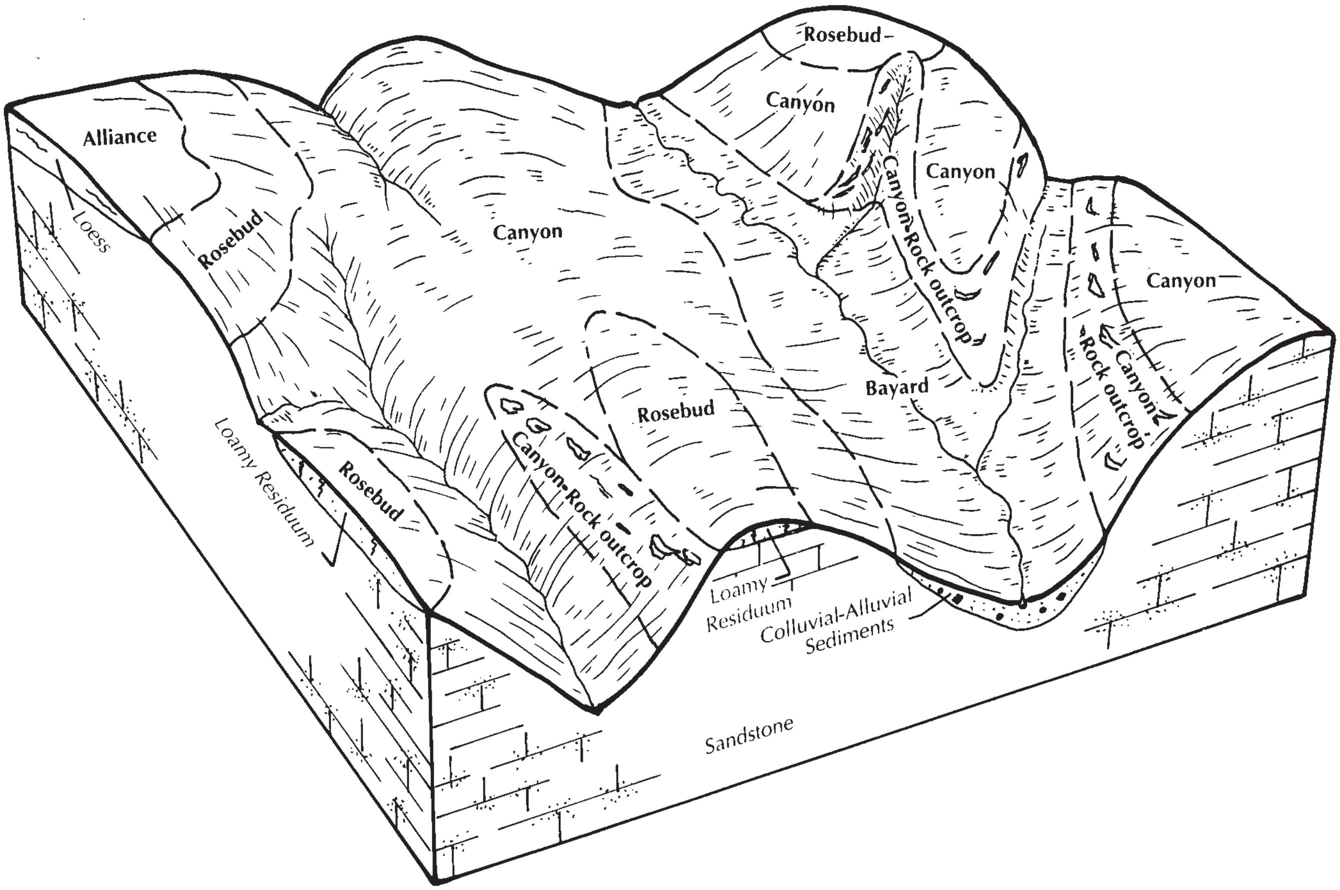

Figure 4.—Typical pattern of soils and parent material in the Canyon-Bayard-Rosebud association.

management concern. Range management that includes proper grazing use and timely deferments from grazing or haying helps to maintain or improve the range condition.

7. Dix-Altvan Association

Shallow and moderately deep over gravelly sand, excessively drained and well drained, very gently sloping to very steep, loamy soils formed in loamy, sandy, and gravelly sediments; on uplands and stream terraces

This association consists of soils on side slopes, ridgetops, and breaks on uplands and stream terraces. Slopes range from 1 to 50 percent.

This association has a total area of about 32,600 acres, or more than 4 percent of the county. It is about 51 percent Dix soils, 20 percent Altvan soils, and 29 percent minor soils (fig. 5).

Dix soils are on narrow ridgetops and convex shoulders of dissected side slopes and formed in loamy, sandy, and gravelly sediments. They are gently sloping to very steep and are excessively drained. Typically, the surface layer is dark grayish brown gravelly loam 6 inches thick. The transitional layer is brown gravelly sandy loam about 5 inches thick. The underlying material to a depth of 60 inches is brown gravelly loamy coarse sand in the upper part and pale brown very gravelly sand in the lower part.

Altvan soils are on upland ridgetops, side slopes, and breaks of stream terraces and formed in loamy sediment. They are very gently sloping to strongly sloping and are well drained. Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is dark brown loam about 4 inches thick. The subsoil is about 19 inches thick. It is brown clay loam in the upper part; pale brown, calcareous clay loam in the next part; and very pale brown, calcareous loam in the lower part. The underlying material to a depth of 60 inches is very pale brown, calcareous fine sandy loam in the upper part; very pale brown, calcareous gravelly sand in the next part; and pink gravelly sand in the lower part.

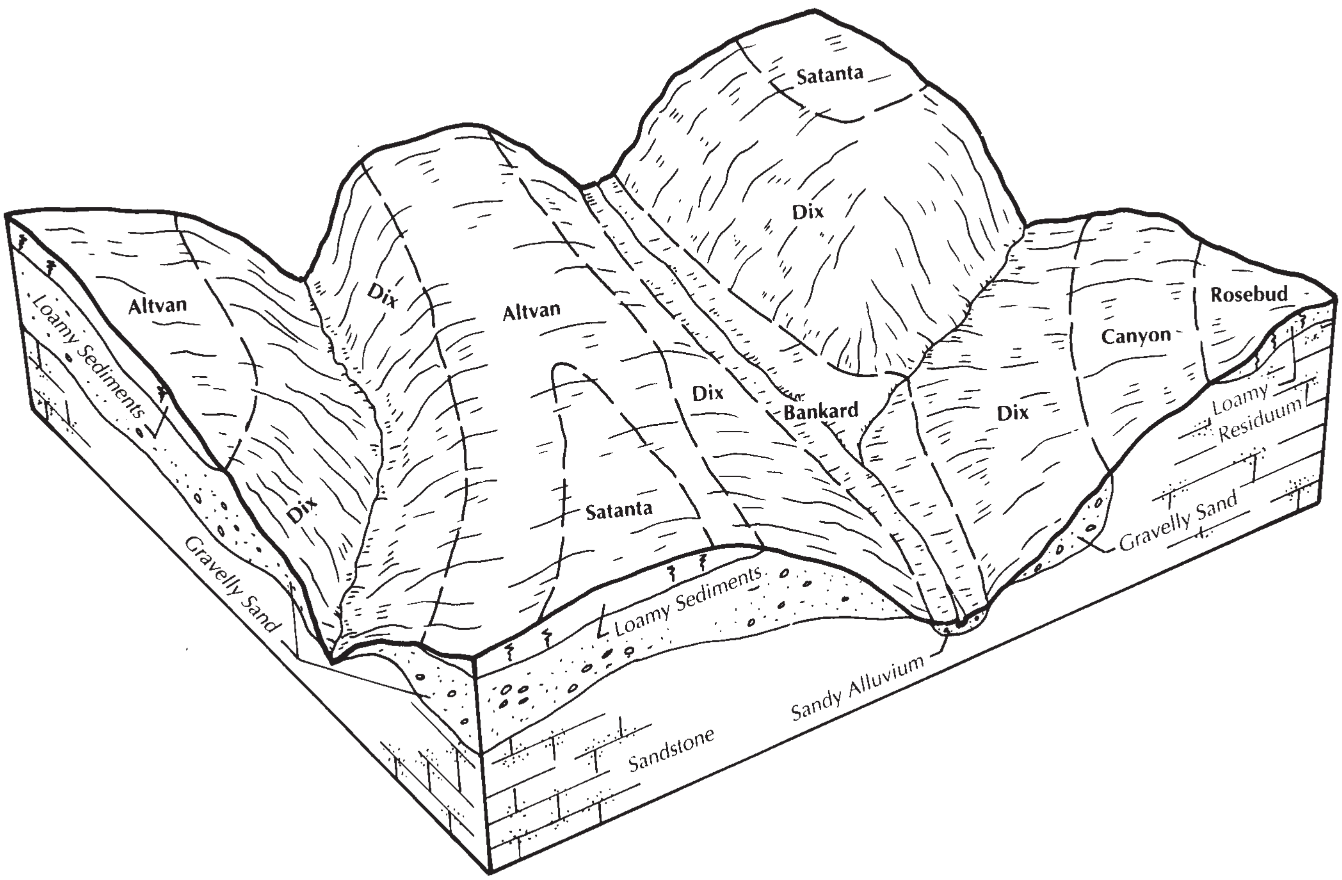

Figure 5.—Typical pattern of soils and parent material in the Dix-Altvan association.

Of minor extent in this association are Bankard, Bayard, Canyon, Rosebud, and Satanta soils. Bankard soils are on flood plains. Bayard soils are on foot slopes and have less clay than the Altvan soils. Canyon soils are in landscape positions similar to those of the Dix soils and are shallow to weakly cemented, fine grained, limy sandstone bedrock. Rosebud soils are in landscape positions similar to those of the Altvan soils and have weakly cemented, fine grained, limy sandstone bedrock at a depth of 20 to 40 inches. Satanta soils are in landscape positions similar to those of the Altvan soils and are deep over gravelly sand.

Farms in this association are diversified, mainly a combination of livestock and cash-grain enterprises. Many of the farms extend into cultivated areas of the adjacent associations. Most of this association supports native grasses and is used as rangeland. Beef cattle is the main livestock enterprise. Some of the very gently sloping to strongly sloping areas are cultivated. The main cultivated crops are millet and wheat. The steep and very steep slopes and the shallow depth to gravelly sand limit the use of most areas to rangeland and wildlife habitat.

Soil blowing and water erosion are the main hazards in this association. Maintaining or increasing the productivity of the rangeland is the main management concern. Range management that includes proper grazing use and timely deferments from grazing or haying help to maintain or improve the range condition. A system of conservation tillage, cover crops, or using the soils as rangeland help to control soil blowing and water erosion.

8. Mitchell-Epping-Rock Outcrop Association

Areas of Rock outcrop and very deep and shallow, well drained, gently sloping to very steep, loamy soils formed in colluvial and alluvial sediments and material weathered from siltstone; on uplands and foot slopes

This association consists of soils on breaks, ridgetops, and side slopes in the uplands and on foot slopes. Also, it includes strips of Rock outcrop. Slopes

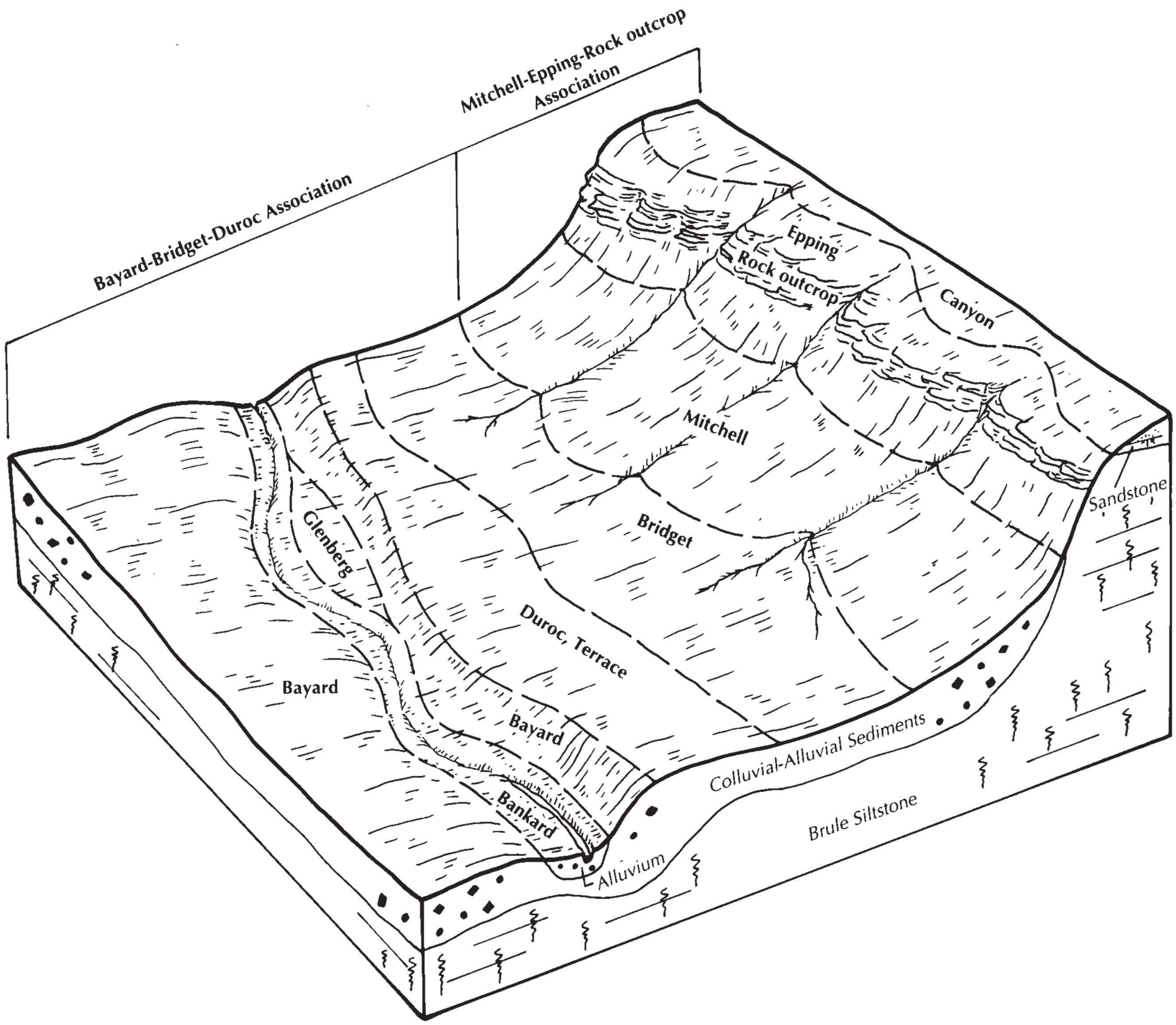

Figure 6.—Typical pattern of soils and parent material in the Mitchell-Epping-Rock outcrop and Bayard-Bridget-Duroc associations.

range from 3 to 60 percent.

This association has a total area of about 6,130 acres, or less than 1 percent of the county. It is about 50 percent Mitchell soils, 25 percent Epping soils, 12 percent Rock outcrop, and 13 percent minor soils (fig. 6).

Mitchell soils are on foot slopes and valley side slopes and formed in colluvial and alluvial sediments weathered from siltstone. They are gently sloping to steep. Typically, the surface layer is light brownish gray, calcareous very fine sandy loam about 5 inches thick. The transitional layer is pale brown, calcareous silt loam about 12 inches thick. The underlying material is very pale brown, calcareous silt loam to a depth of 60 inches.

Epping soils are on narrow ridgetops and side slopes on the upland breaks and formed in loamy material weathered from siltstone. They are gently sloping to very steep. Typically, the surface layer is pale brown, calcareous loam about 5 inches thick. The underlying material is very pale brown, calcareous loam to a depth of 13 inches. To a depth of 60 inches it is very pale brown, calcareous siltstone bedrock.

The areas of Rock outcrop consist of strips of narrow, very steep areas of bare rock and areas where the soil is very thin over bedrock. The bedrock is mainly siltstone.

Of minor extent in this association are Bridget and Canyon soils. Bridget soils are on the lower foot slopes and have a thicker dark upper layer than the major soils. Canyon soils are on the slightly higher parts of the landscape and are shallow to weakly cemented, fine grained, limy sandstone bedrock.

Most of the soils in this association support native grasses and are used as rangeland (fig. 7). Beef cattle is the main livestock enterprise. The steep and very steep slopes and the shallow soil limit the use of most areas to rangeland and wildlife habitat.

The use of these soils as rangeland helps to control soil blowing and water erosion. Maintaining or increasing the productivity of the rangeland is the main management concern. Range management that includes proper grazing use and timely deferments from grazing or haying helps to maintain or improve the range condition.

9. Alliance-Canyon-Sidney Association

Deep and shallow, well drained, nearly level to steep, loamy soils formed in loess, calcareous residuum, and calcareous colluvium; on uplands

This association consists of soils on divides, ridgetops, and side slopes in the uplands. Slopes range from 0 to 30 percent.

This association has a total area of about 31,610 acres, or more than 4 percent of the county. It is about 26 percent Alliance soils, 22 percent Canyon soils, 11 percent Sidney soils, and 41 percent minor soils.

Alliance soils are on divides, ridgetops, and side slopes in the uplands and formed in silty loess that overlies weakly cemented, fine grained, limy sandstone. They are nearly level to gently sloping. Typically, the surface layer is grayish brown loam about 6 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is about 20 inches thick. The upper part is brown silty clay loam, and the lower part is pale brown silt loam. The underlying material to a depth of 52 inches is very pale brown, calcareous silt loam. To a depth of 60 inches it is very pale brown, weakly cemented, fine grained, limy sandstone bedrock.

Canyon soils are on narrow ridgetops and dissected side slopes in the uplands and formed in loamy, calcareous material weathered from weakly cemented, fine grained, limy sandstone. They are gently sloping to steep. Typically, the surface layer is grayish brown, calcareous fine sandy loam about 6 inches thick. The underlying material is pale brown, calcareous gravelly loam to a depth of 11 inches. To a depth of 60 inches it is white and light gray, weakly cemented, fine grained, limy sandstone bedrock.

Sidney soils are on side slopes in the uplands and formed in loamy, calcareous colluvium weathered from weakly cemented, fine grained, limy sandstone. They are gently sloping and strongly sloping. Typically, the surface layer is grayish brown, calcareous loam about 7 inches thick. The subsoil is light brownish gray, calcareous loam about 11 inches thick. The underlying material to a depth of 50 inches is calcareous loam. The upper part is very pale brown, and the lower part is light gray. To a depth of 60 inches it is white, weakly cemented, fine grained, limy sandstone bedrock.

Of minor extent in this association are Bankard, Bayard, Dix, Duroc, and Rosebud soils. Bankard soils are on flood plains. Bayard soils are on foot slopes and do not have sandstone bedrock within a depth of 60 inches. Dix soils are in landscape positions similar to those of the Canyon soils and have very gravelly sand within a depth of 20 inches. Duroc soils are in upland swales and have a dark upper layer that is more than 20 inches thick. Rosebud soils are in landscape positions similar to those of the Alliance and Sidney soils and have sandstone bedrock at a depth of 20 to 40 inches.

Farms in this association are mainly a combination of cash-grain and livestock enterprises. The nearly level to strongly sloping soils on divides, ridgetops, and side slopes are used for cultivated crops. The soils on the steeper side slopes and narrow ridgetops support native grasses and are used as rangeland. Topography is the main limitation affecting irrigation, but the water supply may also be a limitation. The main dryland crops are millet and wheat.

Soil blowing and water erosion are the main hazards in cultivated areas. In areas managed for dryland crops, insufficient rainfall is the main limitation. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Range management that includes proper grazing use and timely deferments from grazing or haying helps to maintain or improve the range condition.

10. Busher-Tassel Association

Deep and shallow, well drained, gently sloping to very steep, loamy and sandy soils formed in material weathered from fine grained sandstone; on uplands

This association consists of soils on ridgetops and side slopes in the uplands. Slopes range from 3 to 60 percent.

This association has a total area of about 17,930 acres, or more than 2 percent of the county. It is about

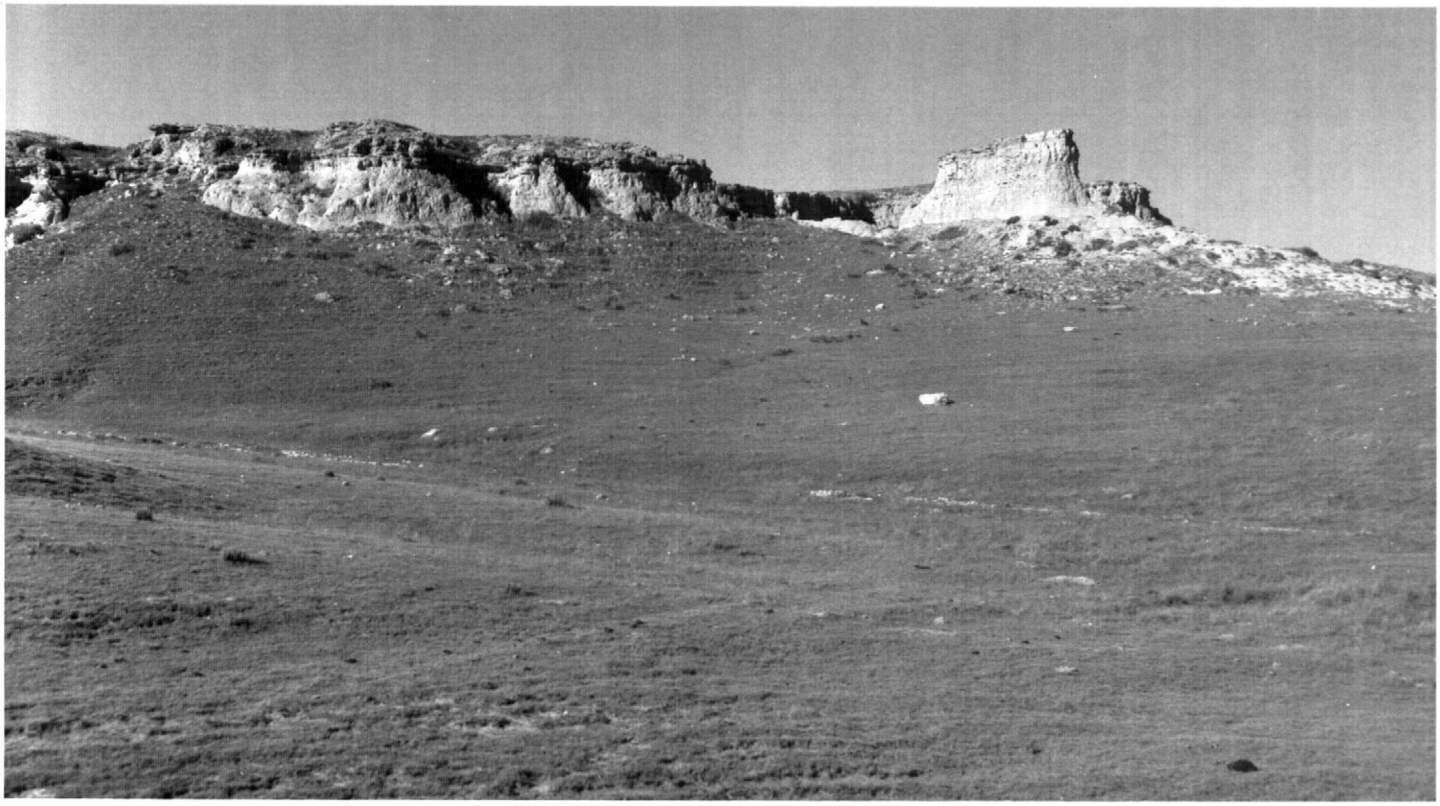

Figure 7.—An area of the Mitchell-Epping-Rock outcrop association used mainly as rangeland.

41 percent Busher soils, 32 percent Tassel soils, and 27 percent minor soils.

Busher soils are on convex ridgetops and side slopes on the uplands and formed in material weathered from weakly cemented, fine grained sandstone. They are gently sloping to moderately steep. Typically, the surface layer is grayish brown fine sandy loam about 6 inches thick. The subsurface layer is fine sandy loam about 13 inches thick. The upper part is grayish brown, and the lower part is brown. The subsoil is brown, calcareous fine sandy loam about 12 inches thick. The underlying material to a depth of 45 inches is very pale brown and calcareous. The upper part is fine sandy loam, and the lower part is loamy very fine sand. To a depth of 60 inches it is weakly cemented, fine grained sandstone bedrock.

Tassel soils are on narrow ridgetops and the upper parts of side slopes on the uplands and formed in calcareous material weathered from weakly cemented, fine grained sandstone. They are gently sloping to very steep. Typically, the surface layer is dark grayish brown loamy very fine sand about 3 inches thick. The subsurface layer is brown, calcareous, loamy very fine sand about 3 inches thick. The underlying material is pale brown, calcareous, loamy very fine sand. Weakly cemented, fine grained sandstone bedrock is at a depth of about 13 inches.

Of minor extent in this association are Bankard, Canyon, Dix, and Jayem soils and areas of Rock outcrop. Bankard soils are on flood plains. Canyon soils are in landscape positions similar to those of the Tassel soils and have more clay in the soil than the major soils. Dix soils are in landscape positions similar to those of the Tassel soils and have very gravelly sand within a depth of 20 inches. Jayem soils are in the less sloping areas in the uplands. Areas of Rock outcrop are in landscape positions similar to those of the Tassel soils and consist of bare sandstone.

Most areas of the soils in this association support native grasses and are used as rangeland. Beef cattle is the main livestock enterprise. A few of the gently sloping and strongly sloping areas are cultivated. The main cultivated crops are millet and wheat. The steep and very steep slopes and the shallow soil limit the use of most areas to rangeland and wildlife habitat.

The use of these soils as rangeland helps to control soil blowing and water erosion. Water erosion, soil blowing, and the shallow soil are the main management concerns affecting cultivated areas. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion. Maintaining or increasing the productivity of the rangeland is the main management concern. Range management that includes proper grazing use and timely deferments from grazing or haying helps to maintain or improve the range condition.

11. Bayard-Bridget-Duroc Association

Very deep, well drained, nearly level to gently sloping, loamy and silty soils formed in colluvial and alluvial sediment and eolian material; on foot slopes, stream terraces, and alluvial fans

This association consists of soils on foot slopes, stream terraces, and alluvial fans. Slopes range from 0 to 6 percent.

This association has a total area of about 81,430 acres, or about 11 percent of the county. It is about 39 percent Bayard soils, 25 percent Bridget soils, 15 percent Duroc soils, and 21 percent minor soils (fig. 6).

Bayard soils are on foot slopes, alluvial fans, and stream terraces and formed in colluvial and alluvial sediment. They are nearly level to gently sloping. Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, calcareous fine sandy loam about 4 inches thick. The transitional layer is light brownish gray, calcareous fine sandy loam about 10 inches thick. The underlying material is calcareous fine sandy loam to a depth of 60 inches. The upper part is light brownish gray, and the lower part is pale brown.

Bridget soils are on alluvial fans, stream terraces, and foot slopes and formed in colluvial and alluvial sediment. They are nearly level to gently sloping. Typically, the surface layer is grayish brown, calcareous very fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, calcareous very fine sandy loam about 8 inches thick. The transitional layer is light brownish gray, calcareous very fine sandy loam about 6 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 60 inches.

Duroc soils are in swales on stream terraces and formed in alluvial and colluvial sediment and eolian material. They are nearly level. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, calcareous silt loam about 2 inches thick. The subsoil is calcareous silt loam about 33 inches thick. The upper part is dark grayish brown, the next part is grayish brown, and the lower part is brown. The underlying material to a depth of 60 inches is pale brown, calcareous silt loam.

Of minor extent in the association are Bankard, Glenberg, Mitchell, and Satanta soils. Bankard and Glenberg soils are on flood plains and are stratified. Mitchell soils are on foot slopes and valley side slopes and have a thinner, dark upper layer than the major soils. Satanta soils are on valley side slopes and have gravelly loamy sand below a depth of 40 inches.

Farms in this association are diversified, mainly a combination of cash-grain and livestock enterprises. Many of the farms extend into the adjacent associations on the breaks into the uplands. Most of the acreage of this association is cultivated, and part of the acreage is irrigated. The main crops are millet and wheat in dryland areas. The main irrigated crops are alfalfa, corn, and forage crops. The forage crops are used for winter feed.

Soil blowing and water erosion are the main hazards in cultivated areas. In the areas managed for dryland crops, insufficient rainfall is the main limitation. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Applying sufficient irrigation water at a rate that permits maximum absorption and minimum runoff is essential. Range management that includes proper grazing use and timely deferment from grazing or haying helps to maintain or improve the range condition.

12. Las-Glenberg-McCook Association

Very deep, somewhat poorly drained and well drained, nearly level, loamy soils formed in calcareous alluvium; on flood plains

This association consists of soils on flood plains. Slopes range from 0 to 2 percent.

This association has a total area of about 9,660 acres, or more than 1 percent of the county. It is about 33 percent Las soils, 29 percent Glenberg soils, 24 percent McCook soils, and 14 percent minor soils.

Las soils are subject to occasional flooding. They formed in calcareous, loamy alluvium. They are nearly level and are somewhat poorly drained. Typically, the surface layer is grayish brown, calcareous loam about 4 inches thick. The subsurface layer is light brownish gray, calcareous clay loam about 7 inches thick. The underlying material to a depth of 60 inches is calcareous and is stratified light brownish gray and light gray loam, clay loam, sandy loam, and sandy clay loam.

Glenberg soils are subject to rare flooding. They formed in stratified, calcareous alluvium derived from mixed sources. They are nearly level and are well drained. Typically, the surface layer is grayish brown, calcareous fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is stratified light brownish gray, light gray, and grayish brown, calcareous fine sandy loam, loamy fine sand, very fine sandy loam, and silt loam.

McCook soils are subject to rare flooding. They formed in weakly stratified, calcareous, loamy alluvium. They are nearly level and are well drained. Typically, the surface layer is grayish brown, calcareous very fine sandy loam about 12 inches thick. The transitional layer is light brownish gray, calcareous very fine sandy loam about 7 inches thick. The underlying material to a depth of 60 inches is calcareous. The upper part is grayish brown very fine sandy loam, the next part is light brownish gray very fine sandy loam, and the lower part is light brownish gray fine sandy loam.

Of minor extent in this association are Bankard and Las Animas soils. Bankard soils are in landscape positions similar to those of the Las soils, are somewhat excessively drained, and have more sand and less silt in the profile than the major soils. Las Animas soils are in landscape positions that are slightly lower than those of the Las soils and are poorly drained.

Farms in this association are diversified, mainly a combination of cash-grain and livestock enterprises. Many of the farms extend into the adjacent associations on foot slopes and breaks into the uplands. Most cultivated areas are irrigated. The main irrigated crops are alfalfa, corn, forage crops, and sugar beets. The main dryland crops are millet and wheat. The forage crops are used for winter feed. Most areas support native grasses and are used as rangeland. A few areas are planted to grasses that are used as pasture or hayland.

The hazard of soil blowing in cultivated areas can be controlled by a system of conservation tillage that leaves a cover of crop residue on the soil most of the time. Flooding also is a hazard. In the areas managed for dryland crops, insufficient rainfall is the main limitation. Applying sufficient irrigation water at a rate that permits maximum absorption and minimum runoff is essential. Proper grazing use, timely deferment of grazing or haying, and a planned grazing system help to maintain or improve the range condition.

Detailed Soil Map Units

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 the heading "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, Alliance loam, 1 to 3 percent slopes, is a phase of the Alliance 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. Altvan-Dix complex, 3 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 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 systems.

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

Ao—Alliance loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on broad upland divides. It formed in loess that is underlain by weakly cemented, fine grained, limy sandstone. Areas range from 5 to 70 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark grayish brown, friable silty clay loam; the next part is brown and dark grayish brown, friable silty clay loam; and the lower part is light gray, very friable, calcareous silt loam. The underlying material is very pale brown, calcareous silt loam about 12 inches thick. To a depth of 60 inches it is weathered, very pale brown, weakly cemented, fine grained, limy sandstone bedrock. In some places the depth to sandstone bedrock is more than 60 inches. In other places the surface layer is fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Altvan, Duroc, Goshen, and Rosebud soils. Altvan soils have gravelly sand at a depth of 20 to 40 inches. They are on side slopes. Duroc soils have less clay in the subsoil than the Alliance soil and a dark surface layer that is more than 20 inches thick. They are in the lower concave areas. Goshen soils have a dark surface layer that is more than 20 inches thick. They are in swales. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Alliance soil and contain more sand and less silt in the profile. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Alliance soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. The use of a winter cover crop reduces soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the rate of water intake. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Building up or mounding the site with suitable fill material improves the filtering capacity of the field. This soil is generally suited to dwellings. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

AoB—Alliance loam, 1 to 3 percent slopes. This deep, very gently sloping, well drained soil is on side slopes and upland divides. It formed in loess that is underlain by weakly cemented, fine grained, limy sandstone. Areas range from 5 to 60 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is grayish brown, friable loam about 3 inches thick. The subsoil is friable and about 20 inches thick. It is brown silty clay loam in the upper part and pale brown silt loam in the lower part. The underlying material to a depth of 52 inches is very pale brown, calcareous silt loam. To a depth of 60 inches it is very pale brown, weakly cemented, fine grained, limy sandstone bedrock. In some areas the soil contains more sand. In other areas gravelly sand, instead of sandstone, is at the lowest level. In some places the depth to sandstone bedrock is more than 60 inches. In other places the surface layer is fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Altvan and Rosebud soils. Altvan soils have gravelly sand at a depth of 20 to 40 inches. They are on the steeper side slopes. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Alliance soil and contain more sand and less silt in the profile. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Alliance soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the rate of water intake. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates are good. The lack of seasonal rainfall is the main limitation. Water erosion is the principal hazard. A drip irrigation system can be used to provide additional water as needed. Planting on the contour helps to control water erosion. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Building up or mounding the site with suitable fill material improves the filtering capacity of the soil. This soil is generally suited to dwellings. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; and windbreak suitability group 3.

AoC—Alliance loam, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on side slopes and ridgetops in the uplands. It formed in loess that is underlain by weakly cemented, fine grained, limy sandstone. Areas range from 5 to 30 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 7 inches thick. The subsoil is friable and about 18 inches thick. It is grayish brown silty clay loam in the upper part, brown silt loam in the next part, and pale brown, calcareous silt loam in the lower part. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of about 43 inches. It is very pale brown, weakly cemented, fine grained, limy sandstone bedrock to a depth of 60 inches. In some places the depth to sandstone bedrock is more than 60 inches. In other places the subsoil contains less clay. In some areas the surface layer is fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Altvan and Rosebud soils. The included soils are in landscape positions similar to those of the Alliance soil. Altvan soils have gravelly sand at a depth of 20 to 40 inches. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Alliance soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If the slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil losses are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates are good. The lack of seasonal rainfall is the main limitation. Water erosion is the principal hazard. A drip irrigation system can be used to provide additional water as needed. Planting the trees on the contour and terracing help to control water erosion. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Building up or mounding the site with suitable fill material improves the filtering capacity of the soil. This soil is generally suited to dwellings. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

AtB—Altvan loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil has gravelly sand at a depth of 20 to 40 inches. It is on side slopes and ridgetops in the uplands and on stream terraces. It formed in loamy sediments. Areas range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is dark brown, friable loam about 4 inches thick. The subsoil is friable and about 19 inches thick. It is brown clay loam in the upper part; pale brown, calcareous clay loam in the next part; and very pale brown, calcareous loam in the lower part. The underlying material to a depth of 60 inches is very pale brown, calcareous fine sandy loam in the upper part; very pale brown, calcareous gravelly sand in the next part; and pink, calcareous gravelly sand in the lower part. In some places the surface layer is fine sandy loam or silt loam. In other places the subsoil contains less clay. In some areas the gravelly sand is thin and underlain by weakly cemented, fine grained, limy sandstone.

Included with this soil in mapping are small areas of Alliance, Johnstown, Rosebud, and Satanta soils. Alliance soils are deep to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Altvan soil. Johnstown soils have a dark surface layer that is more than 20 inches thick and have a buried horizon. They are on the less sloping landscapes. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Altvan soil. Satanta soils have gravelly loamy sand below a depth of 40 inches. They are in landscape positions similar to those of the Altvan soil. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the solum of the Altvan soil and very rapid in the underlying material. Available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas support native grasses and are used for grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate helps to control excessive runoff and erosion. If the slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade. During land leveling, care should be taken not to expose the underlying sand and gravel.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. Water erosion is a hazard. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. Planting trees on the contour and terracing help to control water erosion. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of the underground water supplies. The sides of shallow excavations can cave in unless they are shored. This soil generally is suited to dwellings.

The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Mixing the base material for roads with additives, such as hydrated lime, can help to prevent excessive shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-7, irrigated; Silty range site; and windbreak suitability group 6G.

AtC—Altvan loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil has gravelly sand at a depth of 20 to 40 inches. It is on side slopes and ridgetops in the uplands and on stream terraces. It formed in loamy sediments. Areas range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 5 inches thick. The subsoil is friable and about 16 inches thick. The upper part is brown clay loam, the next part is pale brown and brown clay loam, and the lower part is very pale brown, calcareous loam. The underlying material to a depth of 60 inches is calcareous. The upper part is light gray fine sandy loam, and the lower part is reddish yellow, light brown, and gray gravelly sand. In some places the surface layer is fine sandy loam. In other places the subsoil contains less clay. In some areas gravelly sand or gravel occurs at shallower depths. In a few areas the gravelly sand is thin and underlain by weakly cemented, fine grained, limy sandstone.

Included with this soil in mapping are small areas of Satanta soils, which have gravelly loamy sand below a depth of 40 inches. They are in landscape positions similar to those of the Altvan soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the solum of the Altvan soil and very rapid in the underlying material. Available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. Some areas support grasses and are used as rangeland. A few small areas are irrigated.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure improve tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion and soil blowing are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If the slopes are uniform, level benches or parallel terraces constructed at a proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If this soil needs to be land leveled, care should be taken not to expose the underlying gravelly sand.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of the underground water supplies. The sides of shallow excavations can cave in unless they are shored. This soil generally is suited to dwellings.

The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Mixing the base material for roads with additives, such as hydrated lime, can help to prevent excessive shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IVe-1, dryland, and IVe-7, irrigated; Silty range site; and windbreak suitability group 6G.

AvD—Altvan-Dix complex, 3 to 9 percent slopes. These very deep, gently sloping and strongly sloping soils are on uplands and stream terraces. The well drained Altvan soil has gravelly coarse sand at a depth of 20 to 40 inches. It formed in loamy sediments on convex ridgetops and side slopes in the uplands and on breaks of stream terraces. The excessively drained Dix soil has gravelly coarse sand at a depth of 10 to 20 inches. It formed in loamy and sandy gravelly sediments on upland ridgetops and stream terraces. Areas range from 10 to 90 acres in size. They are 50 to 70 percent Altvan soil and 20 to 40 percent Dix soil. These two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Altvan soil has a surface layer of grayish brown, friable loam about 7 inches thick. The subsoil is about 26 inches thick. The upper part is grayish brown, friable clay loam; the next part is grayish brown, firm clay loam; the next part is brown, friable loam; and the lowest part is light gray, calcareous loam. The underlying material is light gray to a depth of 60 inches. It is calcareous fine sandy loam in the upper part and gravelly coarse sand in the lower part. In some places the depth to gravelly coarse sand is more than 40 inches. In places the surface layer is fine sandy loam.

Typically, the Dix soil has a surface layer of brown, friable sandy loam about 7 inches thick. The subsurface layer is dark grayish brown and brown, friable sandy loam about 4 inches thick. The transitional layer is brown, friable sandy loam about 7 inches thick. The underlying material to a depth of 60 inches is yellowish brown loamy coarse sand in the upper part, light yellowish brown loamy sand in the next part, light brown gravelly coarse sand in the next part, and light brown and pinkish gray gravelly loamy coarse sand in the lowest part. In some areas the soil contains more clay. In some places the surface layer is lighter in color and less than 10 inches thick.

Included with these soils in mapping are small areas of Alliance soils and outcrops of gravel. Alliance soils have weakly cemented, fine grained, limy sandstone bedrock at a depth of 40 to 60 inches. They are in landscape positions similar to those of the Altvan and Dix soils. The outcrops of gravel are on steep breaks and narrow ridgetops. Included areas make up 10 to 15 percent of the unit.

Permeability in the Altvan soil is moderate in the solum and very rapid in the underlying material. Permeability in the Dix soil is rapid and very rapid. Available water capacity is moderate in the Altvan soil and very low in the Dix soil. Runoff is medium on both soils. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of these soils is used for cultivated crops. Some areas support grasses and are used as rangeland. A few small areas are irrigated.

If used for dryland crops, these soils are poorly suited to winter wheat and millet. Water erosion is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface and the use of cover crops help to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Returning crop residue helps to maintain tilth and increase the organic matter content of these soils and improve the fertility of the Dix soil.

If irrigated, these soils are poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion and soil blowing are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing. The efficient use of irrigation water is a management concern because of the slope. The very low available water capacity of the Dix soil needs to be considered in determining the rate of irrigation water to be applied. A sprinkler irrigation system can be used on these soils. A gravity irrigation system is unsuited to areas of the Altvan soil that have slopes of more than 6 percent. It is unsuited to the Dix soil because of the gravelly coarse sand within a depth of 40 inches. In areas that need to be land leveled, care should be taken not to expose the gravelly coarse sand of the Altvan soil.

These soils are suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland. Brush management may be needed to control undesirable woody plants that invade the site.

The Altvan soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat, and the Dix soil generally is unsuited. Onsite investigation is needed to identify the areas that are best suited to windbreaks. The survival and growth rates of adapted species are fair in areas of the Altvan soil. Water erosion is a severe hazard. The lack of seasonal rainfall is the main limitation. Planting trees on the contour and terracing help to control water erosion. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. These soils generally are suited to dwellings.

The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Mixing the base material for roads with additives, such as hydrated lime, can help to prevent excessive shrinking and swelling. Roads built on these soils need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

These soils are assigned to capability units IVe-1, dryland, and IVe-7, irrigated. The Altvan soil is in the Silty range site, and the Dix soil is in the Shallow to Gravel range site. The Altvan soil is in windbreak suitability group 6G, and the Dix soil is in windbreak suitability group 10.

Bb—Bankard loamy sand, 0 to 2 percent slopes. This very deep, nearly level, somewhat excessively drained soil is on flood plains. It is occasionally flooded. It formed in stratified sandy, calcareous alluvium. Areas are elongated and range from 5 to more than 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loamy sand about 6 inches thick. The underlying material to a depth of 60 inches is stratified brown, grayish brown, and pale brown, calcareous fine sand, loamy very fine sand, loamy sand, and gravelly sand. In some places the underlying material is noncalcareous.

Included with this soil in mapping are small areas of Bayard, Bridget, Dwyer, and Glenberg soils. Bayard and Bridget soils contain more silt and less sand than the Bankard soil. They are not stratified and are higher on the landscape. Dwyer soils are not stratified. They are more uniformly textured than the Bankard soil and are on the steeper, higher, dune-like, adjacent landscapes. Glenberg soils contain more silt and less sand than the Bankard soil. They are in landscape positions similar to those of the Bankard soil. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Bankard soil, and available water capacity is low. Runoff is slow. The organic matter content is low. The water intake rate is very high.

Most of the acreage of this soil supports grasses and is used for grazing or hay. Some of the areas are cultivated.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Soil blowing is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface and the use of cover crops help to control soil blowing and conserve moisture. Stripcropping helps to control soil blowing. Returning crop residue to the soil and applying feedlot manure improve tilth and increase the organic matter content.

If irrigated, this soil is poorly suited to corn and alfalfa. Water can be applied by a sprinkler irrigation system. Soil blowing is a severe hazard. The use of a winter cover crop helps to control soil blowing. A system of conservation tillage, such as disking or chiseling, no-till plant, and till plant, helps keep crop residue on the surface, control soil blowing, and conserve moisture. Returning crop residue and applying manure to the soil improve tilth, organic matter content, and fertility.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 85 percent or more of the total annual forage. Other perennial grasses and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, sedges, and forbs dominate the site. Under these conditions the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.8 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Soil blowing and the scarcity of seasonal rainfall are the main limitations. Maintaining strips of sod or other vegetation between the tree rows helps to control soil blowing. Supplemental moisture can be provided by an irrigation system during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled by cultivation with conventional equipment and by timely applications of the appropriate kind of herbicide.

This soil is not suited to septic tank absorption fields because of the flooding and the poor filtering capacity. This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. This soil is not suited to dwellings or small commercial buildings because of the flooding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by flooding.

This soil is assigned to capability units IVe-5, dryland, and IVe-11, irrigated; Sandy Lowland range site; and windbreak suitability group 7.

Bc—Bankard loamy fine sand, channeled. This very deep, very gently sloping, somewhat excessively drained soil is on flood plains that are dissected by intermittent stream channels, which make up about 30 percent of the unit, are sparsely vegetated, and are lower in elevation. This soil is frequently flooded. It formed in stratified sandy, calcareous alluvium. Areas are long and narrow and range from 5 to more than 100 acres in size. Slopes are mainly 0 to 3 percent.

Typically, the surface layer is grayish brown, very friable, calcareous loamy fine sand about 11 inches thick. The underlying material is pale brown, calcareous, stratified loamy sand, coarse sand, gravelly coarse sand, and gravelly sand to a depth of 60 inches. In some places the surface layer is darker and thicker.

Included with this soil in mapping are small areas of Bayard, Bridget, Dwyer, and Glenberg soils. Bayard and Bridget soils contain more silt and less sand than the Bankard soil. They are not stratified and are higher on the landscape. Dwyer soils are not stratified. They are more uniformly textured than the Bankard soil and are on the steeper, higher, dune-like, adjacent landscapes. Glenberg soils contain more silt and less sand than the Bankard soil. They are in landscape positions similar to those of the Bankard soil. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Bankard soil, and available water capacity is low. Runoff is slow. The organic matter content is low.

Nearly all of the acreage of this soil supports native grasses and is used as rangeland.

This soil is unsuited to farming because of the severe hazard of flooding and the droughtiness. The droughtiness is a result of the low available water capacity. Overcoming the hazard of flooding and the soil limitations by a system of cultivation generally is not practical.

If this soil is used as range, the climax vegetation is dominantly blue grama, needleandthread, prairie sandreed, and sand bluestem. These species make up 65 percent or more of the total annual forage. Sand dropseed, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and prairie sandreed decrease in abundance and are replaced by blue grama, buffalograss, sand dropseed, needleandthread, sedges, and forbs. If overgrazing continues for many years, blue grama, sedges, common pricklypear, fringed sagewort, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 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 out of 3 years helps to keep sand bluestem and prairie sandreed in the plant community. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The low available water capacity and droughtiness are limitations. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

This soil generally is not suited to septic tank absorption fields because of the flooding and the poor filtering capacity. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. This soil is not suited to dwellings and small commercial buildings because of the flooding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by flooding.

This soil is assigned to capability unit VIw-7, dryland; Shallow to Gravel range site; and windbreak suitability group 10.

Be—Bayard fine sandy loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on foot slopes, alluvial fans, and stream terraces. It formed in colluvial and alluvial sediments weathered predominantly from the surrounding weakly cemented, fine grained, limy sandstone. Areas range from 15 to 150 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is very friable, calcareous fine sandy loam about 10 inches thick. The upper part is grayish brown, and the lower part is grayish brown and brown. The transitional layer is pale brown, very friable, calcareous fine sandy loam about 9 inches thick. The underlying material is calcareous fine sandy loam to a depth of 60 inches. The upper part is pale brown and very pale brown, and the lower part is pale brown. In some places carbonates are at or near the surface. In other places the dark surface layer is more than 20 inches thick. In some areas the soil contains more sand. In other areas the subsoil contains more clay and silt.

Included with this soil in mapping are small areas of Bankard, Bridget, and Glenberg soils. Bankard soils have more sand and less silt in the profile than the Bayard soil. They are stratified and are on flood plains. Bridget soils are in landscape positions similar to those of the Bayard soil. They have more silt and less sand in the profile. Glenberg soils are lighter in color than the Bayard soil. They are stratified and are on flood plains. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Bayard soil, and available water capacity is moderate. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used for dryland cultivated crops. Some of the acreage is used as rangeland. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling and disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth and increase the content of organic matter. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing is the main hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling and disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and leaching of nutrients. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses in the tree rows that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide. Restricting cultivation to the tree rows helps to control soil blowing.

This soil generally is suited to septic tank absorption fields, dwellings, and small commercial buildings. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads and streets caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIe-3, dryland, and IIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

BeB—Bayard fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on foot slopes, alluvial fans, and stream terraces. It formed in colluvial and alluvial sediments weathered predominantly from the surrounding weakly cemented, fine grained, limy sandstone. Areas range from 10 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, very friable, calcareous fine sandy loam about 2 inches thick. The transitional layer is pale brown, very friable, calcareous fine sandy loam about 12 inches thick. The underlying material is calcareous to a depth of 60 inches. The upper part is pale brown fine sandy loam, and the lower part is light brownish gray and pale brown loamy fine sand. In some places the surface layer is thinner and lighter in color. In other areas the dark surface layer is more than 20 inches thick. In a few areas the subsoil contains more clay and silt. In some places the soil contains more sand. In other places carbonates are at or near the surface.

Included with this soil in mapping are small areas of Bankard, Bridget, and Glenberg soils. Bankard soils have more sand and less silt in the profile than the Bayard soil. They are stratified and are on flood plains. Bridget soils are in landscape positions similar to those of the Bayard soil. They have more silt and less sand in the profile. Glenberg soils are lighter in color than the Bayard soil. They are stratified and are on flood plains. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Bayard soil, and available water capacity is moderate. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used for dryland cultivated crops. Some of the acreage is used as rangeland. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. 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 that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Contour farming helps to control erosion. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture (fig. 8). Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff, water erosion, and leaching of nutrients. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses in the tree rows that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide. Restricting cultivation to the tree rows helps to control soil blowing. Planting the trees on the contour and terracing help to control runoff and water erosion.

This soil generally is suited to septic tank absorption fields, dwellings, and small commercial buildings. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIe-3, dryland,

Figure 8.—Leaving corn stubble helps to trap snow in winter on Bayard fine sandy loam, 1 to 3 percent slopes, to conserve moisture and control soil blowing.

and IIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

BeC—Bayard fine sandy loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on foot slopes, alluvial fans, and stream terraces. It formed in colluvial and alluvial sediments weathered predominantly from the surrounding weakly cemented, fine grained, limy sandstone. Areas range from 5 to 150 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, very friable, calcareous fine sandy loam about 4 inches thick. The transitional layer is light brownish gray, very friable, calcareous fine sandy loam about 10 inches thick. The underlying material is calcareous fine sandy loam to a depth of 60 inches. The upper part is light brownish gray, and the lower part is pale brown. In some places the subsoil contains more clay and silt. In some areas the surface layer is thinner and lighter in color. In a few areas carbonates are at or near the surface.

Included with this soil in mapping are small areas of Bridget and Canyon soils. Bridget soils are in landscape positions similar to those of the Bayard soil. They contain more silt and less sand in the profile. Canyon soils have weakly cemented, fine grained, limy sandstone bedrock at shallow depths. They are in the higher and steeper areas. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Bayard soil, and available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used for dryland cultivated crops. Some of the acreage is used as rangeland. A few areas are irrigated.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. 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 that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Terraces and contour farming help to control erosion. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff, water erosion, and leaching of nutrients. Timely application and efficient distribution of water are needed. If a sprinkler irrigation system is used, less land preparation is needed. If a gravity irrigation system is used, extensive land leveling is needed to attain a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Overgrazing also can result in a severe hazard of water erosion. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. Water erosion is a hazard. Planting trees on the contour and terracing help to control runoff and water erosion. The weeds and undesirable grasses in the tree rows that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide. Restricting cultivation to the tree rows helps to control soil blowing.

This soil generally is suited to septic tank absorption fields and dwellings. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IVe-3, dryland, and IIIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

BeD—Bayard fine sandy loam, 6 to 9 percent slopes. This very deep, strongly sloping, well drained soil is on foot slopes. It formed in colluvial and alluvial sediments weathered predominantly from the surrounding weakly cemented, fine grained, limy sandstone. Areas range from 5 to 50 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, very friable, calcareous fine sandy loam about 6 inches thick. The transitional layer is light brownish gray, very friable, calcareous fine sandy loam about 11 inches thick. The underlying material is calcareous to a depth of 60 inches. The upper part is light brownish gray fine sandy loam, and the lower part is pale brown loamy fine sand. In some places the subsoil contains more clay and silt. In other places carbonates are at or near the surface. In a few places the soil contains more sand.

Included with this soil in mapping are small areas of Bridget and Canyon soils. Bridget soils are in landscape positions similar to those of the Bayard soil. They contain more silt and less sand in the profile. Canyon soils have weakly cemented, fine grained, limy sandstone bedrock at shallow depths. They are in the higher and steeper areas. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Bayard soil, and available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used as rangeland. Some of the acreage is used for dryland cultivated crops. A few areas are irrigated.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Soil blowing and water erosion are severe hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. Soil blowing and water erosion are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and water erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and use of terraces help to control water erosion and runoff. A gravity irrigation system is unsuited to this soil.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 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. This soil generally is the first to be overgrazed when it is in a pasture that includes Sands or Choppy Sands range sites. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses in the tree rows that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide. Restricting cultivation to the tree rows helps to control soil blowing.

This soil generally is suited to septic tank absorption fields and dwellings. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the roads by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IVe-3, dryland, and IVe-8, irrigated; Sandy range site; and windbreak suitability group 5.

BeE—Bayard fine sandy loam, 9 to 20 percent slopes. This very deep, moderately steep and steep, well drained soil is on foot slopes. It formed in colluvial and alluvial sediments weathered predominantly from the surrounding weakly cemented, fine grained, limy sandstone. Areas range from 10 to 125 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 4 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 6 inches thick. The transitional layer is pale brown, very friable, calcareous fine sandy loam about 10 inches thick. The underlying material is calcareous fine sandy loam to a depth of 60 inches. The upper part is pale brown, and the lower part is very pale brown. In some places the subsoil contains more clay and silt. In other areas the lower parts of the soil profile may contain more sand. In some areas sandstone is below a depth of 40 inches. In some places carbonates are at or near the surface.

Included with this soil in mapping are small areas of Bridget and Canyon soils. Bridget soils have more silt and less sand in the profile than the Bayard soil. They are lower on the landscape. Canyon soils have weakly cemented, fine grained, limy sandstone bedrock at shallow depths. They are higher on the landscape than the Bayard soil. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Bayard soil, and available water capacity is moderate. Runoff is rapid. The organic matter content is moderately low.

Nearly all of the acreage of this soil supports native grasses and is used as rangeland. Very few very small areas are used for cultivated crops.

This soil generally is unsuited to farming because of the slope and soil blowing. Overcoming soil blowing and the slope by a system of cultivation generally is not practical.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 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. This soil generally is the first to be overgrazed when it is in a pasture that includes Sands or Choppy Sands range sites. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Soil blowing and the scarcity of seasonal rainfall are the main limitations. Maintaining strips of sod or other vegetation between the tree rows helps to control soil blowing. The trees need to be planted in shallow furrows with as little disturbance of the soil as possible to prevent damage to the seedlings by windblown sand. Supplemental moisture can be provided by an irrigation system during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

This soil generally is not suited to sanitary facilities because of the steep slope. A suitable alternative site should be selected, or the less sloping areas may be used where land shaping and installing the absorption field on the contour helps to ensure that the system operates properly. The sides of shallow excavations can cave in unless they are shored. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Cutting and filling can provide a suitable grade for roads. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the roads by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability unit VIe-3, dryland; Sandy range site; and windbreak suitability group 7.

Bg—Bridget very fine sandy loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on broad foot slopes, alluvial fans, and stream terraces. It formed in loamy, calcareous, colluvial and alluvial sediments. Areas range from 10 to 120 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous very fine sandy loam about 6 inches thick. The subsurface layer is grayish brown, very friable, calcareous very fine sandy loam about 4 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 5 inches thick. The underlying material to a depth of 60 inches is calcareous silt loam. The upper layer is pale brown, the next layer is very pale brown, the next layer is pale brown, and the lower layer is very pale brown. In some places the dark surface layer is more than 20 inches thick. In other places the soil contains more clay and silt. In some areas the surface layer is lighter in color. In other areas fine sandy loam is below a depth of 30 inches.

Included with this soil in mapping are Bankard, Bayard, and Glenberg soils. Bankard soils have more sand and less silt in the profile than the Bridget soil. They are occasionally flooded and frequently flooded and are on flood plains. Bayard soils are in landscape positions similar to those of the Bridget soil. They have more sand and less silt in the profile. Glenberg soils have more sand and less silt in the profile than the Bridget soil. They are stratified and are on flood plains. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for dryland cultivated crops. Some areas are used as rangeland. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing is the main hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling and disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows.

This soil generally is suited to septic tank absorption fields, dwellings, and small commercial buildings. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and IIe-6, irrigated; Silty range site; and windbreak suitability group 3.

BgB—Bridget very fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on broad foot slopes, alluvial fans, and stream terraces. It formed in loamy, calcareous, colluvial and alluvial sediments. Areas range from 10 to 250 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous very fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, very friable, calcareous very fine sandy loam about 8 inches thick. The transitional layer is light brownish gray, very friable, calcareous very fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is very pale brown, calcareous very fine sandy loam. In some places the dark surface layer is more than 20 inches thick. In other places the soil contains more clay and silt. In some areas the dark surface layer is less than 7 inches thick and is lighter in color. In other areas fine sandy loam is below a depth of 30 inches.

Included with this soil in mapping are Bankard and Bayard soils. Bankard soils are occasionally flooded and frequently flooded. They have more sand and less silt in the profile than the Bridget soil and are on flood plains. Bayard soils are in landscape positions similar to those of the Bridget soil. They have more sand and less silt in the profile. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for dryland cultivated crops. Some areas are used for rangeland. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Contour farming helps to control water erosion. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Water erosion and soil blowing are the principal hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Planting on the contour helps to control water erosion.

This soil generally is suited to septic tank absorption fields, dwellings, and small commercial buildings. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIe-3, dryland, and IIe-6, irrigated; Silty range site; and windbreak suitability group 3.

BgC—Bridget very fine sandy loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on foot slopes. It formed in loamy, calcareous, colluvial and alluvial sediments. Areas range from 10 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous very fine sandy loam about 5 inches thick. The subsurface layer is brown, very friable, calcareous very fine sandy loam about 3 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 9 inches thick. The underlying material to a depth of 60 inches is very pale brown and calcareous. It is very fine sandy loam in the upper part and fine sandy loam in the lower part. In some areas the soil has more clay and silt. In some places the dark surface layer is less than 7 inches thick.

Included with this soil in mapping are small areas of Bayard soils, which are in landscape positions similar to those of the Bridget soil and have more sand and less silt in the profile. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used as rangeland. Some areas are used for cultivated crops. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. 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 that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; wheat; dry, edible beans; and alfalfa. Water can be applied by a sprinkler irrigation system. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve water. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. Water erosion is a hazard. Planting the trees on the contour and terracing help to control water erosion. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows.

This soil generally is suited to septic tank absorption fields and dwellings. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIe-3, dryland, and IIIe-6, irrigated; Silty range site; and windbreak suitability group 3.

BgD—Bridget very fine sandy loam, 6 to 9 percent slopes. This very deep, strongly sloping, well drained soil is on foot slopes. It formed in loamy, calcareous, colluvial and alluvial sediments. Areas range from 10 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous very fine sandy loam about 5 inches thick. The subsurface layer is brown, very friable, calcareous very fine sandy loam about 6 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 3 inches thick. The underlying material to a depth of 60 inches is pale brown, calcareous very fine sandy loam in the upper part and very pale brown, calcareous very fine sandy loam in the lower part. In some places the dark surface layer is less than 7 inches thick. In some areas this soil has more clay and silt. In some places fine sand is below a depth of 30 inches.

Included with this soil in mapping are small areas of Bayard soils and scattered sandstone boulders. Bayard soils are in landscape positions similar to those of the Bridget soil. They have more sand and less silt in the profile. The sandstone boulders generally are scattered on the surface of the soil. They fell from rock outcrops at the higher elevations. Included areas make up about 10 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil supports grasses and is used for grazing or hay. Some of the areas are cultivated.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. A gravity irrigation system is unsuited to this soil because of the slope. Water erosion and soil blowing are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserve moisture. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at a proper grade can help to control erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If this soil needs to be land leveled, care should be taken not to expose the fine sand.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, blue grama, little bluestem, sideoats grama, and western wheatgrass. These species make up 50 percent or more of the total annual forage. Buffalograss, needleandthread, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, western wheatgrass, 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 and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control water erosion. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows.

This soil generally is suited to septic tank absorption fields and dwellings. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IVe-3, dryland, and IVe-6, irrigated; Silty range site; and windbreak suitability group 3.

BuC—Busher fine sandy loam, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on broad convex ridgetops in the uplands. It formed in material weathered from fine grained sandstone. Areas range from 5 to 70 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is very friable fine sandy loam about 13 inches thick. It is brown in the upper part and pale brown in the lower part. The underlying material is loamy very fine sand. It is very pale brown in the upper part and light gray and calcareous in the lower part. White, fine grained sandstone bedrock is at a depth of about 56 inches. In some places the surface layer is thinner and lighter in color. In other places the dark surface layer is more than 20 inches thick. In places the subsoil contains more clay.

Included with this soil in mapping are small areas of Dix, Jayem, and Tassel soils. The excessively drained Dix soils have very gravelly sand at a depth of 10 to 20 inches. They are in the steeper areas. Jayem soils are in landscape positions similar to those of the Busher soil. They do not have free carbonates within a depth of 40 inches and do not have sandstone within a depth of 60 inches. Tassel soils are shallow and have a calcareous surface layer that is lighter in color than that of the Busher soil. They are in the steeper areas. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Busher soil, and available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing is a severe hazard and water erosion is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Contour farming helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade. During land leveling, care should be taken not to expose the underlying sandstone.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive and small blowouts can form. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Soil blowing and water erosion are severe hazards. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Planting the trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

Building up or mounding sites for septic tank absorption fields with suitable fill material improves the filtering capacity of the field. The sides of shallow excavations can cave in unless they are shored. This soil is generally suited to dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded.

This soil is assigned to capability units IIIe-3, dryland, and IIIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

BxD—Busher-Tassel complex, 3 to 9 percent slopes. These gently sloping and strongly sloping, well drained soils are on uplands. The Busher soil is deep, and the Tassel soil is shallow. The Busher soil is on the broader parts of convex ridgetops and on smooth, convex side slopes. The Tassel soil is on narrow ridgetops, sharp slope breaks, and the upper parts of side slopes. These soils formed in material weathered from fine grained sandstone. Areas range from 10 to 140 acres in size. They are 50 to 75 percent Busher soil and 15 to 40 percent Tassel soil. These two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Busher soil has a surface layer of grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is very friable fine sandy loam about 13 inches thick. The upper part is grayish brown, and the lower part is brown. The subsoil is brown, very friable, calcareous fine sandy loam about 12 inches thick. The underlying material to a depth of 45 inches is very pale brown and calcareous. The upper part is fine sandy loam, and the lower part is loamy very fine sand. To a depth of 60 inches it is calcareous, weakly cemented, fine grained sandstone bedrock. In some places the surface layer contains more sand and is lighter in color. In other places the carbonates are leached from the profile, and the subsoil contains more clay. In some areas the soil is moderately deep to sandstone bedrock.

Typically, the Tassel soil has a surface layer of light brownish gray, very friable, calcareous fine sandy loam about 5 inches thick. The underlying material is pale brown, calcareous fine sandy loam about 12 inches thick. To a depth of 60 inches it is white, fine grained sandstone bedrock. In some places the surface layer is darker. In other places the depth to sandstone bedrock is less than 6 inches. In some areas the soil contains more clay.

Included with these soils in mapping are small areas of Dix and Duroc soils and outcrops of sandstone. The excessively drained Dix soils have very gravelly sand at a depth of 10 to 20 inches. They are in landscape positions similar to those of the Busher and Tassel soils. Duroc soils have more clay and less sand in the profile than the Busher and Tassel soils. They have a dark surface layer that is more than 20 inches thick and are in upland swales and on side slopes near drainageways. The outcrops of sandstone are on narrow ridgetops and sharp slope breaks. Included areas make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Busher and Tassel soils. Runoff is medium on both soils. Available water capacity is moderate in the Busher soil and very low in the Tassel soil. The organic matter content is moderately low in the Busher soil and low in the Tassel soil. The root zone is deep in the Busher soil and shallow in the Tassel soil.

Most of the acreage of these soils supports native grasses and is used as rangeland. Some areas are used for farming, and nearly all of the farming is for dryland crops.

If used for dryland crops, these soils are poorly suited to winter wheat and millet. Soil blowing and water erosion are severe hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching, and the use of cover crops help keep crop residue on the surface and help to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Returning crop residue to these soils improves tilth and maintains the organic matter content.

If irrigated, these soils are poorly suited to such crops as corn; dry, edible beans; and alfalfa. Water can be applied by a sprinkler irrigation system. Soil blowing and water erosion are severe hazards. A winter cover crop helps to control soil blowing. The very low available water capacity of the shallow Tassel soil needs to be considered when irrigation water is applied. A system of conservation tillage, such as disking or chiseling, no-till plant, and till plant, helps keep crop residue on the surface, control soil blowing and water erosion, and conserve moisture. Returning crop residue to these soils helps to maintain and improve tilth and fertility.

If the Busher soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the Tassel soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, sand bluestem, and threadleaf sedge. These species make up 55 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and sand bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 animal unit month per acre on the Busher soil and 0.3 animal unit month per acre 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. These soils generally are the first to be overgrazed when they are in a pasture that includes the Sands range site. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If the Busher soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

The Busher soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion and soil blowing are severe hazards. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Planting the trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

The Tassel soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

On the Busher soil, building up or mounding sites for septic tank absorption fields with suitable fill material improves the filtering capacity of the field. The sides of shallow excavations can cave in unless they are shored. The Busher soil is generally suited to dwellings and roads, except in areas where the slope is more than 8 percent. In these areas dwellings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. Cutting and filling can provide a suitable grade for roads.

The Tassel soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. The soft bedrock can be excavated, and in areas of the Tassel soil that have slope of more than 8 percent, cutting and filling are needed to provide a suitable grade for roads.

These soils are assigned to capability unit IVe-3, dryland, and IVe-8, irrigated. The Busher soil is in the Sandy range site, and the Tassel soil is in the Shallow Limy range site. The Busher soil is in windbreak suitability group 5, and the Tassel soil is in windbreak suitability group 10.

ByE—Busher-Tassel complex, 9 to 20 percent slopes. These moderately steep and steep, well drained soils are on uplands. The Busher soil is deep, and the Tassel soil is shallow. The Busher soil is on ridgetops and convex side slopes. The Tassel soil is on narrow ridges, sharp slope breaks, and dissected side slopes. These soils formed in material weathered from fine grained sandstone. Areas range from 10 to 200 acres in size. They are 45 to 70 percent Busher soil and 20 to 45 percent Tassel soil. These two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Busher soil has a surface layer of dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsurface layer is brown, very friable fine sandy loam about 7 inches thick. The subsoil is brown, very friable fine sandy loam about 13 inches thick. The underlying material is pale brown, calcareous fine sandy loam about 13 inches thick. To a depth of 60 inches it is light gray, fine grained sandstone bedrock. In some places the carbonates are leached from the profile. In other places the subsoil contains more clay. In some areas the soil is moderately deep to sandstone bedrock.

Typically, the Tassel soil has a surface layer of dark brown, very friable loamy very fine sand about 3 inches thick. The subsurface layer is brown, very friable, calcareous loamy very fine sand about 3 inches thick. The underlying material is pale brown, calcareous loamy very fine sand to a depth of 18 inches. To a depth of 60 inches it is very pale brown, calcareous fine grained sandstone bedrock. In some places the depth to sandstone bedrock is less than 6 inches. In other places the soil contains more clay.

Included with these soils in mapping are small areas of Dix and Duroc soils and outcrops of sandstone bedrock. Dix soils have very gravelly sand within a depth of 20 inches. They are on small knobs at higher elevations. Duroc soils have a dark surface layer that is more than 20 inches thick. They have more clay and less sand in the profile than the Busher and Tassel soils and are in small upland swales. The outcrops of sandstone bedrock are on narrow ridgetops and sharp slope breaks. Included areas make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Busher and Tassel soils. Runoff is medium on both soils. Available water capacity is moderate in the Busher soil and very low in the Tassel soil. The organic matter content is moderately low in the Busher soil and low in the Tassel soil. The root zone is shallow in the Tassel soil and deep in the Busher soil.

Nearly all of the acreage of these soils supports native grasses and is used as rangeland. A few small areas have scattered trees.

These soils generally are unsuited to farming because of the slope, soil blowing, and water erosion. Overcoming soil blowing, water erosion, and the slope by a system of cultivation generally is not practical.

If the Busher soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the Tassel soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, sand bluestem, and threadleaf sedge. These species make up 55 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and sand bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 animal unit month per acre on the Busher soil and 0.3 animal unit month per acre 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. These soils generally are the first to be overgrazed when they are in a pasture that includes the Sands range site. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In some areas brush management may be needed to control the woody plants that invade the site.

If the Busher soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

The Busher soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion and soil blowing are severe hazards. Planting trees on the contour and maintaining strips of sod between the rows help to control soil blowing and water erosion. Trees need to be planted in shallow furrows with as little disturbance of the soil as possible. The lack of seasonal rainfall is the main limitation. An irrigation system can supply water needed during periods of insufficient moisture. The weeds and undesirable grasses in the tree rows that compete with the trees for moisture can be controlled by cultivation with conventional equipment and timely applications of the appropriate herbicide.

The Tassel soil generally is unsuited to the trees and shrubs grown as windbreaks or to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

On the Busher soil, building up or mounding sites for septic tank absorption fields with suitable fill material improves the filtering capacity of the field. In areas of this soil that have slope of less than 15 percent, land shaping and installing the absorption field on the contour helps to ensure that the system operates properly. On slopes of more than 15 percent, this soil generally is not suitable for sanitary facilities because of the steep slope. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. Dwellings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. Cutting and filling can provide a suitable grade for roads.

The Tassel soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. The soft bedrock generally can be easily excavated during the construction of dwellings with basements. Dwellings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. The soft bedrock can be excavated, and cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit VIe-3, dryland. The Busher soil is in the Sandy range site, and the Tassel soil is in the Shallow Limy range site. The Busher soil is in windbreak suitability group 7, and the Tassel soil is in windbreak suitability group 10.

CcF—Canyon fine sandy loam, 6 to 30 percent slopes. This shallow, strongly sloping to steep, well drained soil is on narrow ridgetops and convex shoulders of dissected side slopes in the uplands. It formed in material weathered from weakly cemented, fine grained, limy sandstone. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous fine sandy loam about 6 inches thick. The underlying material to a depth of 11 inches is pale brown, calcareous gravelly loam. To a depth of 60 inches it is white and light gray, weakly cemented, fine grained, limy sandstone bedrock. In some areas the depth to sandstone bedrock is more than 60 inches. In a few small areas the slope may be less than 6 or more than 30 percent. In some places the soil contains less clay.

Included with this soil in mapping are small areas of

Rosebud and Sidney soils and areas of rock outcrop. Rosebud soils have more clay in the subsoil than the Canyon soil. They are moderately deep to weakly cemented, fine grained, limy sandstone bedrock and are higher on the landscape. Sidney soils have weakly cemented, fine grained, limy sandstone bedrock at a depth of 40 to 60 inches. They are on the lower part of side slopes. The areas of rock outcrop are bare exposures of sandstone. They generally are on the steepest parts of the landscape. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the Canyon soil, and available water capacity is very low. Runoff is rapid. The organic matter content is low. The root zone is shallow.

Nearly all of the acreage of this soil is used as rangeland. This soil is unsuited to dryland or irrigated farming because of the slope, a shallow root zone, and the hazard of erosion.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Other grasses and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is excellent condition, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. In some areas brush management may be needed to control the woody plants that invade the site.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

This soil generally is not suited to septic tank absorption fields because of the steep slopes and the shallowness to bedrock. A suitable alternative site should be selected. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. Cutting and filling generally can provide a suitable grade for roads. The soft bedrock can be excavated during the construction of roads.

This soil is assigned to capability unit VIs-4, dryland; Shallow Limy range site; and windbreak suitability group 10.

CdG—Canyon-Rock outcrop complex, 11 to 60 percent slopes. This map unit consists of a moderately steep, steep, and very steep, well drained, shallow Canyon soil and areas of Rock outcrop on uplands. The Canyon soil is on 11 to 45 percent slopes, which are the less sloping areas of narrow ridgetops and dissected side slopes. It formed in material weathered from weakly cemented, fine grained, limy sandstone. The areas of Rock outcrop consist of fine grained, limy sandstone. They are on the steeper part of ridgetops and dissected side slopes. Areas range from 10 to more than 400 acres in size. They are 40 to 60 percent Canyon soil and 30 to 50 percent areas of Rock outcrop.

Typically, the Canyon soil has a surface layer of dark grayish brown, very friable, calcareous fine sandy loam about 5 inches thick. The transitional layer is brown, very friable, calcareous fine sandy loam about 5 inches thick. The underlying material is pale brown, calcareous loam to a depth of 14 inches. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In some areas the depth to sandstone bedrock is more than 60 inches. In a few areas the slope may be less than 11 percent. In a few areas the soil contains less clay.

Typically, the areas of Rock outcrop consist of fine grained, limy sandstone. Thin to thick layers of strongly cemented sandstone alternate with layers of weakly cemented sandstone. In some places outcrops of gravel are at similar elevations. In other places outcrops of calcareous siltstone are at slightly lower elevations.

Included with this unit in mapping are small areas of the well drained Bayard, Rosebud, and Sidney soils. Bayard soils do not have sandstone bedrock within a depth of 60 inches. They are on foot slopes. Rosebud soils have more clay in the subsoil than the Canyon soil. They have weakly cemented, fine grained, limy sandstone bedrock at a depth of 20 to 40 inches and are higher on the landscape. Sidney soils have weakly cemented, fine grained, limy sandstone bedrock below a depth of 40 inches. They are on the lower part of side slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Canyon soil, and available water capacity is very low. The organic matter content is low in the Canyon soil. Runoff is rapid in the Canyon soil and very rapid in areas of Rock outcrop. The root zone is shallow in the Canyon soil.

All the acreage of this complex supports native grasses and is used as rangeland (fig. 9). Many areas

Figure 9.—An area of Canyon-Rock outcrop complex, 11 to 60 percent slopes, used as rangeland.

support only sparse vegetation.

The soils in this unit are unsuited to dryland or irrigated farming because of the slope, a shallow root zone, the hazard of erosion, and the high percentage of Rock outcrop.

If the Canyon soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Other grasses and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock from one area to another. In some areas brush management may be needed to control the woody plants that invade the site.

The Canyon soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

This unit generally is not suited to septic tank absorption fields because it is shallow over bedrock and because of the steep and very steep slopes. A suitable alternative site should be selected. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. Cutting and filling can provide suitable grades for roads. The soft bedrock generally can be excavated during the construction of roads.

This unit is assigned to capability unit VIIs-4, dryland. The Canyon soil is in the Shallow Limy range site and windbreak suitability group 10. The Rock outcrop is not assigned interpretive groupings.

CeE—Canyon-Bayard complex, 6 to 20 percent slopes. These strongly sloping to steep, well drained soils are on uplands and foot slopes. The Canyon soil is shallow, and the Bayard soil is very deep. The Canyon soil is on sharp slope breaks and narrow upland ridges. The Bayard soil is on foot slopes. The Canyon soil formed in material weathered from weakly cemented, fine grained, limy sandstone. The Bayard soil formed in colluvial and alluvial sediments weathered predominantly from weakly cemented, fine grained, limy sandstone. Areas range from 5 to more than 500 acres in size. They are 40 to 60 percent Canyon soil and 30 to 50 percent Bayard soil. The two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Canyon soil has a surface layer of dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The transitional layer is grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The underlying material is light brownish gray, calcareous gravelly loam to a depth of 11 inches. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. It is very pale brown and light brownish gray. In some places the depth to sandstone bedrock is more than 60 inches.

Typically, the Bayard soil has a surface layer of grayish brown, very friable fine sandy loam about 12 inches thick. The transitional layer is grayish brown, very friable, calcareous fine sandy loam about 5 inches thick. The underlying material to a depth of 60 inches is calcareous. The upper part is light brownish gray fine sandy loam, the next part is light gray very fine sandy loam, and the lowest part is light gray fine sandy loam. In some places sandstone is within a depth of 60 inches. In other places carbonates are at or near the surface.

Included with these soils in mapping are small areas of Rosebud and Sidney soils and areas of Rock outcrop. Rosebud soils have more clay in the subsoil than the Canyon and Bayard soils. They have weakly cemented, fine grained, limy sandstone bedrock at a depth of 20 to 40 inches and are higher on the landscape. Sidney soils have weakly cemented, fine grained, limy sandstone bedrock at a depth of 40 to 60 inches. They are in landscape positions similar to those of the Bayard soil. The areas of Rock outcrop are on narrow ridgetops and on sharp slope breaks. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the Canyon soil and moderately rapid in the Bayard soil. Available water capacity is very low in the Canyon soil and moderate in the Bayard soil. Runoff is medium on both soils. The organic matter content is low in the Canyon soil and moderately low in the Bayard soil. The root zone is shallow in the Canyon soil and deep in the Bayard soil.

Nearly all of the acreage of these soils supports native grasses and is used as rangeland (fig. 10).

These soils generally are unsuited to farming because of the moderately steep and steep slope. Overcoming the slope by a system of cultivation generally is not practical.

If the Canyon soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Other grasses and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the Bayard soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition on the Canyon soil, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution

Figure 10.—Canyon-Bayard complex, 6 to 20 percent slopes, is used mainly as rangeland.

of grazing. In some areas brush management may be needed to control the woody plants that invade the site.

If the range is in excellent condition on the Bayard soil, the suggested initial stocking rate is 0.5 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If the Bayard soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

The Canyon soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. In areas of the Bayard soil where the slope is as much as 15 percent, land shaping and installing the distribution lines on the contour help to ensure that the absorption fields function properly. On slopes of more than 15 percent, the Bayard soil generally is not suited to sanitary facilities. A suitable alternative site should be selected. The sides of shallow excavations in the Bayard soil can cave in unless they are shored. On the Canyon soil, the soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. On both soils, buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. On the Canyon soil, the bedrock needs to be excavated during the construction of roads. On the Bayard soil, a good surface drainage system can minimize the damage to roads and streets caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. On both soils, cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit VIs-4, dryland. The Canyon soil is in the Shallow Limy range site, and the Bayard soil is in the Sandy range site. These soils are in windbreak suitability group 10.

CtB—Creighton very fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. It formed in calcareous eolian material. Areas range from 5 to 70 acres in size.

Typically, the surface layer is brown, very friable very fine sandy loam about 6 inches thick. The subsurface layer is brown, very friable very fine sandy loam about 5 inches thick. The subsoil is very friable very fine sandy loam about 29 inches thick. The upper part is brown, and the lower part is light yellowish brown and calcareous. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 60 inches. In some places loamy very fine sand and fine sand is below a depth of 40 inches. In other places the soil is free of carbonates at a depth of more than 20 inches. In some areas a dark surface soil is below a depth of 20 inches. In some areas sandstone is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Alliance and Keith soils. The included soils are in landscape positions similar to those of the Creighton soil. They have more clay and silt than the Creighton soil. Alliance soils have weakly cemented, fine grained, limy sandstone bedrock at a depth of 40 to 60 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Creighton soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are used for irrigated crops. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control water erosion. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Water erosion is a hazard. Planting on the contour helps to control water erosion.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. This soil generally is suited to dwellings and roads.

This soil is assigned to capability units IIe-3, dryland, and IIe-6, irrigated; Silty range site; and windbreak suitability group 3.

CtC—Creighton very fine sandy loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. It formed in calcareous eolian material. Areas range from 5 to 60 acres in size.

Typically, the surface layer is grayish brown, very friable very fine sandy loam about 5 inches thick. The subsurface layer is grayish brown, very friable very fine sandy loam about 5 inches thick. The subsoil is very friable very fine sandy loam about 20 inches thick. The upper part is brown, and the lower part is pale brown and very pale brown and calcareous. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 60 inches. In some places the soil is free of carbonates at a depth of more than 20 inches. In other places sandstone is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Alliance and Keith soils. The included soils are in landscape positions similar to those of the Creighton soil. They have more clay and silt than the Creighton soil. Alliance soils have weakly cemented, fine grained, limy sandstone bedrock at a depth of 40 to 60 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Creighton soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. Water erosion is the main hazard. Erosion can be controlled by planting trees on the contour and terracing. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. This soil generally is suited to dwellings and roads.

This soil is assigned to capability units IIIe-3, dryland, and IIIe-6, irrigated; Silty range site; and windbreak suitability group 3.

DhD—Dix gravelly loam, 3 to 11 percent slopes. This very deep, gently sloping to moderately steep, excessively drained soil is on narrow ridgetops and convex shoulders of dissected side slopes on uplands and stream terraces. Very gravelly sand is at a depth of 10 to 20 inches. This soil formed in gravelly sediments. Areas range from 5 to more than 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable gravelly loam about 6 inches thick. The transitional layer is brown, very friable gravelly loam about 5 inches thick. The underlying material to a depth of 60 inches is brown gravelly loamy coarse sand in the upper part and pale brown very gravelly sand in the lower part. In some areas the soil contains more clay. In other areas the slope may be more than 11 percent.

Included with this soil in mapping are small areas of Altvan, Canyon, and Rosebud soils. Altvan soils have gravelly sand at a depth of 20 to 40 inches. They have more clay in the subsoil than the Dix soil and are in the less sloping areas. Canyon soils are shallow to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Dix soil. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They contain more clay in the subsoil than the Dix soil and are in the less sloping areas. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the solum of the Dix soil and very rapid in the underlying material. Available water capacity is very low. Runoff is medium. The organic matter content is moderately low. The root zone is shallow.

Nearly all of the acreage of this soil is used as rangeland. A few small areas are cultivated. This soil is unsuited to dryland or irrigated farming because of a shallow root zone and the hazard of erosion.

If this soil is used as range, the climax vegetation is dominantly blue grama, little bluestem, needleandthread, and sand bluestem. These species make up 60 percent or more of the total annual forage. Sand dropseed, other perennial grasses, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by blue grama, sand dropseed, needleandthread, and forbs. If overgrazing continues for many years, blue grama, sedges, common pricklypear, fringed sagewort, and other forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.4 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 out of 3 years helps keep little bluestem in the plant community. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The very low available water capacity and droughtiness are limitations. The amount of forage produced depends on the frequency and amount of seasonal rainfall. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. If trees and shrubs are planted, their survival or growth is severely limited by the shallow root zone. Onsite investigation is needed to identify the areas that are best suited to windbreaks.

The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. The soil generally is suited to dwellings and roads, except in areas where the slope is more than 8 percent. In these areas dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Cutting and filling can provide a suitable grade for roads.

This soil is assigned to capability unit VIs-4, dryland; Shallow to Gravel range site; and windbreak suitability group 10.

DhG—Dix gravelly loam, 11 to 50 percent slopes. This very deep, moderately steep to very steep, excessively drained soil is on narrow ridgetops and convex shoulders of dissected side slopes on uplands and stream terraces. Gravelly coarse sand is at a depth of 10 to 20 inches. This soil formed in gravelly sediments. Areas range from 5 to more than 500 acres in size.

Typically, the surface layer is dark brown, very friable gravelly loam about 6 inches thick. The transitional layer is brown and dark yellowish brown, very friable gravelly loam about 4 inches thick. The underlying material is gravelly coarse sand to a depth of 60 inches. The upper part is yellowish brown, and the lower part is light yellowish brown. In some areas the soil contains more clay. In other areas an accumulation of carbonates is present in the underlying material. In a few small areas the slope is less than 11 percent.

Included with this soil in mapping are small areas of Altvan, Bankard, Canyon, and Tassel soils. Altvan soils contain more clay in the subsoil than the Dix soil. They have gravelly sand at a depth of 20 to 40 inches and are in the less sloping areas. Bankard soils are calcareous and stratified and are on flood plains.

Canyon and Tassel soils are calcareous and shallow to weakly cemented, fine grained, limy sandstone bedrock. They are in landscape positions similar to those of the Dix soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the solum of the Dix soil and very rapid in the underlying material. Available water capacity is very low. Runoff is medium. The organic matter content is moderately low.

Nearly all of the acreage of this soil is used as rangeland. This soil is unsuited to dryland or irrigated farming because of the steep and very steep slopes and the hazard of erosion.

If this soil is used as range, the climax vegetation is dominantly blue grama, little bluestem, needleandthread, and sand bluestem. These species make up 60 percent or more of the total annual forage. Sand dropseed, other perennial grasses, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by blue grama, sand dropseed, needleandthread, and forbs. If overgrazing continues for many years, blue grama, sedges, common pricklypear, fringed sagewort, and other forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 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 out of 3 years helps keep little bluestem in the plant community. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The very low available water capacity and droughtiness are limitations. The amount of forage produced depends on the frequency and amount of seasonal rainfall.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. If trees and shrubs are planted, their survival or growth are severely limited by the very low available water capacity and the moderately steep and steep slopes. The steep and very steep slopes prevent the use of conventional tree planting and tillage equipment.

This soil generally is not suited to septic tank absorption fields because of the steep and very steep slopes. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. Dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Cutting and filling can provide a suitable grade for roads.

This soil is assigned to capability unit VIIs-4, dryland; Shallow to Gravel range site; and windbreak suitability group 10.

Du—Duroc loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on slightly concave parts of alluvial fans and in upland swales. It formed in alluvial sediment and eolian material. 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 dark grayish brown, friable loam about 13 inches thick. The subsoil is friable and about 36 inches thick. It is grayish brown loam in the upper part; grayish brown, calcareous silt loam in the next part; and brown and dark grayish brown, calcareous silt loam in the lower part. The underlying material is very pale brown, calcareous loam to a depth of 60 inches. In some areas the soil contains more sand, and in other areas it contains more clay. In places it has buried horizons.

Included with this soil in mapping are small areas of Keith and Lodgepole soils. Keith soils contain more clay in the subsoil than the Duroc soil. They have dark upper layers within a depth of 20 inches and are slightly higher on the landscape. Lodgepole soils contain more clay in the subsoil than the Duroc soil. They are deeper to carbonates and are in depressions. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Duroc soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderate.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler system is used. Timely application and efficient distribution of water is needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The weeds and undesirable grasses that compete with trees for moisture can be controlled by cultivation with conventional equipment between the tree rows and by hoeing by hand, rototilling, and applying the appropriate herbicide in the row.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and I-6, irrigated; Silty range site; and windbreak suitability group 1.

DuB—Duroc loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on slightly concave parts of alluvial fans and side slopes near drainageways. It formed in alluvial sediment and eolian material. Areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is dark grayish brown, friable, and about 29 inches thick. The upper part is loam, and the lower part is silt loam. The transitional layer is brown, friable, calcareous silt loam about 9 inches thick. The underlying material is calcareous silt loam to a depth of 60 inches. It is pale brown in the upper part and very pale brown in the lower part. In some areas the soil contains more clay. In other areas the soil contains more sand. In a few small areas the soil has a buried horizon.

Included with this soil in mapping are small areas of Alliance and Keith soils. The included soils are in landscape positions slightly higher than those of the Duroc soil. Alliance soils contain more clay in the subsoil than the Duroc soil. They have dark upper layers within a depth of 20 inches and have weakly cemented, fine grained, limy sandstone bedrock below the underlying material. Keith soils contain more clay in the subsoil than the Duroc soil and have dark upper layers within a depth of 20 inches. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Duroc soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderate.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the organic matter content. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the organic matter content. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row helps distribute water evenly, control erosion, and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Planting on the contour helps to control water erosion.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIe-1, dryland, and IIe-6, irrigated; Silty range site; and windbreak suitability group 3.

Dv—Duroc loam, terrace, gravelly substratum, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on stream terraces. It formed in 40 to 60 inches of alluvial sediment and eolian material over gravelly and sandy sediments. Areas range from 40 to about 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 7 inches thick. The subsurface layer is dark grayish brown, friable loam about 3 inches thick. The subsoil is friable and about 19 inches thick. The upper part is dark grayish brown clay loam, the next part is grayish brown clay loam, and the lower part is grayish brown, calcareous clay loam. The underlying material to a depth of 49 inches is light gray and very pale brown, calcareous loam. To a depth of 60 inches or more it is very pale brown, calcareous gravelly sand. In some places the dark upper layers are less than 20 inches thick. In other places this soil has a darker buried layer in the subsoil. In a few areas this soil does not have gravelly sand in the underlying material.

Included with this soil in mapping are small areas of Altvan and Bayard soils. The included soils are in landscape positions slightly higher than those of the Duroc soil. Altvan soils have more clay in the subsoil than the Duroc soil. They have gravelly sand at a depth of 20 to 40 inches. Bayard soils have less clay and more sand than the Duroc soil. They have dark upper layers within a depth of 20 inches. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the solum of the Duroc soil and very rapid in the lower part of the underlying material. Available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderate.

Nearly all of the acreage of this soil is used for cultivated crops. Much of the area is irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIc-1, dryland, and I-6, irrigated; Silty range site; and windbreak suitability group 3.

Dx—Duroc silt loam, terrace, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on broad, low fans and stream terraces. It formed in alluvial sediment and eolian material. Areas range from 20 to more than 400 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable, calcareous silt loam about 2 inches thick. The subsoil is friable, calcareous silt loam about 33 inches thick. The upper part is dark grayish brown, the next part is grayish brown, and the lower part is pale brown. The underlying material to a depth of 60 inches is pale brown, calcareous silt loam. In some areas this soil has a buried horizon. In other areas this soil is calcareous at or near the surface. In some places the dark upper layers are less than 20 inches thick. In other places the subsoil is silty clay loam or clay loam.

Included with this soil in mapping are small areas of Bayard and Glenberg soils. The included soils have less silt and more sand than the Duroc soil. Bayard soils have dark upper layers within a depth of 20 inches and are slightly higher on the landscape. Glenberg soils are stratified and are on flood plains. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Duroc soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderate.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. Supplemental water for seedlings may be needed during periods of scarce rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivating with conventional equipment between the tree rows and by hoeing by hand, rototilling, and applying the appropriate herbicide in the row.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIc-1, dryland, and I-6, irrigated; Silty range site; and windbreak suitability group 1.

DyE—Dwyer loamy fine sand, 9 to 17 percent slopes. This very deep, moderately steep, excessively drained soil is on dune like formations on the edges of alluvial terraces near the larger drainageways. It formed in eolian sand. Areas range from 4 to 50 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loamy fine sand about 4 inches thick. The underlying material to a depth of 60 inches is calcareous. The upper part is brown loamy fine sand, and the lower part is pale brown fine sand. In some areas the soil is darker.

Included with this soil in mapping are small areas of Bankard, Bayard, Bridget, and Glenberg soils. Bankard and Glenberg soils are stratified and are on flood plains. Bayard and Bridget soils contain more silt and less sand than the Dwyer soil. They are on terraces and foot slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Dwyer soil. Available water capacity is low. Runoff is slow. The organic matter content is moderately low.

Most of the acreage of this soil is used as rangeland. This soil generally is not suited to dryland or irrigated cultivated crops because of the slope, the sandy texture, and the very severe hazard of erosion.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, prairie sandreed, and needleandthread. These species make up 45 percent or more of the total annual forage. Blue grama, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand lovegrass and little bluestem decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Soil blowing and the scarcity of seasonal rainfall are the main limitations. Maintaining strips of sod or other vegetation between the tree rows helps to control soil blowing. The trees need to be planted in shallow furrows with as little disturbance of the soil as possible to prevent damage to the seedlings from windblown sand. Supplemental moisture can be provided by an irrigation system during periods of scarce rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Dwellings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Cutting and filling can provide a suitable grade for roads.

This soil is assigned to capability unit VIe-5, dryland; Sands range site; and windbreak suitability group 7.

ErE—Epping-Mitchell complex, 3 to 20 percent slopes. These gently sloping to steep, well drained soils are on uplands and foot slopes. The Epping soil is shallow, and the Mitchell soil is very deep. The Epping soil is on sharp slope breaks and narrow ridgetops and formed in loamy material weathered from siltstone containing volcanic ash. The Mitchell soil is on foot slopes and alluvial and valley side slopes and formed in colluvial and alluvial sediments weathered from siltstone. Areas are long and narrow and range from 10 to 100 acres in size. They are 40 to 60 percent Epping soil and 30 to 50 percent Mitchell soil. The two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Epping soil has a surface layer of pale brown, very friable and friable, calcareous loam about 5 inches thick. The underlying material is very pale brown, calcareous loam to a depth of 13 inches. To a depth of 60 inches it is very pale brown, calcareous siltstone bedrock. In some areas siltstone rock fragments and granitic pebbles are present on the surface.

Typically, the Mitchell soil has a surface layer of grayish brown, very friable, calcareous very fine sandy loam about 4 inches thick. The subsurface layer is brown, very friable, calcareous very fine sandy loam about 5 inches thick. The transitional layer is very friable, calcareous very fine sandy loam about 10 inches thick. The upper part is pale brown, and the lower part is very pale brown. The underlying material to a depth of 60 inches is calcareous very fine sandy loam. The upper part is very pale brown, and the lower part is pale brown. In some areas the soil contains more clay and less silt in the profile. In other areas calcareous siltstone is within a depth of 60 inches. In some places the soil has a thicker dark surface layer.

Included with these soils in mapping are small areas of Altvan soils and areas of rock outcrop. Altvan soils have gravelly sand at a depth of 20 to 40 inches. They have a thicker, darker surface layer and more clay in the subsoil than the Epping and Mitchell soils. They are slightly lower on the landscape. The areas of rock outcrop consist of siltstone. They are on knobs, the steeper side slopes, and narrow ridges. Included areas make up about 5 to 10 percent of the unit.

Permeability is moderate in the Epping and Mitchell soils. Available water capacity is very low in the Epping soil and high in the Mitchell soil. Runoff is rapid in both soils. The organic matter content is low in both soils. The root zone is shallow in the Epping soil and deep in the Mitchell soil.

Nearly all of the acreage in this map unit supports native grasses and is used as rangeland (fig. 11). A few incidental acres are used as cropland.

These soils generally are unsuited to farming because of the moderately steep and steep slope, the droughtiness of the shallow Epping soil, and soil blowing. Overcoming soil blowing and the slope by a system of cultivation generally is not practical.

If the Epping soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, and threadleaf sedge. These species make up 65 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by sideoats grama, blue grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the Mitchell soil is used as range or hayland, the climax vegetation is dominantly little bluestem, sideoats grama, and blue grama. These species make up 40 percent or more of the total annual forage. Buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by hairy grama, prairie sandreed, western wheatgrass, needleandthread, plains muhly, sedges, 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 excessive.

If the range is in excellent condition on the Epping soil, the suggested stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. In some areas brush management may be needed to control the woody plants that invade the site.

If the range is in excellent condition on the Mitchell soil, the suggested initial stocking rate is 0.4 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. Properly located fences and livestock

Figure 11.—An area of Epping-Mitchell complex, 3 to 20 percent slopes, used as rangeland.

watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If the Mitchell soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

The Epping soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

The Mitchell soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Only tree and shrub species that can tolerate a high amount of calcium in the soil should be planted. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control runoff and water erosion. A lack of seasonal rainfall is the main limitation. An irrigation system can provide supplemental moisture needed during periods of scarce rainfall. Cultivation between the rows and careful use of the appropriate herbicide in the row help to control undesirable grasses and weeds.

The Epping soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. The soft bedrock needs to be excavated, and cutting and filling can provide a suitable grade for roads.

In areas of the Mitchell soil that have slope of less than 15 percent, land shaping and installing the absorption field on the contour helps to ensure that the system operates properly. In areas that have slope of more than 15 percent, the Mitchell soil generally is not suited to sanitary facilities. A suitable alternative site should be selected. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit VIs-4, dryland. The Epping soil is in the Shallow Limy range site and windbreak suitability group 10. The Mitchell soil is in the Limy Upland range site and windbreak suitability group 8.

Gd—Glenberg fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on flood plains. It is subject to rare flooding. It formed in stratified, calcareous alluvial sediment derived from mixed sources. Areas are elongated and range from 5 to 120 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is stratified light brownish gray, light gray, and grayish brown, calcareous fine sandy loam, loamy fine sand, very fine sandy loam, and silt loam. In some places the soil has buried horizons in the lower part.

Included with this soil in mapping are small areas of Bankard, Bayard, Bridget, and Dwyer soils. Bankard soils are in landscape positions similar to those of the Glenberg soil. They have more sand and less silt in the profile. Bayard and Bridget soils have a thicker dark surface layer than that of the Glenberg soil. They are not stratified and are higher on the landscape. Also, Bridget soils have more silt in the control section than the Glenberg soil. Dwyer soils are not stratified. They are more uniformly textured than the Glenberg soil and are on the steeper, higher, dune-like formations on bottom land. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Glenberg soil, and available water capacity is moderate. Runoff is slow. The organic matter content is low. The water intake rate is moderately high.

Most of the acreage of this soil is used as rangeland. Some of the acreage is dry-farmed. A few areas are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth and increase the content of organic matter. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing is the main hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increases the organic matter content, and improves the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and leaching of nutrients. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. A tailwater recovery system can be constructed to conserve water.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, prairie sandreed, and needlegrass. These species make up 50 percent or more of the total annual forage. Blue grama, sedges, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, sedges, and forbs dominate the site. Under these conditions the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.8 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. Supplemental water for seedlings may be needed during periods of scarce rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment between the tree rows and by hoeing by hand, rototilling, and applying the appropriate herbicide in the row.

The flooding is a hazard on sites for septic tank absorption fields. The sides of shallow excavations can cave in unless they are shored. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by flooding.

This soil is assigned to capability units IIIe-3, dryland, and IIe-8, irrigated; Sandy Lowland range site; and windbreak suitability group 1L.

Go—Goshen silt loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is in upland swales. It is subject to rare flooding. It formed in silty alluvium derived mainly from soils formed in loess. Areas range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer is grayish brown, friable silt loam about 5 inches thick. The subsoil is grayish brown and about 32 inches thick. The upper part is firm silty clay loam, and the lower part is friable, calcareous silt loam. The underlying material is very pale brown, calcareous silt loam to a depth of 60 inches. In some areas the subsoil contains less clay. In other areas bedrock is in the underlying material. In some places the soil profile contains more clay. In a few small areas this soil has buried horizons.

Included with this soil in mapping are small areas of Alliance, Keith, and Sidney soils. The included soils have dark upper layers within a depth of 20 inches and are higher on the landscape than the Goshen soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Goshen soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the organic matter content. Adjusting the water application rate to the water intake rate of the soil helps to control ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment between the tree rows and by hoeing by hand, rototilling, and applying the appropriate herbicide in the rows.

The flooding and the moderate permeability are limitations on sites for septic tank absorption fields. Increasing the size of the absorption field generally can overcome the restricted permeability. Constructing dwellings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 1.

JmB—Jayem fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. It formed in eolian material weathered from noncalcareous sandstone. Areas range from 5 to 250 acres in size.

Typically, the surface layer is dark brown, very friable fine sandy loam about 14 inches thick. The subsoil is very friable fine sandy loam about 32 inches thick. The upper part is brown, and the lower part is yellowish brown. The underlying material to a depth of 60 inches is very pale brown, calcareous fine sandy loam. In some areas the dark upper layers are more than 20 inches thick. In other areas the soil contains more sand. In some places the soil is calcareous at shallower depths.

Included with this soil in mapping are small areas of Busher, Duroc, and Keith soils. Busher soils have carbonates at shallower depths. They have sandstone bedrock at a depth of 40 to 60 inches and are on the steeper slopes. Duroc soils have more silt and less sand in the profile than the Jayem soil. They have a dark surface layer that is more than 20 inches thick and are in upland swales and along drainageways. Keith soils are in landscape positions similar to those of the Jayem soil. They have less sand and more clay in the subsoil and have carbonates at shallower depths. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Jayem soil, and available water capacity is moderate. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately high.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing is a severe hazard and water erosion is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Contour farming helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water is needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In these areas, care should be taken not to expose the underlying fine sandy loam. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall and soil blowing are the main limitations. An irrigation system can provide the supplemental moisture needed during periods of scarce rainfall. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

This soil generally is suited to septic tank absorption fields, dwellings, and roads. The sides of shallow excavations can cave in unless they are shored.

This soil is assigned to capability units IIIe-3, dryland, and IIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

JmC—Jayem fine sandy loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. It formed in eolian material weathered from noncalcareous sandstone. Areas range from 5 to 200 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is brown, very friable fine sandy loam about 14 inches thick. The subsoil is pale brown, very friable fine sandy loam about 11 inches thick. The underlying material to a depth of 60 inches is fine sandy loam. It is pale brown and light yellowish brown in the upper part and very pale brown and calcareous in the lower part. In some places the soil is calcareous at a shallower depth. In other places the dark upper layers are more than 20 inches thick. In some small areas the slope is 1 to 3 percent.

Included with this soil in mapping are small areas of Busher and Keith soils. Busher soils have carbonates at shallower depths. They have sandstone at a depth of 40 to 60 inches and are on the steeper slopes. Keith soils are in landscape positions similar to those of the Jayem soil. They contain more clay throughout the profile, especially in the subsoil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Jayem soil, and available water capacity is moderate. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately high.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Soil blowing and water erosion are severe hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing (fig. 12). Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade. During land leveling, care should be taken not to expose the underlying fine sandy loam.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive and small blowouts can form. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion and soil blowing are severe hazards. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Planting the trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of scarce rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment and by timely applications of the appropriate herbicide.

This soil generally is suited to septic tank absorption fields, dwellings, and roads. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. The sides of shallow excavations can cave in unless they are shored.

This soil is assigned to capability units IVe-3, dryland, and IIIe-8, irrigated; Sandy range site; and windbreak suitability group 5.

Figure 12.—Stripcropping in an area of Jayem fine sandy loam, 3 to 6 percent slopes.

Jo—Johnstown loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on slightly convex slopes on broad upland flats. Gravelly sand is below a depth of 40 inches. This soil formed in loess and loamy sediment. It has a buried soil. Areas range from 25 to 360 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 5 inches thick. The subsurface layer is grayish brown, friable loam about 4 inches thick. The subsoil is friable and about 37 inches thick. The upper part is grayish brown clay loam, the next part is dark grayish brown clay loam, the next part is brown clay loam, the next part is pale brown silt loam, and the lowest part is very pale brown, calcareous silt loam. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand. In some areas the gravelly sand is at a depth of more than 60 inches. In other areas this soil does not have buried horizons, and the dark layer is less than 20 inches thick.

Included with this soil in mapping are small areas of Altvan and Duroc soils. Altvan soils have gravelly sand at a depth of 20 to 40 inches and are in the more sloping areas. Duroc soils have less clay in the subsoil than the Johnstown soil. They do not have buried horizons and are in upland swales. Included soils make up about 5 percent of the unit.

Permeability is moderate in the solum of the Johnstown soil and rapid in the underlying material. Available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

Ke—Keith loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on slightly convex slopes on broad upland divides. It formed in loess. Areas range from 10 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is grayish brown, friable loam about 3 inches thick. The subsoil is friable and about 16 inches thick. The upper part is brown silty clay loam, the next part is brown silt loam, and the lower part is pale brown silt loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is silt loam, and the lower part is very fine sandy loam. In some areas the subsoil contains less clay. In other areas the slope is 1 to 3 percent. In some places weakly cemented, fine grained, limy sandstone is at a depth of less than 60 inches.

Included with this soil in mapping are small areas of Duroc and Kuma soils. The included soils have a dark surface layer that is more than 20 inches thick. They are slightly lower on the landscape than the Keith soil. Duroc soils contain less clay in the subsoil than the Keith soil. Kuma soils have a buried soil. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

This soil generally is suited to septic tank absorption fields. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

KeB—Keith loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on broad summits of uplands. It formed in loess. Areas range from 10 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is grayish brown, very friable loam about 4 inches thick. The subsoil is friable and about 13 inches thick. The upper part is brown silt loam, and the lower part is pale brown silt loam. The underlying material is calcareous to a depth of 60 inches. The upper part is pale brown silt loam, and the lower part is very pale brown very fine sandy loam. In some places gravel pebbles occur in the soil profile. In other places weakly cemented, fine grained, limy sandstone is in the lower part of the underlying material. In a few small areas the soil has buried horizons.

Included with this soil in mapping are small areas of Duroc, Rosebud, and Ulysses soils. Duroc soils have dark upper layers that are more than 20 inches thick. They have less clay in the subsoil than the Keith soil and are in the lower areas. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They are on small knolls and side slopes. Ulysses soils are in landscape positions similar to those of the Keith soil. They contain less clay in the subsoil and have carbonates nearer to the surface. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to planting that enhances wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. Water erosion is a hazard. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Planting on the contour helps to control water erosion.

This soil generally is suited to septic tank absorption fields. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; and windbreak suitability group 3.

KeC—Keith loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on convex side slopes in the uplands. It formed in loess. Areas range from 5 to 50 acres in size.

Typically, the surface layer is grayish brown, friable loam about 6 inches thick. The subsurface layer is grayish brown, friable loam about 5 inches thick. The subsoil is friable silt loam about 25 inches thick. The upper part is brown, the next part is pale brown, and the lower part is pale brown and calcareous. The underlying material is very pale brown and calcareous to a depth of 60 inches. It is silt loam in the upper part and very fine sandy loam in the lower part. In some places gravel pebbles occur in the profile. In other places weakly cemented, fine grained, limy sandstone is in the lower part of the underlying material.

Included with this soil in mapping are small areas of Rosebud and Ulysses soils. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. They are on small knolls and side slopes. Ulysses soils are in landscape positions similar to those of the Keith soil. They contain less clay in the subsoil and have carbonates nearer to the surface. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion (fig. 13).

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil.

Figure 13.—Terraces on Keith loam, 3 to 6 percent slopes.

A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. Water erosion is a hazard. A drip irrigation system can be used to provide additional water as needed. Planting the trees on the contour and terracing help to control water erosion. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

This soil generally is suited to septic tank absorption fields. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

Ku—Kuma loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on slightly convex or concave slopes on broad upland flats. It formed in loess over a buried soil. Areas range from 10 to more than 640 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 7 inches thick. The subsoil is about 35 inches thick. The upper part is brown and dark brown, friable silty clay loam; the next part is dark grayish brown, friable silt loam; the next part is brown, very friable silt loam; and the lower part is pale brown, very friable silt loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is silt loam, and the lower part is very fine sandy loam. In some areas this soil does not have buried horizons. In other areas gravelly sand is in the lower part of the underlying material.

Included with this soil in mapping are small areas of Alliance, Duroc, and Keith soils. Alliance and Keith soils have dark upper layers within a depth of 20 inches and do not have buried horizons. Alliance soils are in landscape positions similar to those of the Kuma soil. They have weakly cemented, fine grained, limy sandstone bedrock below a depth of 40 inches. Duroc soils do not have buried horizons. They have less clay in the subsoil than the Kuma soil and are in swales. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Kuma soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

Lm—Las loam, 0 to 1 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on flood plains. It formed in calcareous, loamy alluvium that is light in color. This soil is occasionally flooded. Areas range from 10 to more than 500 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loam about 4 inches thick. The subsurface layer is light brownish gray, friable, calcareous clay loam about 7 inches thick. The underlying material to a depth of 60 inches is stratified light brownish gray and light gray, calcareous loam, clay loam, sandy loam, and sandy clay loam. In some places the soils are better drained. In other places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Glenberg, Las Animas, and McCook soils. Glenberg soils are in landscape positions similar to those of the Las soil. They contain less clay and more sand. They are well drained. Las Animas soils are poorly drained. They have more sand and less clay than the Las soil and are slightly lower on the landscape. McCook soils contain less clay and more silt than the Las soil. They are well drained and are slightly higher on the landscape. Also included are small areas of soils where the surface layer is strongly affected by alkalinity. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Las soil, and available water capacity is high. Runoff is slow. The apparent seasonal high water table is at a depth of about 2 to 3 feet. The organic matter content is low. The water intake rate is moderately low.

Most of the acreage of this soil supports native vegetation and is used as rangeland or hayland. A few areas are cultivated, and most are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. The flooding is a hazard. Soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. The wetness from the seasonal high water table also is a limitation that can delay planting or tillage in the spring. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Flooding is a hazard. Wetness is a limitation, and soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive ponding.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil.

If this soil is used as range or hayland, the climax vegetation is dominantly indiangrass, switchgrass, sedges, and rushes. These species make up 40 percent or more of the total annual forage. Prairie cordgrass, bluegrass, and forbs dominate the rest. If subject to continuous heavy grazing or improperly harvested for hay, indiangrass, switchgrass, and prairie cordgrass decrease in abundance and are replaced by western wheatgrass, bluegrass, slender wheatgrass, sedges, and rushes. If overgrazing or improper haying methods continue for many years, bluegrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.5 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. This soil generally is the first to be overgrazed when it is in a pasture that includes better drained soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring, before the ground thaws.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Tree and shrub species that can withstand the occasional wetness survive and grow well. During wet years, cultivation and planting may be delayed until the soil has begun to dry. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by timely cultivation or by application of the approved herbicide.

This soil is not suited to septic tank absorption fields and dwellings because of the flooding and wetness. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. Shoring needs to be completed during dry periods. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate side ditches and culverts help to prevent the damage to roads caused by flooding and wetness.

This soil is assigned to capability units IVw-4, dryland, and IIw-6, irrigated; Subirrigated range site; and windbreak suitability group 2S.

Lw—Las Animas loam, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is on flood plains. It formed in thick, calcareous, stratified alluvial sediment derived from mixed sources. This soil is frequently flooded. Individual areas are generally long and narrow and are along active and abandoned stream channels. Areas range from 10 to more than 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loam about 5 inches thick. The transitional layer is light brownish gray, very friable, calcareous fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is stratified light gray and light brownish gray, calcareous fine sandy loam, sandy loam, loamy fine sand, and very fine sandy loam. In some places the soil contains more silt and clay and is somewhat poorly drained.

Included with this soil in mapping are small areas of Bankard, Bayard, and Glenberg soils and areas of marsh. Bankard soils contain more sand than the Las Animas soil. They are somewhat excessively drained and are slightly higher on the landscape. Bayard soils are well drained and are on alluvial fans, stream terraces, and foot slopes. Glenberg soils are well drained and are slightly higher on the landscape than the Las Animas soil. The areas of marsh are ponded for long periods, support such plants as cattails and reeds, and are lower on the landscape than the Las Animas soil. Included areas make up about 10 percent of the unit.

Permeability is moderately rapid in the Las Animas soil, and the available water capacity is low. The runoff is ponded. The seasonal high water table ranges from the surface during wet years to a depth of about 1.5 feet during dry years. The organic matter content is low.

Nearly all areas of this soil support native vegetation. They are used as rangeland or are left idle and used as wildlife habitat.

This soil is not suitable for dry-farmed or irrigated crops because of the seasonal high water table and the frequent flooding.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and sedges. These species make up 65 percent or more of the total annual forage. Bluegrass, slender wheatgrass, green muhly, 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 methods continue 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. This soil produces a high quantity of low-quality forage. 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. Grazing and heavy machinery traffic when the soil is wet can result in surface compaction and the formation of mounds and ruts, which make grazing or harvesting for hay difficult.

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

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. If trees and shrubs are planted, their survival and growth are severely limited by the seasonal high water table and the flooding. Some areas can support the trees or shrubs used to enhance wildlife habitat if suitable species are planted by hand or if other special management is applied.

This soil is not suited to septic tank absorption fields and dwellings because of the flooding and wetness. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. Shoring needs to be completed during dry periods. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate side ditches and culverts help to prevent the damage to roads caused by flooding and wetness. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability unit Vw-7, dryland; Wetland range site; and windbreak suitability group 10.

Ly—Lodgepole silt loam, 0 to 1 percent slopes. This very deep, nearly level, somewhat poorly drained soil is in depressions on the uplands. It formed in loess and loamy sediment. This soil is ponded for short periods. Areas are circular or oval in shape and range from 3 to 150 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 7 inches thick. The subsurface layer is light brownish gray, friable silt loam about 2 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, firm silty clay; the next part is grayish brown, very firm clay; and the lower part is grayish brown, firm silty clay. The underlying material to a depth of 58 inches is brown, calcareous silt loam. To a depth of 60 inches or more it is very pale brown, calcareous sandy loam. In some places weakly cemented, fine grained, limy sandstone is below a depth of 40 inches.

Included with this soil in mapping are small areas of Alliance, Duroc, and Keith soils. Alliance and Keith soils contain less clay in the subsoil than the Lodgepole soil. They have a dark surface layer within a depth of less than 20 inches and are slightly higher on the landscape. Duroc soils contain less clay in the subsoil than the Lodgepole soil. They are on the slightly higher, adjacent landscapes. Included soils make up about 10 percent of the unit.

Permeability is very slow in the Lodgepole soil, and available water capacity is high. The soil is occasionally ponded for short periods from March through June. A perched seasonal high water table fluctuates from about 6 inches above the surface to within a depth of 1 foot below the surface in spring. The organic matter content is moderate. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is used for cultivated crops. Some areas support native grasses and are used for hay and grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Ponding is a severe hazard. Crops are often damaged because runoff from adjacent areas after heavy rains results in ponding. Weed competition is a problem because timely cultivation is difficult. Soil compaction is a problem if the soil is worked when wet. Soil blowing may be a hazard in dry years in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing. Returning crop residue to the soil and applying manure improve tilth and increase the content of organic matter.

This soil is unsuited to irrigation. Because of a slow water intake rate, the soil is easily ponded and cannot be easily managed for irrigated crops.

This soil is suited to range and native hay. Continuous heavy grazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. If trees and shrubs are planted, their survival and growth are severely limited because the soil is somewhat poorly drained and is ponded for short periods. Onsite investigation is needed to identify the areas that are best suited to windbreaks.

This soil is not suited to septic tank absorption fields and dwellings because of the very slow permeability and the ponding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the level of ponding and providing adequate side ditches and culverts help to prevent the damage to roads caused by ponding and wetness. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, can help to prevent excessive shrinking and swelling.

This soil is assigned to capability units IIIw-2, dryland, and IVw-2, irrigated; Clayey Overflow range site; and windbreak suitability group 10.

Mc—McCook very fine sandy loam, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on flood plains. It is subject to rare flooding. It formed in weakly stratified, calcareous, loamy alluvium. Areas range from 15 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous very fine sandy loam about 12 inches thick. The transitional layer is light brownish gray, very friable, calcareous very fine sandy loam about 7 inches thick. The underlying material to a depth of 60 inches is calcareous. The upper part is grayish brown very fine sandy loam, the next part is light brownish gray very fine sandy loam, and the lower part is light brownish gray fine sandy loam.

Included with the soil in mapping are areas of Bankard, Bridget, and Las soils. Bankard soils contain more sand than the McCook soil. They are on the lower flood plains. Bridget soils are not stratified and are on the higher stream terraces and foot slopes. Las soils are somewhat poorly drained. They have more clay at a depth of 10 to 40 inches and are lower on the landscape than the McCook soil. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the McCook soil, and available water capacity is high. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. Some areas are irrigated. A few areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing is the main hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling and disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range and native hay. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. Supplemental water for seedlings may be needed during periods of scarce rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment between the tree rows and by hoeing by hand, rototilling, and applying the appropriate herbicide in the row.

The flooding and the moderate permeability are limitations on sites for septic tank absorption fields. Increasing the size of the absorption field generally can overcome the restricted permeability. Constructing dwellings and buildings on raised, well compacted fill material help to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by flooding. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the roads by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIc-1, dryland, and IIe-5, irrigated; Silty Lowland range site; and windbreak suitability group 1L.

MkC—Mitchell very fine sandy loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on foot slopes and valley side slopes. It formed in colluvial and alluvial sediments weathered from siltstone. Areas range from 10 to more than 200 acres in size.

Typically, the surface layer is very friable, calcareous very fine sandy loam about 11 inches thick. The upper part is grayish brown, and the lower part is pale brown. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 12 inches thick. The underlying material is calcareous to a depth of 60 inches. It is pale brown very fine sandy loam in the upper part and very pale brown silt loam in the lower part. A buried layer of pale brown, calcareous silt loam is at a depth of 35 to 39 inches. In some places siltstone occurs within a depth of 60 inches. In other places a few pebbles are in the soil. In some areas the surface layer is darker and thicker.

Included with this soil in mapping are small areas of Bayard soils, which are darker than the Mitchell soil, have more sand in the profile, and are on the lower foot slopes. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Mitchell soil, and available water capacity is high. Runoff is medium. The organic matter content is low. The water intake rate is moderate.

Most of the acreage of this soil is used as rangeland. Some areas are used for cultivated crops. A few acres are irrigated.

If used for dryland crops, this soil is suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. 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 that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn; wheat; dry, edible beans; and alfalfa. Water can be applied by a sprinkler irrigation system. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade. Soil blowing and water erosion are the main hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve water. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, sideoats grama, and blue grama. These species make up 40 percent or more of the total annual forage. Buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by hairy grama, prairie sandreed, western wheatgrass, needleandthread, plains muhly, sedges, 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 excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.4 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The species selected for planting should be those that can tolerate a high amount of calcium. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of insufficient rainfall. Cultivation between the rows and careful use of herbicides in the row help to control undesirable grasses and weeds. Planting trees on the contour and terracing help to control runoff and water erosion.

This soil generally is suited to septic tank absorption fields, dwellings, and roads. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded.

This soil is assigned to capability units IIIe-3, dryland, and IIIe-6, irrigated; Limy Upland range site; and windbreak suitability group 8.

MkD—Mitchell very fine sandy loam, 6 to 9 percent slopes. This very deep, strongly sloping, well drained soil is on foot slopes and valley side slopes. The soil formed in colluvial and alluvial sediments weathered from siltstone. Areas range from 5 to 150 acres in size.

Typically, the surface layer is light brownish gray, very friable, calcareous very fine sandy loam about 5 inches thick. The transitional layer is pale brown, very friable, calcareous silt loam about 12 inches thick. The underlying material to a depth of 60 inches is very pale brown, calcareous silt loam. In some places siltstone occurs within a depth of 60 inches. In other places a few pebbles are in the soil. In some areas the surface layer is thicker and darker.

Included with this soil in mapping are small areas of Bayard soils, which are darker than the Mitchell soil, have more sand in the profile, and are on the lower foot slopes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Mitchell soil, and available water capacity is high. Runoff is rapid. The organic matter content is low. The water intake rate is moderate.

Most of the acreage of this soil is used as rangeland. Some areas are used for cultivated crops.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. A scarcity of rainfall in summer commonly limits the cultivated crops that can be successfully grown. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil helps to maintain tilth, increase the content of organic matter, and improve the water intake rate. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. A gravity irrigation system is unsuited to this soil because of the slope. Water erosion and soil blowing are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserve moisture. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at a proper grade can help to control erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, sideoats grama, and blue grama. These species make up 40 percent or more of the total annual forage. Buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by hairy grama, prairie sandreed, western wheatgrass, needleandthread, plains muhly, sedges, 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 excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.4 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The species selected for planting should be those that can tolerate a high amount of calcium. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of insufficient rainfall. Cultivation between the rows and careful use of herbicides in the row help to control undesirable grasses and weeds.

This soil generally is suited to septic tank absorption fields, dwellings, and roads. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded.

This soil is assigned to capability units IVe-3, dryland, and IVe-6, irrigated; Limy Upland range site; and windbreak suitability group 8.

MkE—Mitchell very fine sandy loam, 9 to 20 percent slopes. This very deep, moderately steep and steep, well drained soil is on foot slopes and valley side slopes. The soil formed in colluvial and alluvial sediments weathered from siltstone. Areas range from 5 to more than 100 acres in size.

Typically, the surface layer is brown, very friable, calcareous very fine sandy loam about 5 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 13 inches thick. The underlying material to a depth of 60 inches is calcareous very fine sandy loam. It is pale brown in the upper part and very pale brown in the lower part. In some places siltstone occurs within a depth of 60 inches. In other places a few pebbles are mixed in the soil. In some areas the surface layer is thicker and darker.

Included with this soil in mapping are small areas of Bayard and Epping soils. Bayard soils are darker than the Mitchell soil. They have more sand in the profile and are on the lower foot slopes. Epping soils have siltstone bedrock within a depth of 20 inches and are higher on the landscape than the Mitchell soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Mitchell soil, and available water capacity is high. Runoff is rapid. The organic matter content is low.

Nearly all of the acreage of this soil supports native grasses and is used as rangeland.

This soil is generally unsuited to farming because of the slope and soil blowing. Overcoming soil blowing and the slope by a system of cultivation generally is not practical.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, sideoats grama, and blue grama. These species make up 40 percent or more of the total annual forage. Buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by hairy grama, prairie sandreed, western wheatgrass, needleandthread, plains muhly, sedges, 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 excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.4 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The species selected for planting should be those that can tolerate a high amount of calcium. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control runoff and water erosion. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of insufficient rainfall. Cultivation between the rows and careful use of the appropriate herbicide in the row help to control undesirable grasses and weeds.

This soil generally is not suited to septic tank absorption fields in those areas where the slope is more than 15 percent. In those areas where the slope is less than 15 percent, land shaping and installing the distribution lines on the contour help to ensure that the absorption field functions properly. The moderate permeability is a limitation on sites for septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Buildings and dwellings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Cutting and filling can provide a suitable grade for roads.

This soil is assigned to capability unit VIe-3, dryland; Limy Upland range site; and windbreak suitability group 8.

Pg—Pits, sand and gravel. This map unit consists mainly of very deep, gently sloping to steep mounds of gravel, sand, and overburden and the adjacent pits that have nearly level bottoms and nearly vertical side slopes. The areas are on uplands and in some places on flood plains. The pits on the flood plains contain water, and the surrounding areas are subject to rare flooding. The areas of sand and gravel are excessively drained. Areas generally are irregular in shape and range from 5 to 15 acres in size.

Typically, the soil material consists of a mixture of medium and fine sand, some gravel, and some loamy material. A soil profile has not developed. In some places sandstone bedrock is exposed on the pit bottoms.

This map unit is assigned to capability unit VIIIs-8, dryland. It is not assigned to a windbreak suitability group or to a range site.

ReG—Rock outcrop-Epping complex, 11 to 60 percent slopes. This map unit consists of areas of very steep Rock outcrop and a shallow Epping soil on upland breaks. The areas of Rock outcrop consist of siltstone and are on the steeper parts of ridgetops and dissected side slopes of upland breaks. The Epping soil is steep and very steep and well drained. It is on side slopes of upland breaks and narrow ridgetops. It formed in material weathered from siltstone containing volcanic ash. Areas are long and narrow and range from 5 to more than 300 acres in size. They are 35 to 60 percent areas of Rock outcrop and 30 to 55 percent Epping soil.

Typically, the areas of Rock outcrop consist of limy siltstone bedrock.

Typically, the Epping soil has a surface layer of pale brown, very friable, calcareous loam about 4 inches thick. The transitional layer is pale brown, very friable, calcareous silt loam about 4 inches thick. The underlying material to a depth of 10 inches is very pale brown, calcareous silt loam. Below a depth of 10 inches it is siltstone bedrock. In some places the soil is moderately deep to siltstone bedrock.

Included with this unit in mapping are small areas of the very deep Mitchell soils, which are on foot slopes that are lower on the landscape than the Epping soil. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Epping soil. Runoff is rapid in the Epping soil and very rapid in areas of Rock outcrop. Available water capacity is very low in the Epping soil. The organic matter content is low in the Epping soil. The root zone is shallow in the Epping soil.

Nearly all of the acreage of this map unit supports native grasses and is used as rangeland. This unit is unsuited to farming because of the excessive slope, a shallow root zone, the hazard of erosion, and the areas of Rock outcrop.

If the Epping soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, and threadleaf sedge. These species make up 65 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock from one area to another. In some areas brush management may be needed to control the woody plants that invade the site.

The Epping soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

The Epping soil generally is not suited to septic tank absorption fields because of the steep and very steep slopes and the shallow depth to bedrock. A suitable alternative site should be selected. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. Cutting and filling can provide a suitable grade for roads. The soft bedrock generally can be excavated during the construction of roads.

This complex is assigned to capability unit VIIs-4, dryland. The Epping soil is in the Shallow Limy range site and windbreak suitability group 10. The areas of Rock outcrop are not assigned to interpretive groupings.

RhG—Rock outcrop-Tassel complex, 20 to 60 percent slopes. This map unit consists of areas of sandstone Rock outcrop and a shallow Tassel soil on uplands. The Tassel soil is steep and very steep and is well drained. The areas of sandstone Rock outcrop are on the upper part of side slopes, the summits of narrow ridgetops, and the upper part of dissected side slopes. The Tassel soil formed in calcareous material weathered from fine grained sandstone. It is on dissected side slopes, summits, and shoulders of narrow upland ridgetops. Areas range from 10 to 100 acres in size. They are 35 to 60 percent areas of Rock outcrop and 30 to 55 percent Tassel soil. The areas of Rock outcrop and the Tassel soil occur as areas so intricately mixed or so small in size that it is not practical to separate them in mapping.

Typically, the areas of Rock outcrop consist of blocky, fine grained sandstone bedrock. In places it is interlayered with cemented and uncemented gravels.

Typically, the Tassel soil has a surface layer of grayish brown, very friable, calcareous loamy very fine sand about 3 inches thick. The transitional layer is brown, very friable, calcareous loamy very fine sand about 3 inches thick. The underlying material to a depth of 12 inches is calcareous loamy very fine sand. The upper part is brown, and the lower part is pale brown. Below a depth of 12 inches is fine grained sandstone bedrock. In some places the soil contains more clay and less sand. In other places carbonates have been leached from the surface.

Included with this unit in mapping are small areas of Busher and Dix soils. Busher soils are deep. They have a darker and thicker surface layer than the Tassel soil and are on convex side slopes that do not exceed 30 percent. Dix soils have very gravelly sand at a depth of 10 to 20 inches. They typically do not have free carbonates and are in landscape positions similar to those of the Tassel soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Tassel soil, and available water capacity is very low. Runoff is rapid in the Tassel soil and very rapid in areas of Rock outcrop. The organic matter content is low in the Tassel soil. The root zone is shallow in the Tassel soil.

Nearly all of the acreage in this map unit is used as rangeland. This complex is unsuited to farming because of the slope, a shallow root zone, the hazard of erosion, and the areas of Rock outcrop.

If the Tassel soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, sand bluestem, and threadleaf sedge. These species make up 55 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and sand bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition on the Tassel soil, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock from one area to another. In some areas brush management may be needed to control the woody plants that invade the site.

The Tassel soil generally is unsuited to the trees and shrubs grown as windbreaks or to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

The Tassel soil generally is not suited to sanitary facilities and dwellings because of the slope and the shallowness to bedrock. A suitable alternative site should be selected. The soft bedrock generally can be excavated during the construction of roads. Cutting and filling can provide a suitable grade for roads.

This complex is assigned to capability unit VIIs-4, dryland. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10. The areas of Rock outcrop are not assigned to interpretive groupings.

Ro—Rosebud loam, 0 to 1 percent slopes. This moderately deep, nearly level, well drained soil is on broad upland divides. It formed in loamy, calcareous material that weathered from weakly cemented, fine grained, limy sandstone. Areas range from 5 to 30 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsoil is about 12 inches thick. The upper part is brown, firm clay loam; the next part is brown and pale brown, firm clay loam; and the lower part is pale brown, friable, calcareous loam. The underlying material to a depth of 23 inches is very pale brown, calcareous sandy loam. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In places the soil contains more silt and less sand and is deep over bedrock.

Included with this soil in mapping are small areas of Canyon soils, which contain less clay than the Rosebud soil and have carbonates at shallower depths. They are shallow over bedrock and are in the steeper areas. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Rosebud soil, and available water capacity is low. Runoff is slow. The organic matter content is moderate. The root zone is moderately deep. The water intake rate is moderate.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application helps to control water erosion and runoff. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. During land leveling, care should be taken not to expose the underlying bedrock.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. Supplemental water can be provided by an irrigation system during dry periods. A cover crop between the rows helps to control soil blowing. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by timely use of the appropriate herbicide.

Building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the fields. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. A good surface drainage system can minimize the damage to roads and streets caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 6R.

RoB—Rosebud loam, 1 to 3 percent slopes. This moderately deep, very gently sloping, well drained soil is on side slopes and summits in the uplands. It formed in loamy, calcareous material that weathered from weakly cemented, fine grained, limy sandstone. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 4 inches thick. The subsoil is friable and about 26 inches thick. The upper part is dark grayish brown clay loam, the next part is brown loam, the next part is light brownish gray, calcareous loam, and the lower part is light gray, calcareous loam. The underlying material is white, weakly cemented, fine grained, limy sandstone bedrock to a depth of 60 inches. In some areas the soil contains more silt and less sand and is deep over bedrock.

Included with this soil in mapping are small areas of Altvan and Canyon soils. Altvan soils are in landscape positions similar to those of the Rosebud soil. They have gravelly sand at a depth of 20 to 40 inches. Canyon soils contain less clay than the Rosebud soil and have carbonates at shallower depths. They are shallow over bedrock and are in the steeper areas. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Rosebud soil, and available water capacity is low. Runoff is medium. The organic matter content is moderate. The root zone is moderately deep. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. During land leveling, care should be taken not to expose the underlying bedrock.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat (fig. 14). The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. Supplemental water can be provided by an irrigation system during dry periods. Water erosion is a hazard. Planting trees on the contour and terracing help to control water erosion. A cover crop between the rows helps to control soil blowing. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by timely use of the appropriate herbicide.

Building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the fields. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. A good surface drainage system can minimize the damage to roads and streets caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 6R.

RoC—Rosebud loam, 3 to 6 percent slopes. This moderately deep, gently sloping, well drained soil is on side slopes in the uplands. It formed in loamy, calcareous material that weathered from weakly cemented, fine grained, limy sandstone. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsoil is friable and about 16 inches thick. The upper part is grayish brown and brown clay loam; the next part is brown clay loam; and the lower part is very pale brown, calcareous loam. The underlying material to a depth of 35 inches is pale brown, calcareous very fine sandy loam. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In some places the surface layer is thinner. In other places the soil contains more silt and less sand and is deep to sandstone.

Included with this soil in mapping are small areas of Altvan, Canyon, and Sidney soils. Altvan soils are in landscape positions similar to those of the Rosebud soil. They have gravelly sand at a depth of 20 to 40 inches. The shallow Canyon soils are on ridges, side slopes, and knolls. Sidney soils are in landscape positions similar to those of the Rosebud soil. They contain more sand and less clay in the subsoil and are deep. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Rosebud soil, and available water capacity is low. Runoff is medium. The organic matter content is moderate. The root zone is moderately deep. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. Water erosion and soil blowing are hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control water erosion and soil blowing. The efficient use of irrigation water is a

Figure 14.—A windbreak in an area of Rosebud loam, 1 to 3 percent slopes.

management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at a proper grade can help to control erosion. A gravity irrigation system is poorly suited to this soil because of the slope. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If this soil needs to be land leveled, care should be taken not to expose the underlying bedrock.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control water erosion. A cover crop between the rows helps to control soil blowing. The lack of seasonal rainfall is the main limitation. Supplemental water can be provided by an irrigation system during dry periods. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by timely use of the appropriate herbicide.

Building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the soil. The soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IVe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 6R.

RsD—Rosebud-Canyon complex, 3 to 9 percent slopes. These gently sloping and strongly sloping, well drained soils are on uplands. The Rosebud soil is moderately deep, and the Canyon soil is shallow. These soils formed in loamy, calcareous material that weathered from weakly cemented, fine grained, limy sandstone. The Rosebud soil is on side slopes and summits. The Canyon soil is on narrow ridgetops and convex shoulders of dissected side slopes. Areas range from 5 to 400 acres in size. They are 40 to 65 percent Rosebud soil and 25 to 50 percent Canyon soil. The two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Rosebud soil has a surface layer of dark grayish brown, friable loam about 4 inches thick. The subsoil is friable clay loam about 13 inches thick. The upper part is dark brown, and the lower part is pale brown and calcareous. The underlying material to a depth of 33 inches is pale brown and calcareous. It is sandy clay loam in the upper part and sandy loam in the lower part. To a depth of 60 inches it is white and very pale brown, weakly cemented, fine grained, limy sandstone bedrock. In some places the soil contains less clay. In other places the soil contains more silt and less sand and is deep over bedrock.

Typically, the Canyon soil has a surface layer of dark grayish brown, friable loam about 4 inches thick. The transitional layer is brown, friable, calcareous loam about 4 inches thick. The underlying material is brown, calcareous loam to a depth of 15 inches. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In some places the soil has less clay.

Included with these soils in mapping are small areas of Altvan and Sidney soils. Altvan soils have gravelly sand at a depth of 20 to 40 inches. They are in landscape positions similar to those of the Canyon soil and contain more clay. Sidney soils contain more sand and less clay in the control section than the Rosebud soil. They are deep and are in landscape positions similar to those of the Rosebud soil. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Rosebud and Canyon soils. Available water capacity is low in the Rosebud soil and very low in the Canyon soil. Runoff is medium on both soils. The organic matter content is moderate in the Rosebud soil and low in the Canyon soil. The root zone is moderately deep in the Rosebud soil and shallow in the Canyon soil.

Most of the acreage of these soils supports grasses and is used as rangeland. A few areas are used for cultivated crops.

If used for dryland crops, these soils are poorly suited to winter wheat and millet. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure improve tilth and the water intake rate and increase the content of organic matter.

If the Rosebud soil is used as range or hayland, the climax vegetation is dominantly big bluestem, blue grama, little bluestem, sideoats grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Buffalograss, needleandthread, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, western wheatgrass, 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 and soil blowing are excessive.

If the Canyon soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Other grasses and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition on the Rosebud soil, the suggested initial stocking rate is 0.5 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If the Rosebud soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

If the range is in excellent condition on the Canyon soil, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. In some areas brush management may be needed to control the woody plants that invade the site.

The Rosebud soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion is a severe hazard. Planting trees on the contour and terracing help to control water erosion. The lack of seasonal rainfall is the main limitation. Supplemental water can be provided by an irrigation system during dry periods. A cover crop between the rows helps to control soil blowing. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by timely use of the appropriate herbicide.

The Canyon soil generally is unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

On the Rosebud soil, building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the field. Land shaping and installing the distribution lines on the contour help to ensure that the absorption field functions properly. The Canyon soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. On these soils the soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded.

On the Rosebud soil, a good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. On the Canyon soil, the soft bedrock generally can be excavated during the construction of roads. In areas of these soils that have slope of more than 8 percent, cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit IVe-1, dryland. The Rosebud soil is in the Silty range site, and the Canyon soil is in the Shallow Limy range site. The Rosebud soil is in windbreak suitability group 6R, and the Canyon soil is in windbreak suitability group 10.

Sb—Satanta loam, gravelly substratum, 0 to 1 percent slopes. This very deep, nearly level, well drained soil is on broad uplands. It formed in loamy eolian or alluvial sediments over gravelly loamy sand. Areas range from 5 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 4 inches thick. The subsurface layer is grayish brown, very friable loam about 3 inches thick. The subsoil is friable and about 22 inches thick. The upper part is grayish brown clay loam, the next part is light brownish gray, calcareous loam, and the lower part is very pale brown, calcareous loam. The underlying material to a depth of 60 inches is very pale brown and calcareous. It is loam in the upper part and gravelly loamy sand in the lower part. In some places the soil has a dark buried horizon in the subsoil. In other places the soil has a thicker dark surface layer. In some areas the soil contains more silt and less sand and does not have sand and gravel.

Included with this soil in mapping are small areas of Alliance, Altvan, and Duroc soils. Alliance soils are in landscape positions similar to those of the Satanta soil. They have weakly cemented, fine grained, limy sandstone bedrock below a depth of 40 inches. They contain more silt and less sand than the Satanta soil. Altvan soils are in landscape positions similar to those of the Satanta soil. They have gravelly sand at a depth of 20 to 40 inches. Duroc soils have less sand throughout the profile than the Satanta soil. They have a dark surface layer that is more than 20 inches thick and are in swales and drainageways. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the solum and the upper part of the underlying material of the Satanta soil and is rapid in the lower part of the underlying material. Available water capacity is high. Runoff is slow. The organic matter content is moderately low. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Insufficient moisture during years of below normal rainfall is the main limitation. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to conserve moisture and control soil blowing. Returning crop residue to the soil and applying manure improve the water intake rate.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Soil blowing is a slight hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and ponding. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. This soil generally is suited to dwellings. The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

SbB—Satanta loam, gravelly substratum, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on upland side slopes and high stream terraces. It formed in loamy eolian or alluvial sediments over gravelly loamy 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 brown, friable loam about 4 inches thick. The subsoil is friable and about 17 inches thick. The upper part is brown clay loam, the next part is pale brown clay loam, and the lower part is very pale brown, calcareous loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is loam, the next part is fine sandy loam, and the lower part is gravelly loamy sand. In some places the soil has a dark buried horizon in the subsoil. In other places the soil has a thicker dark surface layer. In some areas the underlying material does not have gravelly loamy sand.

Included with this soil in mapping are small areas of Alliance, Altvan, and Rosebud soils. The included soils are in landscape positions similar to those of the Satanta soil. Alliance soils contain more silt and less sand than the Satanta soil. They are deep to weakly cemented, fine grained, limy sandstone bedrock. Altvan soils have gravelly sand at a depth of 20 to 40 inches. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the solum and the upper part of the underlying material of the Satanta soil and is rapid in the lower part of the underlying material. Available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately low.

Nearly all of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Only a small acreage supports grasses and is used for hay or grazing.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by gravity or sprinkler irrigation systems. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control water erosion. Returning crop residue to the soil and applying manure help improve tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. Timely application and efficient distribution of water are needed. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide. Planting on the contour helps to control water erosion.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. This soil generally is suited to dwellings. The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIe-1, dryland, and IIe-4, irrigated; Silty range site; and windbreak suitability group 3.

SbC—Satanta loam, gravelly substratum, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on upland side slopes and high stream terraces. It formed in loamy eolian or alluvial sediments over gravelly sandy loam. Areas range from 10 to 40 acres in size.

Typically, the surface layer is grayish brown, friable loam about 5 inches thick. The subsurface layer is grayish brown, friable loam about 5 inches thick. The subsoil is friable and about 17 inches thick. The upper part is light brownish gray clay loam, and the lower part is pale brown, calcareous loam. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is loam, and the lower part is gravelly sandy loam. In some places weakly cemented, fine grained, limy sandstone is below a depth of 40 inches. In other places the soil has less sand and gravel throughout the profile.

Included with this soil in mapping are small areas of Altvan and Rosebud soils. The included soils are in landscape positions similar to those of the Satanta soil. Altvan soils have gravelly sand at a depth of 20 to 40 inches. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the solum and the upper part of the underlying material of the Satanta soil and is rapid in the lower part of the underlying material.

Available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately low.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade help to control erosion. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. Water erosion is a severe hazard. Planting the trees on the contour and terracing help to control water erosion. The lack of seasonal rainfall is the main limitation. A drip irrigation system can be used to provide additional water as needed. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. This soil generally is suited to dwellings. The foundations of buildings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

SnC—Sidney loam, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on side slopes in the uplands. The soil formed in loamy, calcareous colluvium that weathered from weakly cemented, fine grained, limy sandstone. Areas of this soil range from 5 to 30 acres in size.

Typically, the surface layer is brown, very friable, calcareous loam about 7 inches thick. The subsoil is pale brown, very friable, calcareous loam about 12 inches thick. The underlying material to a depth of 50 inches is very pale brown, calcareous loam. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In some places the subsoil contains more clay.

Included with this soil in mapping are small areas of Altvan and Rosebud soils. The included soils are in landscape positions similar to those of the Sidney soil. Altvan soils have more clay in the subsoil than the Sidney soil. They have gravelly sand at a depth of 20 to 40 inches. Rosebud soils have more clay in the subsoil than the Sidney soil. They are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Sidney soil, and available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderately low.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion.

A sprinkler irrigation system can be used on this soil. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are good. Water erosion is a severe hazard. The lack of seasonal rainfall is the main limitation. Planting trees on the contour and terracing help to control water erosion. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the fields. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-6, irrigated; Silty range site; and windbreak suitability group 3.

SoD—Sidney-Canyon complex, 3 to 9 percent slopes. These gently sloping and strongly sloping, well drained soils are on uplands. The Sidney soil is deep, and the Canyon soil is shallow. The Sidney soil is on side slopes in the uplands and formed in loamy, calcareous colluvium that weathered from weakly cemented, fine grained, limy sandstone. The Canyon soil is on narrow ridgetops and convex shoulders of dissected side slopes and formed in material that weathered from weakly cemented, fine grained, limy sandstone. Areas range from 5 to 400 acres in size. They are 40 to 60 percent Sidney soil and 30 to 50 percent Canyon soil. The two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Sidney soil has a surface layer of grayish brown, friable, calcareous loam about 7 inches thick. The subsoil is light brownish gray, friable, calcareous loam about 11 inches thick. The underlying material to a depth of 50 inches is calcareous loam. The upper part is very pale brown, and the lower part is light gray. To a depth of 60 inches it is white, weakly cemented, fine grained, limy sandstone bedrock. In some places the soil contains more clay.

Typically, the Canyon soil has a surface layer of dark grayish brown, friable, calcareous loam about 6 inches thick. The underlying material to a depth of 11 inches is brown, calcareous gravelly loam. To a depth of 60 inches it is weakly cemented, fine grained, limy sandstone bedrock. In some places the soil has less clay. In other places the soil has a stony surface.

Included with these soils in mapping are small areas of Altvan and Rosebud soils. The included soils are in landscape positions similar to those of the Sidney and Canyon soils. Altvan soils have more clay in the subsoil than the Sidney and Canyon soils. They have gravelly sand at a depth of 20 to 40 inches. Rosebud soils have more clay in the subsoil than the Sidney and Canyon soils. They are moderately deep to weakly cemented, fine grained, limy sandstone bedrock. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Sidney and Canyon soils. Available water capacity is moderate in the Sidney soil and very low in the Canyon soil. Runoff is medium on both soils. The organic matter content is moderately low in the Sidney soil and low in the Canyon soil. The root zone is deep in the Sidney soil and shallow in the Canyon soil.

Most of the acreage of these soils is used for cultivated crops. Some areas support grasses and are used as rangeland. A few small areas are irrigated.

If used for dryland crops, these soils are poorly suited to winter wheat and millet. Water erosion is a severe hazard and soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. In cultivated areas, most of the original surface layer has been removed by erosion, and the thickness of the loamy material over the sandstone bedrock has been reduced in the Canyon soil. In these areas numerous sandstone fragments have been dislodged by tillage equipment and are on the surface of the soil. The surface layer in these areas is light in color and calcareous. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure improve tilth, increase the organic matter content, and improve the water intake rate. These soils are poorly suited to irrigation because of the slopes and the shallowness to sandstone bedrock in the Canyon soil.

The Sidney soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

The Canyon soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help keep the native plants in good condition. Brush management may be needed to control undesirable woody plants that invade the site.

The Sidney soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The Canyon soil generally is unsuited. The survival and growth rates of adapted species are good on the Sidney soil. Small areas are suitable sites for planting trees on the Canyon soil; however, onsite investigation is needed.

On the Sidney soil, water erosion is a severe hazard. The lack of seasonal rainfall is the main limitation. Planting trees on the contour and terracing help to control water erosion. An irrigation system can provide the supplemental moisture needed during periods of low rainfall. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation with conventional equipment or by applications of the appropriate herbicide.

On the Sidney soil, the moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field generally can overcome this limitation. Building up or mounding sites for septic tank absorption fields with suitable fill material increases the filtering capacity of the fields. The Canyon soil generally is not suited to septic tank absorption fields because it is shallow over bedrock. A suitable alternative site should be selected. On the Canyon soil, the soft bedrock generally can be easily excavated during the construction of dwellings with basements. In areas of these soils that have slope of 8 percent or more, buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be excavated.

On the Sidney soil, a good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. On the Canyon soil, the bedrock generally can be excavated during the construction of roads. In areas of these soils that have slope of 8 percent or more, cutting and filling are needed to provide a suitable grade for roads.

These soils are assigned to capability unit IVe-1, dryland. The Sidney soil is in the Silty range site, and the Canyon soil is in the Shallow Limy range site. The Sidney soil is in windbreak suitability group 3, and the Canyon soil is in windbreak suitability group 10.

TbF—Tassel-Busher complex, 3 to 30 percent slopes. These gently sloping to steep, well drained soils are on uplands. The shallow Tassel soil is on summits and side slopes of narrow ridgetops; dissected, convex side slopes; and sharp slope breaks. The deep Busher soil is on convex summits and side slopes. These soils formed in material that weathered from fine grained sandstone. Areas range from 10 to more than 100 acres in size. They are 40 to 60 percent Tassel soil and 30 to 50 percent Busher soil. The two soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Tassel soil has a surface layer of dark grayish brown, very friable loamy very fine sand about 3 inches thick. The subsurface layer is brown, very friable, calcareous loamy very fine sand about 3 inches thick. The underlying material is pale brown, calcareous, loamy very fine sand. Weakly cemented, fine grained sandstone bedrock is at a depth of about 13 inches. In some places the soil contains more clay. In other places the depth to sandstone bedrock is less than 6 inches.

Typically, the Busher soil has a surface layer of dark grayish brown, very friable fine sandy loam about 18 inches thick. The subsoil is brown, very friable, calcareous fine sandy loam about 12 inches thick. The underlying material is pale brown, calcareous fine sandy loam about 25 inches thick. To a depth of 60 inches it is white, fine grained sandstone bedrock. In some places the surface layer is loamy very fine sand. In other places the carbonates are leached from the profile. In some areas the surface layer is lighter in color and thinner.

Included with these soils in mapping are small areas of Dix soils and outcrops of sandstone. Dix soils are in landscape positions similar to those of the Tassel and Busher soils. They are excessively drained and have very gravelly sand at a depth of 10 to 20 inches. The outcrops of sandstone are on narrow ridgetops and sharp slope breaks. Included areas make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Tassel and Busher soils. Runoff is medium on both soils. Available water capacity is very low in the Tassel soil and moderate in the Busher soil. The organic matter content is low in the Tassel soil and moderately low in the Busher soil. The root zone is shallow in the Tassel soil and deep in the Busher soil.

Nearly all of the acreage of these soils supports native grasses and is used as rangeland. A few small areas have scattered trees.

These soils are unsuited to farming because of the slope and the shallow root zone in areas of the Tassel soil.

If the Tassel soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, sand bluestem, and threadleaf sedge. These species make up 55 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and sand bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the Busher soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem and little bluestem decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 animal unit month per acre on the Tassel soil and 0.5 animal unit month per acre on the Busher 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. These soils generally are the first to be overgrazed when they are in a pasture that includes the Sands range site. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock from one area to another. In some areas brush management may be needed to control the woody plants that invade the site. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If the Busher soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested for hay only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

These soils are generally unsuited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites for planting trees; however, onsite investigation is needed.

These soils generally are not suited to sanitary facilities because of the steep slopes of both soils and the shallowness over bedrock of the Tassel soil. A suitable alternative site should be selected. The sides of shallow excavations in the Busher soil can cave in unless they are shored. Dwellings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. The soft bedrock generally can be easily excavated during the construction of dwellings with basements. The soft bedrock generally can be excavated during the construction of roads. Cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit VIs-4, dryland. The Tassel soil is in the Shallow Limy range site, and the Busher soil is in the Sandy range site. These soils are in windbreak suitability group 10.

TcG—Tassel-Busher-Rock outcrop complex, 11 to 60 percent slopes. These steep and very steep, well drained soils and areas of Rock outcrop are on uplands. The shallow Tassel soil is on narrow ridgetops and the upper part of dissected side slopes. The deep Busher soil is on side slopes that are typically less than 30 percent. The Tassel and Busher soils formed in material that weathered from fine grained sandstone. The areas of sandstone Rock outcrop are on ridgetops and the upper part of side slopes. Areas range from 20 to 240 acres in size. They are 40 to 60 percent Tassel soil, 20 to 30 percent Busher soil, and 10 to 20 percent areas of Rock outcrop. The two soils and the areas of Rock outcrop are so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Tassel soil has a surface layer of grayish brown, very friable loamy very fine sand about 3 inches thick. The subsurface layer is brown, very friable, calcareous loamy very fine sand about 5 inches thick. The underlying material is brown, calcareous loamy very fine sand. White, fine grained sandstone bedrock is at a depth of about 14 inches. In some places the soil contains more clay and less sand.

Typically, the Busher soil has a surface layer of grayish brown, very friable fine sandy loam about 10 inches thick. The subsurface layer is grayish brown, very friable very fine sandy loam about 3 inches thick. The subsoil is pale brown, very friable very fine sandy loam about 12 inches thick. The underlying material is pale brown, loamy very fine sand to a depth of 42 inches. The lower part is calcareous. It is white, fine grained sandstone bedrock to a depth of 60 inches or more. In some places the soil contains more sand. In other places the carbonates are leached from the profile.

Typically, the areas of Rock outcrop consist of fine grained sandstone. Thin to thick layers of strongly cemented sandstone alternate with layers of weakly cemented sandstone. In some places at similar elevations are outcrops of gravel.

Included with this unit in mapping are small areas of the excessively drained Dix soils, which have very gravelly coarse sand at a depth of 10 to 20 inches and are on narrow ridgetops. Included soils make up about 10 percent of the unit.

Permeability is moderately rapid in the Tassel and Busher soils. Runoff is rapid in the Tassel and Busher soils and is very rapid in the areas of Rock outcrop. Available water capacity is very low in the Tassel soil and moderate in the Busher soil. The organic matter content is low in the Tassel soil and moderately low in the Busher soil. The root zone is shallow in the Tassel soil and deep in the Busher soil.

Nearly all of the acreage in this map unit supports native grasses and savannah vegetation of native grasses interspersed with trees and is used as rangeland (fig. 15).

This unit is unsuited to farming because of the slope and the shallow root zone in areas of the Tassel soil and the areas of Rock outcrop.

If the Tassel soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, blue grama, sand bluestem, and threadleaf sedge. These species make up 55 percent or more of the total annual forage. Prairie sandreed, needleandthread, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and sand bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the Busher soil is used as range, the climax vegetation is dominantly little bluestem, needleandthread, prairie sandreed, and threadleaf sedge. These species make up 60 percent or more of the total annual forage. Other perennial grasses, forbs, and shrubs make up the rest. Ponderosa pine covers 5 to 15 percent of the area. If subject to continuous heavy grazing, little bluestem decreases in abundance and is replaced by hairy grama, needleandthread, and prairie sandreed. If overgrazing continues for many years, the woody plants increase in abundance.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope and the rocky terrain can hinder the movement of livestock. Brush management may be needed to control woody plants that invade the site.

These soils are generally unsuited to trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Small areas are suitable sites

Figure 15.—An area of rangeland on Tassel-Busher-Rock outcrop complex, 11 to 60 percent slopes.

for planting trees; however, onsite investigation is needed.

These soils generally are not suited to septic tank absorption fields because of the slope of both soils and the shallowness over bedrock of the Tassel soil. A suitable alternative site should be selected. The sides of shallow excavations in the Busher soil can cave in unless they are shored. Dwellings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded. The soft bedrock generally can be excavated during the construction of roads. Cutting and filling can provide a suitable grade for roads.

These soils are assigned to capability unit VIIs-4, dryland. The Tassel soil is in the Shallow Limy range site, and the Busher soil is in the Savannah range site. Both soils are in windbreak suitability group 10. The Rock outcrop is not assigned to interpretive groupings.

UyB—Ulysses loam, 1 to 3 percent slopes. This very deep, very gently sloping, well drained soil is on side slopes and summits in the uplands. It formed in calcareous loess. Areas range from 10 to more than 200 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is grayish brown, friable loam about 6 inches thick. The subsoil is friable, calcareous silt loam about 12 inches thick. The upper part is brown, and the lower part is pale brown. The underlying material to a depth of 60 inches is very pale brown, calcareous silt loam. In some areas the dark surface layer is thicker. In other areas the soil has a buried horizon. In a few areas carbonates are at or near the surface.

Included with this soil in mapping are small areas of Alliance, Keith, and Rosebud soils. The included soils are in landscape positions similar to those of the

Ulysses soil. Alliance and Keith soils contain more clay in the subsoil than the Ulysses soil. Rosebud soils are moderately deep to weakly cemented, fine grained, limy sandstone bedrock and contain more clay in the subsoil than the Ulysses soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Ulysses soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Contour farming helps to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity or sprinkler irrigation system can be used on this soil. Less land preparation is needed if a sprinkler irrigation system is used. Timely application and efficient distribution of water are needed. If a gravity irrigation system is used, land leveling is needed to provide a proper grade. In areas that are cut during land leveling, the organic matter content can be increased by returning crop residue to the soil. The soil commonly is deficient in phosphorus and zinc in cut areas. Reducing the grade in the row by adjusting the direction of the row results in an even distribution of water and helps to control erosion and increase the water intake rate. A tailwater recovery system can be constructed to conserve water.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. The lack of seasonal rainfall is the main limitation. An irrigation system can provide the supplemental moisture needed during periods of insufficient rainfall. Cultivation between the rows and careful use of the appropriate herbicide in the row help to control undesirable grasses and weeds. Planting trees on the contour and terracing help to control runoff and water erosion.

This soil generally is suited to septic tank absorption fields. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIe-1, dryland, and IIe-6, irrigated; Silty range site; and windbreak suitability group 3.

UyC—Ulysses loam, 3 to 6 percent slopes. This very deep, gently sloping, well drained soil is on side slopes in the uplands. It formed in calcareous loess. Areas range from 5 to 40 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is brown, very friable loam about 3 inches thick. The subsoil is friable, calcareous silt loam about 10 inches thick. The upper part is pale brown, and the lower part is very pale brown. The underlying material is very pale brown and calcareous to a depth of 60 inches. The upper part is silt loam, and the lower part is very fine sandy loam. In some areas the dark surface soil is thicker. In a few areas carbonates are at or near the surface.

Included with this soil in mapping are small areas of Alliance, Keith, and Rosebud soils. Alliance soils are in landscape positions similar to those of the Ulysses soil. They have more clay in the subsoil and have weakly cemented, fine grained, limy sandstone at a depth of 40 to 60 inches. Keith soils have more clay in the subsoil than the Ulysses soil. They are deeper to free carbonates and are typically on the slightly higher side slopes and upland divides. Rosebud soils are in landscape positions similar to those of the Ulysses soil.

They are moderately deep to weakly cemented, fine grained, limy sandstone bedrock and contain more clay in the subsoil. Included soils make up 10 to 15 percent of this unit.

Permeability is moderate in the Ulysses soil, and available water capacity is high. Runoff is medium. The organic matter content is moderately low. The water intake rate is moderate.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas are used as rangeland.

If used for dryland crops, this soil is suited to winter wheat and millet. Soil blowing and water erosion are moderate hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserve moisture. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to corn; alfalfa; dry, edible beans; and wheat. Water can be supplied by a sprinkler irrigation system. Water erosion is the principal hazard. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at the proper grade can help to control erosion. Timely application and efficient distribution of water are needed. The proper rate of water application and the use of terraces help to control water erosion and runoff. A gravity irrigation system is poorly suited to this soil because of the slope. Less land preparation is needed if a sprinkler irrigation system is used. If a gravity irrigation system is used, extensive land leveling is needed to provide a proper grade.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying methods reduce the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Water erosion and soil blowing are principal hazards. The lack of seasonal rainfall is the main limitation. Planting trees on the contour and terracing help to control runoff and water erosion. An irrigation system can provide the supplemental moisture needed during periods of insufficient rainfall. Cultivation between the rows and careful use of the appropriate herbicide in the row help to control undesirable grasses and weeds.

This soil is generally suited to septic tank absorption fields. The foundations of dwellings should be strengthened and backfilled with coarse material to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

This soil is assigned to capability units IIIe-1, dryland, and IIIe-6, irrigated; Silty range site; and windbreak suitability group 3.

VdD—Valent loamy fine sand, 6 to 9 percent slopes. This very deep, strongly sloping, excessively drained soil is on narrow ridgetops and side slopes in the dunelike uplands. It formed in uniform sandy eolian material that weathered from a variety of sources. Areas range from 5 to 60 acres in size.

Typically, the surface layer is brown, very friable loamy fine sand about 6 inches thick. The transitional layer is brown, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of 60 inches is loamy fine sand. The upper part is pale brown, and the lower part is calcareous and light gray and very pale brown. In some places the surface soil is thicker and darker. In other places free carbonates are nearer to the surface.

Included with this soil in mapping are small areas of Busher, Duroc, Jayem, and Keith soils. Busher soils have a dark surface layer that is thicker than that of the Valent soil. They have sandstone between a depth of 40 to 60 inches and are on ridgetops and convex side slopes. Duroc soils contain more clay and less sand in the profile than the Valent soil. They have a dark surface layer that is more than 20 inches thick and are on narrow upland drainageways and in swales. Jayem soils are in landscape positions similar to those of the Valent soil and are loamy. Keith soils have a dark surface layer that is thicker than that of the Valent soil. They contain more clay and less sand in the profile than the Valent soil and are on upland divides and side slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. Runoff is slow. The organic matter content is low. The water intake rate is very high.

Most of the acreage of this soil is used as rangeland. A few small areas are cultivated and are used for dryland farming.

If used for dryland crops, this soil is poorly suited to winter wheat and millet. Soil blowing and water erosion are severe hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulch with small grain or no-till plant with row crops, keeps crop residue on the surface and is an effective way to control soil blowing and water erosion and conserve moisture. Stripcropping helps to control soil blowing. Terraces and contour farming help to control water erosion. Returning crop residue to the soil and applying manure help to maintain tilth, increase the content of organic matter, and improve the water intake rate.

If irrigated, this soil is poorly suited to corn; alfalfa; dry, edible beans; and wheat. Water can be applied by a sprinkler irrigation system. Water erosion and soil blowing are severe hazards. A winter cover crop helps to control soil blowing. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing. The efficient use of irrigation water is a management concern because of the slope. Adjusting the water application rate to the water intake rate of the soil helps to control excessive runoff and erosion.

A gravity irrigation system is unsuited to this soil. Because of the slope, this soil cannot be easily managed for irrigated crops.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 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. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. The survival and growth rates of adapted species are fair. Soil blowing and water erosion are severe hazards. The lack of seasonal rainfall is the main limitation. Planting trees on the contour and maintaining strips of sod between the rows help to control soil blowing, prevent competition from weeds and undesirable grasses, and control water erosion. The trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Supplemental moisture can be provided by an irrigation system during periods of scarce rainfall.

The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. In areas where the slope is less than 8 percent, this soil is generally suited to dwellings and roads. In areas where the slope is 8 percent or more, dwellings need to be designed so that they conform to the natural slope of the land, or the soil can be graded. In areas where the slope is 8 percent or more, cutting and filling can provide a suitable grade for roads.

This soil is assigned to capability units VIe-5, dryland, and IVe-11, irrigated; Sands range site; and windbreak suitability group 7.

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 Natural Resources Conservation Service.

About 548,000 acres in the survey area, or nearly 72 percent of the total acreage, meets the soil requirements for prime farmland when the soil is irrigated.

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 have limitations or hazards, such as a seasonal high water table, frequent flooding during the growing season, or inadequate rainfall, qualify as prime farmland only in areas where these limitations or hazards have been overcome by such measures as drainage, flood control, or irrigation. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Use and Management of the Soils

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 to prevent 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 and windbreaks; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational 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 under the heading "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

William E. Reinsch, conservation agronomist, Natural Resources Conservation Service, Lincoln, Nebraska, 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 Natural Resources Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants 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 the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Cropland amounts to about 72 percent of the total farmland in Cheyenne County. Nearly 9 percent of the cultivated cropland is irrigated. Small grains are the main dryland crop. Corn and dry beans are the main irrigated crops. Hay makes up most of the rest of the acreage of cropland, along with other minor crops.

Dryland Farm Management

Although dryland cropland is scattered through the county, the greatest concentration of wheat-fallow rotation is in the north and northeastern parts of the county. Dryland crops are grown mainly on silty soils in the uplands in the Alliance-Duroc-Kuma and Kuma-Keith-Duroc associations.

In the county, insufficient rainfall commonly is a limiting factor affecting crop production. Water and wind are erosive factors that can prevent maximum crop production. Good management in areas used for dryland crops reduces the water runoff rate, controls the hazard of erosion, conserves moisture, and improves tilth.

Stripcropping, the use of crop residue, and a conservation tillage system that keeps crop residue on the surface help to control water erosion. Keeping crop residue on the surface or growing a protective plant cover minimizes crusting during and after heavy rains. In winter the stubble holds snow on the field and thus increases the moisture supply. Mechanical practices, such as terraces, reduce the length of slopes and thus reduce the water runoff rate and help to control erosion. Level terraces are most practical on long and rather smooth, moderately sloping upland soils.

In the county, erosion is the major problem on nearly all of the soils used as cropland and in areas of pasture that have been overgrazed. All of the soils are susceptible to soil blowing and water erosion. The winds in the county are more westerly in winter and northwesterly in spring. Erosive wind energy is the most severe in April.

Soil blowing is a major problem in the county because of the climatic conditions, but the hazard is not as great as in some of the surrounding counties. For example, in areas of the Alliance soils, the soil layers that are dark are thinner on the A slope than on the B or even on the C slope. This is partly because of the landscape position and exposure to wind. Keeping crop residue on the surface throughout the winter or until planting helps to control soil blowing. A conservation tillage system that leaves crop residue on the surface, along with stripcropping, is the most economical control for soil blowing.

Contour stripcropping, wind stripcropping, and a conservation tillage system can be used to control soil blowing and water erosion on cropland. Contour stripcropping is best suited to soils in areas where water erosion and soil blowing are problems. The strips should be kept narrow because of the direction of the prevailing winds.

Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Soil blowing results in damage to growing crops, rangeland, and the quality of life in the area.

Controlling erosion minimizes the pollution of streams by sedimentation and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

A cropping system and management practices that control erosion should be planned to fit the soil in each field. The sequence of crops grown on a field combined with practices needed for the management and conservation of the soil is known as a Resource Management System. Resource Management Systems for dryland cropland should maintain tilth, fertility, and a surface cover that protects the soil from erosion and help to control weeds, insects, and diseases.

Tilth is an important factor affecting the germination of seeds and infiltration of water into the soil. Soils that have good tilth are granular and porous. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth.

Resource Management Systems vary according to the soils on which they are used. For example, a Resource Management System for Alliance loam, 3 to 6 percent slopes, would include management practices, such as contour stripcropping 120 foot wide and a minimum of 500 pounds of small grain residue on the surface after planting or vegetative practices, such as a conservation tillage system that maintains 1,000 pounds of small grain residue on the surface or 40 percent of the surface covered with crop residue after planting.

Occasionally, tillage is needed to prepare a seedbed, control weeds, and provide a favorable place for plants to grow. Excessive tillage, however, reduces the plant cover and increases the hazard of erosion. Tillage practices should be limited to those that are essential. Various conservation tillage practices can be used in the county. No-till planting is well suited to small grain and row crops. Grasses and legumes can be established without further seedbed preparation by drilling into a cover of stubble.

Soil fertility is naturally lower in most of the eroded soils and the moderately deep soils than in the uneroded deep soils. All soils, however, require additional plant nutrients for optimum production.

The kind and amount of fertilizer to be applied to the soils used for dryland crops 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.

Irrigation Management

Only about 9 percent of the cropland in Cheyenne County is irrigated. Corn and field beans are grown on 54 percent of the irrigated cropland. A smaller acreage is used for alfalfa hay and other crops. The irrigation water is obtained from wells. Sprinkler systems are scattered throughout the county. The greatest concentration of irrigation is along Lodgepole Creek. Gravity or sprinkler systems are suited to the areas used for row crops. Alfalfa is generally irrigated by border, ditch, or sprinkler systems.

The cropping sequence on soils that are well suited to irrigation consists mostly of row crops. A crop rotation that includes different crops, such as corn and field beans, helps to control the diseases and insects that are common if the same crop is grown year after year.

Gently sloping soils, such as Keith loam, 3 to 6 percent slopes, are subject to water erosion if they are furrow irrigated down the slope. If furrow irrigated, these soils should be contour bench leveled, or contour furrows and a ridge-till conservation tillage system should be used. Land leveling increases the efficiency of irrigation because it results in an even distribution of water.

Contour farming and conservation tillage practices that keep crop residue on the surface help to control both water erosion and soil blowing 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 soils. Some soils, such as Keith loam, 3 to 6 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 type of sprinkler irrigation in the county is the center-pivot system.

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 tailwater recovery pit can be installed to trap excess irrigation tailwater. This water can then 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. 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 Natural Resources Conservation Service. Estimates of the cost of irrigation equipment can be obtained from local dealers and manufacturers.

Weed Control

A suitable cropping sequence or appropriate herbicides help to 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. The applications of some herbicides on sandy soils, such as Dwyer soils, that have low colloidal clay content and on soils that are low in content of organic matter, such as Mitchell soils, can cause crop damage.

Management of Pasture and Hayland

Areas that are used for hay or pasture should be managed for maximum forage production. After a pasture is established, the grasses should be kept productive. In Cheyenne County pastures of cool-season grasses consist mainly of western wheatgrass, intermediate wheatgrass, and pubescent wheatgrass. These grasses start to grow in the spring and reach their peak growth in May and June. They are dormant during July and August unless the pasture is irrigated. For this reason, these cool-season grasses should be managed in a planned grazing system along with native range pastures. The management of introduced pastures should include a pasture rotation. These grasses are more productive when they are grazed in the spring after the grass has reached a height of 5 or 6 inches. Until the plants reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in the spring or too late in the fall weakens the plants. Other cool-season grasses and legumes that are suited to irrigated areas of the county are bromegrass, creeping foxtail, meadow bromegrass, reed canarygrass, alfalfa, and cicer milkvetch.

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 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, barnyard 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 Natural Resources 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, for windbreaks, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit *(4)*. 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, droughty, or alkaline; and *c,* used in only some parts of the United States, 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, IIe-3 and IIIe-1.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of the map units in this survey area is given in the section "Detailed Soil Map Units," in the yields table, and in the Interpretive Groups that follow the tables at the back of this survey.

Rangeland

Kenneth L. Hladek, range conservationist, Natural Resources Conservation Service, helped prepare this section.

About 25 percent of the acreage in Cheyenne County is native grassland used for grazing or hay. Supplemental feed for use by livestock is produced in some areas of cropland. The production of beef cattle is an important agricultural enterprise in the county. As a result, proper management of range and hayland is one of the most important parts of the conservation program in the county. Good range management can improve forage yields and thus increase livestock production. This section can aid ranchers and conservationists in planning the management of range. It defines range sites, explains the evaluation of range condition, and describes planned grazing systems and other aspects of range and hayland management.

Range condition is the present state of the vegetation on a range site compared with the potential, or climax, vegetation on that site. The climax vegetation is a stable plant community that represents the most productive combination of forage plants on a given range site. It reproduces itself naturally and changes little as long as the climate and soil conditions remain unchanged.

Determining the range condition provides an approximate measure of the deterioration that has taken place in the plant community. More importantly, it provides a basis for predicting the degree of improvement possible under different kinds of management. Four condition classes are used to indicate the departure from the potential, or climax, vegetation. They are excellent, good, fair, and poor.

All food that plants use for growth is manufactured in their leaves. The removal of plant leaves during the growing season 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 range use. Plants respond to grazing in different ways. Some decrease in abundance, some increase in abundance, and others not originally part of the plant community can invade the range site. These plant responses to grazing are used in classifying the range condition.

The *decreaser species* are those species in the original plant community that decrease in abundance if grazed closely and continuously during the growing season. The *increaser species* are those species in the original plant community that normally increase in abundance as the decreaser plants become less abundant. The *invader species* are those species not in the original plant community that begin to grow on a site after the decreaser and increaser species have been removed or are less extensive.

Once the range condition has been determined, further investigation can indicate whether it is improving or deteriorating in order to adjust grazing use and management. Important factors affecting trends are vigor in the plant community and the reproductive capacity of both desirable and undesirable plant species.

The goal of range management is an excellent range condition. The highest yields are obtained on a sustained basis if the range is in excellent condition. Also, soil blowing and water erosion are kept at a minimum, and maximum use is made of rainfall and snowmelt.

The following paragraphs describe the management needed on the range in the county. This management includes proper grazing use, planned grazing systems, deferred grazing, range seeding, control of blowouts, brush control, and management of native hayland.

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 of the soils, 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.

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 the 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 to help control erosion, and increases forage production. The proper degree of grazing on range during the entire growing season removes no more than 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, and the kinds and classes of livestock.

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 a measurement of livestock numbers based on the equivalent of one mature cow, weighing approximately 1,000 pounds, and a calf that is at least 4 months of age. An *animal unit month* is the forage or feed necessary to sustain an animal unit for 1 month. The range site for each map unit and the range condition are used to determine the animal unit months for each pasture. The proper stocking rates for range sites in excellent condition are given for many of the soils under the heading "Detailed Soil Map Units." The rates are lower for range sites in less than excellent condition.

For example, in an area of Bridget very fine sandy loam, the suggested initial stocking rate is 0.5 animal unit month per acre if the range is in excellent condition. Thus, a 640-acre pasture in excellent condition can carry 320 animal units for 1 month. If the pasture is to be grazed continuously for 5 months, then the suggested initial stocking rate would be 64 animal units. The stocking rate is based on the condition of the existing plant community and the average annual production of each site. Because of the weather conditions, forage production can vary. 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 most heavily in areas near livestock watering and salting facilities, in the more gently sloping areas, and in areas near roads and trails. Distant corners of pastures and steep areas may be undergrazed. Poor grazing distribution can result from too few watering facilities or from poorly distributed watering and salting facilities, shade, and supplemental feed. A concentration of livestock results in severe overuse of that area while other areas are left unused. Carefully locating fences and salting and watering facilities 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 from livestock. Cross fences should follow natural land features and range sites as much as possible. The potential stocking rates should be similar for all pastures. Generally, the smaller pastures are managed more efficiently than the larger pastures. This efficiency should be considered when the pasture size is determined.

Properly locating salting facilities is one of the easiest means of achieving a more uniform distribution of grazing in a pasture. The salting facilities should be located away from watering facilities. Salt can be easily moved to areas that are undergrazed and can be relocated at different times throughout the grazing season. In areas of soils on the Sands and Sandy range sites, relocating the salting station each time that salt is provided lessens the hazard of soil blowing.

Properly located watering facilities also can improve the distribution of grazing. In Cheyenne County, livestock water is often drawn from wells that are mainly pumped by windmills. Some dugouts are on the wetter range sites. Stockwater dams are mainly in the heavier textured soil associations. They provide livestock water where the drainage area provides adequate runoff. Watering facilities should be spaced at varying distances, depending on the terrain. In rough or hilly areas, the distance between facilities should not be more than 0.5 mile. In the more level areas, it should be no more than 1.0 mile. If the distance is too far, the areas near water will be overgrazed.

Range management also is dependent on the kinds and classes of livestock grazing the pasture. Cattle, sheep, and horses have different grazing habits and nutritional needs. Grazing habits also differ among classes of cattle. Yearlings graze the steeper areas and will graze a pasture more uniformly than cows with calves. Their tendency to trail along fence lines can result in erosion. Cow-calf pairs graze more on the gentle slopes and tend to stay closer to watering facilities than yearlings. They are not so active as yearlings. Livestock distribution may be more of a problem in pastures stocked with cows and calves.

Planned Grazing Systems

Planned grazing systems are effective in achieving maximum forage production and livestock performance while controlling erosion. In a planned grazing system, two or more pastures are alternately rested and grazed in a planned sequence over a period of years. The rest period may be throughout the year or during all or part of the growing season. The same pasture is not grazed during the same period 2 years in a row. As a result, plant vigor, the plant community, and the range condition improve. Planned grazing systems often result in a uniform distribution of grazing and maintain maximum productivity over a period of years. They help to overcome the adverse effects of drought or other climatic conditions on the plants. Planned grazing systems must be adapted to the needs of the rancher. Fences, watering facilities, range sites, range condition, kinds or classes of livestock, and economic factors are used to determine the best system for a particular ranch. Planned grazing systems can eventually increase stocking rates. They also help to control the number of parasites and the likelihood of disease among cattle because the pastures are generally cleaner than those continually grazed.

Deferred Grazing

Deferred grazing allows the plants a prolonged rest period. If grazing is deferred throughout the growing season, the plant community can improve rapidly. The undisturbed grasses leave a mulch at the surface, thus increasing the rate of water infiltration and reducing the susceptibility of the soil to erosion. Deferred grazing allows the desirable species to mature, flower, and seed naturally.

The need for deferment is based on the range condition. To be beneficial, deferment should be for a minimum of 3 months and should coincide with the food storage period of the desirable plants. This period varies, depending on the grass species. It generally is from August to October for warm-season grasses. On some sites a deferment of 3 months is all that is needed, while on other sites a deferment of two complete growing seasons may be needed. Following the period of deferment, the pastures can be grazed after the first significant frost in the fall or early in the spring.

Range Seeding

In some areas, such as formerly cultivated fields, abandoned farmsteads, and severely and continuously overgrazed sites, improved range management alone cannot restore a satisfactory cover of native vegetation. Range seeding may be needed in these areas.

Good stands of native grasses can be reestablished if the seedbed is properly prepared, well adapted species of native grasses are selected for planting, the correct seeding methods are used, and careful management is applied after seeding. Range seeding is most successful when the seedbed is firm and has a cover of mulch. The cover of mulch helps keep the soil moist, lowers the temperature of the surface soil, and helps to control erosion. It can be provided by planting a temporary crop, such as sudangrass, millet, or sorghum. The grass can be seeded directly into the stubble the following fall, winter, or spring. Tillage should be avoided because a firm seedbed is needed. On the sandier soils, the hazard of soil blowing can be controlled by preparing the seedbed and planting the seeds in narrow strips over a period of several years or planting the seeds with a range interseeder.

Seeding mixtures should consist of adapted native grasses that are normally on the site. Consequently, they vary according to the range sites. Using a grassland drill with depth bands ensures the proper placement of seeds at a uniform depth. A range interseeder should be used in areas of soils in the Sands and Sandy range sites and in areas that have a severe hazard of soil blowing when the soils are tilled during seedbed preparation.

Newly seeded areas should not be grazed until after the grass is established. Establishment may take 2 or 3 years, depending on the grass species, the range site, and the method of planting. Initial grazing of these areas should be light. Grazing in late fall and winter or early in spring helps to control weeds until the grass is established.

Additional information about appropriate grass mixtures, grassland drills, and planting times can be obtained from the local office of the Natural Resources Conservation Service.

Control of Blowouts

Blowouts form in areas of sandy soils where the vegetation has been removed either by tillage or by heavy grazing. Most blowouts are along livestock trails or in overgrazed areas. Large blowouts form in areas near wells, where livestock tend to concentrate. Smaller blowouts generally form along trails or fence lines. Drought increases the likelihood that blowouts will form.

Unless stabilized, blowouts are likely to become larger. The wind blows the bare sand to bordering areas, where the windblown sand smothers the vegetation. A planned grazing system can stabilize many blowouts in 4 or 5 years. A stable grade should be established on the steep banks around the edge of the blowout. Otherwise, the steep slopes cannot revegetate and will be a constant source of shifting sand. Locating wells and salting facilities away from the blowout helps to prevent concentration of livestock in the area.

In areas where a natural seed source is not available and on large blowouts, reseeding may be necessary. Fences are needed to keep livestock out of the blowout. The edges should be shaped to a suitable grade. If a fast-growing cover crop is planted in the spring, a suitable mixture of native grass seed can be drilled into the stubble from the crop. The cover crop helps to protect the surface from soil blowing and creates a good 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 the blowout is seeded, the mulch helps to prevent the damage caused by windblown sand while the grasses are becoming 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, and sand sagebrush are the main brush species in Cheyenne County. These plants encroach on the land and reduce forage yields by shading out desirable grasses. Western snowberry grows mainly in areas of loess and in transitional areas between deposits of loess and deposits of sand. Small soapweed can be a problem in areas of soils in the Sands and Thin Loess range sites. It can be controlled by selective grazing. If it is grazed during the winter, it loses vigor and may be broken off below the root crown. Feeding cottonseed cake as a protein supplement increases the amount of small soapweed that cattle consume. Applications of approved herbicide have limited effectiveness.

Western snowberry and sand sagebrush are best controlled by applications of approved herbicide. Repeated applications may be needed during successive years. Areas treated with herbicide should be deferred from grazing to allow adequate recovery of grasses. Recommendations of herbicides are available from the local office of the Natural Resources Conservation Service or from the county extension agent.

Management of Native Hayland

A very limited acreage of rangeland in Cheyenne County is used for the production of native hay. In most of these areas the soils have a seasonal high water table and are in the Wetland, Wet Subirrigated, and Subirrigated range sites. Hay is harvested in a few upland or valley areas that generally are used for grazing. These areas generally are in the Sandy Lowland, Sandy, or Sands range sites.

Proper management can maintain or improve the production of hay. Timely mowing is needed to maintain strong plant vigor and a healthy stand. If the pastures are not mowed during the period between the boot stage, which is just before the emergence of the seed heads, and seed maturity, the plant roots can store more carbohydrates. A mowing height of 3 inches or more helps to maintain plant vigor. Meadows can be moderately grazed without damage after the first frost in the fall.

Meadows should not be grazed or harvested for hay when the soil is wet or the water table is within a depth of 6 inches. Grazing or using heavy machinery during these periods results in the formation of small bogs, ruts, or mounds, which can hinder mowing in later years. After the ground is frozen, livestock can graze without damaging the meadows. Livestock should be removed in the spring before the ground thaws and the soil becomes wet.

If the drier areas are used for hay, the optimum time for mowing is just before the dominant grasses reach the boot stage. Mowing should be regulated so that desirable grasses remain vigorous and healthy. Early mowing allows the plants enough time to recover. The recovered plants help to hold snow on the surface and thus increase the moisture supply.

Technical assistance in managing range and hayland can be obtained from the local office of the Natural Resources Conservation Service.

Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Natural Resources Conservation Service, helped prepare this section.

Windbreaks and environmental plantings have been planted at various times on most farmsteads and ranch headquarters in Cheyenne County (fig. 16). Siberian elm and eastern redcedar are the predominant species. Other species include green ash, honeylocust,

Figure 16.—Windbreaks protect farmsteads, such as this one on Keith loam, 1 to 3 percent slopes, from severe winds.

hackberry, boxelder, Russian-olive, ponderosa pine, blue spruce, honeysuckle, lilac, Siberian peashrub, cotoneaster, and common chokecherry. Eastern cottonwood also is common on farmsteads in the Las-Glenberg-McCook association.

On many farmsteads, Siberian elm is the predominant species. Supplemental plantings of evergreen trees and shrubs are needed to provide high-quality protection from the wind in these areas. Planting trees and shrubs is a continual process because short-lived trees, such as Siberian elm, pass maturity and deteriorate; some trees are destroyed by insects, diseases, or storms; and new plantings are needed on expanding ranches.

Very few field windbreaks and shelterbelts are in the county. A few trees remain, however, from the Timber Claim Act of 1873. These trees consist of blocks of boxelder or green ash.

The species of trees and shrubs grown as windbreaks should be those that are suited to the soils on the selected site. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate of trees and shrubs. Selecting suitable species is the first step toward ensuring survival and a maximum growth rate.

Trees and shrubs are difficult to establish in the county because of a limited supply of moisture. Proper site preparation before planting and control of competing vegetation after planting are the major management objectives when establishing windbreaks. Cover crops may be needed to protect new plants from hot winds and windblown soil. Supplemental watering using drip irrigation systems or other irrigation systems can provide the moisture needed during establishment.

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 that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Natural Resources Conservation Service, the Cooperative Extension Service, the South Platte Natural Resources District, or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 10 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 recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational 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 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 has few or no stones, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones 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 or stones 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 free of stones, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or sand and gravel 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 on the surface.

Wildlife Habitat

Robert O. Koerner, biologist, Natural Resources Conservation Service, helped prepare this section.

Wildlife habitat in Cheyenne County varies, depending on the soil, topography, vegetation, slope, and drainage pattern. The following paragraphs describe the kinds of wildlife habitat in the associations described under the heading "General Soil Map Units."

The Bayard-Bridget-Duroc association has nearly level to gently sloping cropland. This association is suitable habitat for ring-necked pheasants because of the available food in the cropland and the water and cover along Lodgepole Creek.

The Las-Glenberg-McCook association is adjacent to Lodgepole Creek and offers a diversity of cover types. Woody species, such as willow and cottonwood, are adjacent to the creek because of the high water table. Other woody species, such as elm, boxelder, hackberry, terrace native plum, chokecherry, and golden currant, are on the higher part of the stream terrace.

Parts of the association support native grass species, such as big bluestem, little bluestem, sideoats grama, blue grama, and western wheatgrass. Introduced grasses are bromegrass, intermediate wheatgrass, and alfalfa. Crops include corn and wheat. This diversity of plants provides habitat for wildlife species, such as ring-necked pheasants, deer, songbirds, mink, muskrat, weasel, and beaver.

The other areas of cropland south of Lodgepole Creek are in the Kuma-Keith-Duroc and Alliance-Duroc-Kuma associations.

Some inclusions of the Lodgepole soil provide wetland habitat for shorebirds and waterfowl. Trees and shrubs are mainly around farmsteads. Additional field windbreaks can protect fields from soil blowing and water erosion and provide benefits to wildlife. The Kuma-Keith-Duroc and Alliance-Duroc-Kuma associations support substantial populations of antelope during years when the weather is favorable to their survival. Cottontail rabbits are scarce because of the lack of woody vegetation for winter and escape cover.

The Alliance-Duroc-Kuma, Kuma-Keith-Duroc, Rosebud-Sidney-Canyon, Altvan-Satanta-Johnstown, and Jayem-Duroc-Keith associations are predominantly cropland with varying slopes. Wheat and fallow is the predominant crop rotation, along with irrigated corn in areas where water is available. Trees and shrubs are generally lacking, except in pockets where additional moisture is available or in areas around farmsteads where they are planted. To increase the potential habitat for ring-necked pheasants and deer, more field windbreaks should be planted to eastern redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, and Siberian elm. Planting these species also helps to control soil blowing and water erosion. Contour stripcropping can also add diversity and increase the edge effect for wildlife.

The Canyon-Bayard-Rosebud, Dix-Altvan, Mitchell-Epping-Rock outcrop, Alliance-Canyon-Sidney, and Busher-Tassel associations are predominantly rangeland and wildlife habitat. Native grass species include little bluestem, sideoats grama, needleandthread, hairy grama, western wheatgrass, and threadleaf sedge. Moderate populations of antelope are in the northern part of the county in the Canyon-Bayard-Rosebud and Busher-Tassel associations. Antelope are in a habitat that has rough grassland terrain adjacent to areas of cropland. A small population of deer is throughout the county. The greatest concentration of deer is in the Bayard-Bridget-Duroc and Las-Glenberg-McCook associations. A small population of mourning doves is throughout the county.

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, 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 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, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and millet.

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, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, 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 flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, wheatgrass, and 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 boxelder, honeylocust, hackberry, and Siberian elm. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, common chokecherry, and American plum.

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, eastern redcedar, and Rocky Mountain 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 mountainmahogany, Amur honeysuckle, skunkbush sumac, lilac, and Peking cotoneaster.

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, saltgrass, 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 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 pheasant, meadowlark, field sparrow, and cottontail rabbit.

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, thrushes, woodpeckers, squirrels, raccoon, and deer.

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, and mink.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, sharptail grouse, meadowlark, and lark bunting.

Native Woodland

Keith A. Ticknor, forester, Natural Resources Conservation Service, helped prepare this section.

Native woody vegetation in Cheyenne County is on bottom land in areas of the Las-Glenberg-McCook association and on the steep uplands in areas of the Canyon-Bayard-Rosebud and Busher-Tassel associations. The woodland does not have commercial value because the acreage is small and concentrations are not large enough. However, the local use of woodland is an important resource.

Eastern cottonwood, or plains cottonwood, and peachleaf willow are the predominant species in areas of bottom land along the channel. Other species include Siberian elm, American plum, common chokecherry, boxelder, sandbar willow, and golden currant.

Ponderosa pine is scattered on the steep slopes in areas of the Busher-Tassel association. Also, some ponderosa pine grows in areas of rock outcrop in the Canyon-Bayard-Rosebud association near the Buffalo Bend area. Skunkbush sumac, golden currant, and western snowberry (white buckbrush) are species associated with ponderosa pine.

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. Ratings are given for 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 in 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 other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational 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; sand and 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, shrinking and swelling, 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 affect plant growth. Flooding, wetness, slope, stoniness, 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 landfill. 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 or to a cemented pan, and flooding affect absorption of the effluent. Bedrock interferes with installation. Cutbanks caving in 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, and flooding.

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. Slope and bedrock can cause construction problems, and sand 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 should 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 seasonal high water table, slope, and flooding affect both types of landfill. Texture, stones, soil reaction, and content of salts and sodium affect trench 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 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 stones or 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 the 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 depth to bedrock, amount of rock fragments, 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, slopes of 15 to 25 percent, or bedrock between depths of 40 to 60 inches. 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, bedrock shallower than 40 inches, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They 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. They 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. 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 is up to 12 percent silty 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 are free of stones, 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, stones, 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, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high 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 and for embankments, dikes, and levees. 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 (fig. 17). 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 stones or sand and gravel or salts. A high water table affects the amount of usable material. It also affects trafficability.

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 the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, amount of rock fragments, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by toxic substances in the root zone, such as salts. 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, 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, sand and 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. Large stones, 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, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

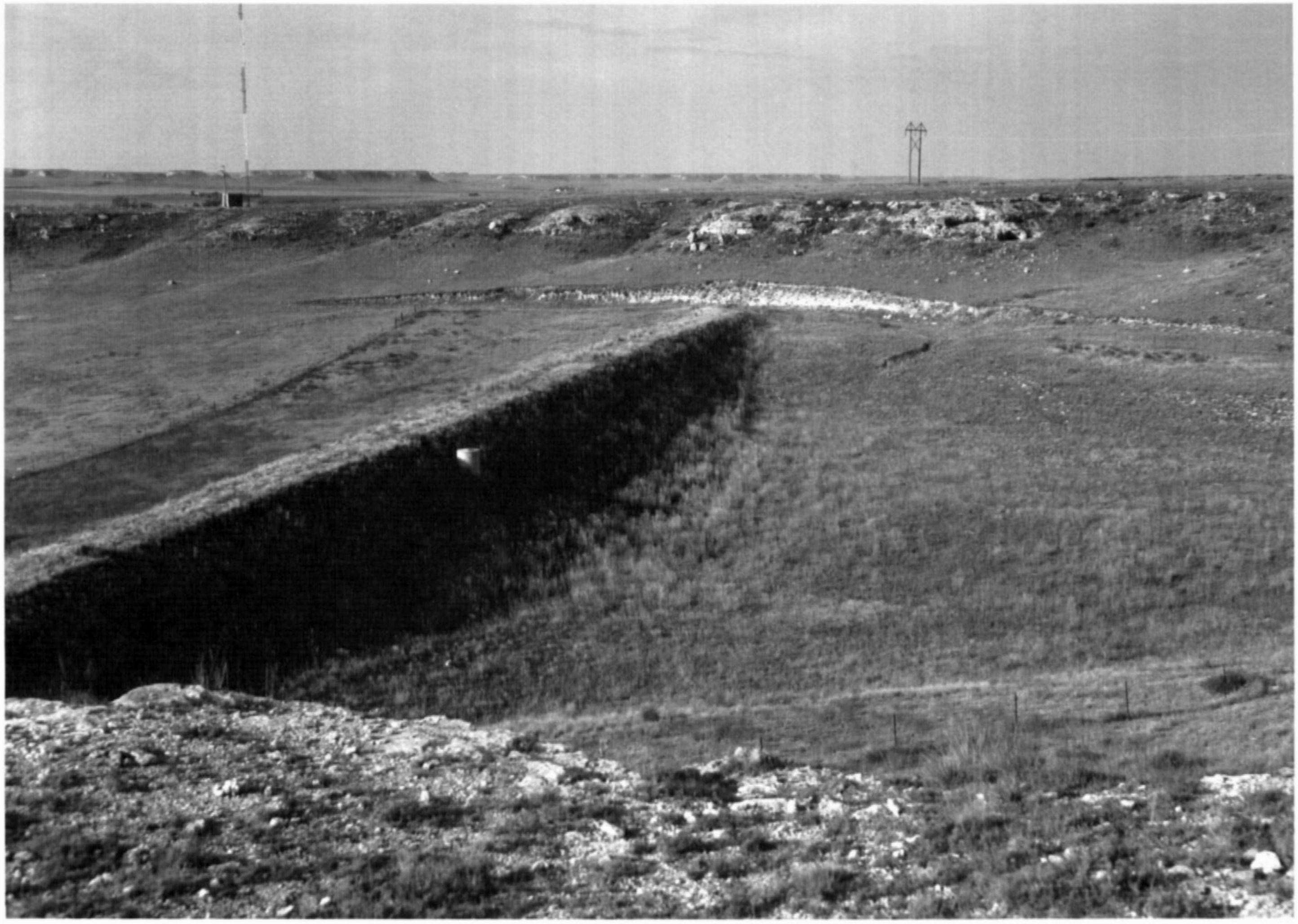

Figure 17.—Earthen dams protect lower lying areas from flooding on Bayard fine sandy loam, 3 to 6 percent slopes.

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 to 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 the heading "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. 18). "Loam," for example, is soil that is 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 *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

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 the group index numbers range from -4 for the best subgrade material to 32 for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 19.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-

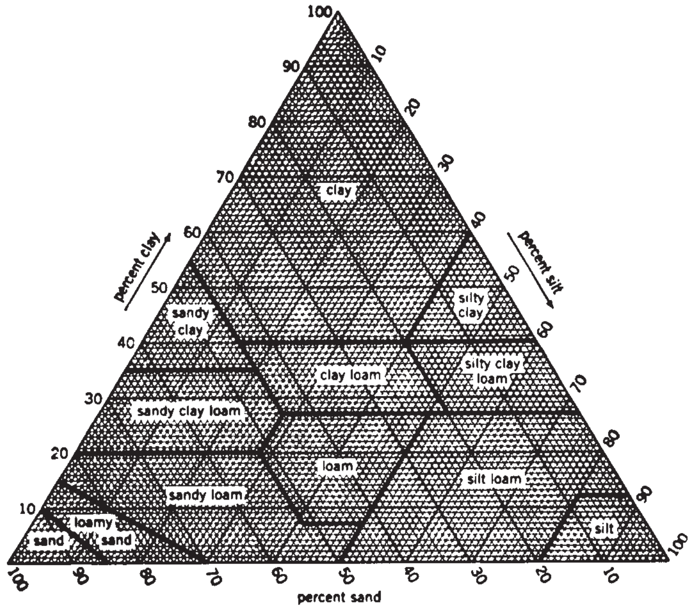

Figure 18.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

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 ovendry 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, 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 (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓-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 and septic tank absorption fields.

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 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 of soil 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 rock 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 not protected by vegetation 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 having a layer that impedes the downward movement of water or soils of 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 and 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 (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information about flooding 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 little or no horizon development.

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 estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are 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. Only saturated zones within a depth of about 6 feet are indicated.

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.

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 results in a severe hazard of corrosion. 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.

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 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); Specific gravity—T 100 (AASHTO). The group index number that is part of the AASHTO classification is computed by using the Nebraska Modified System.