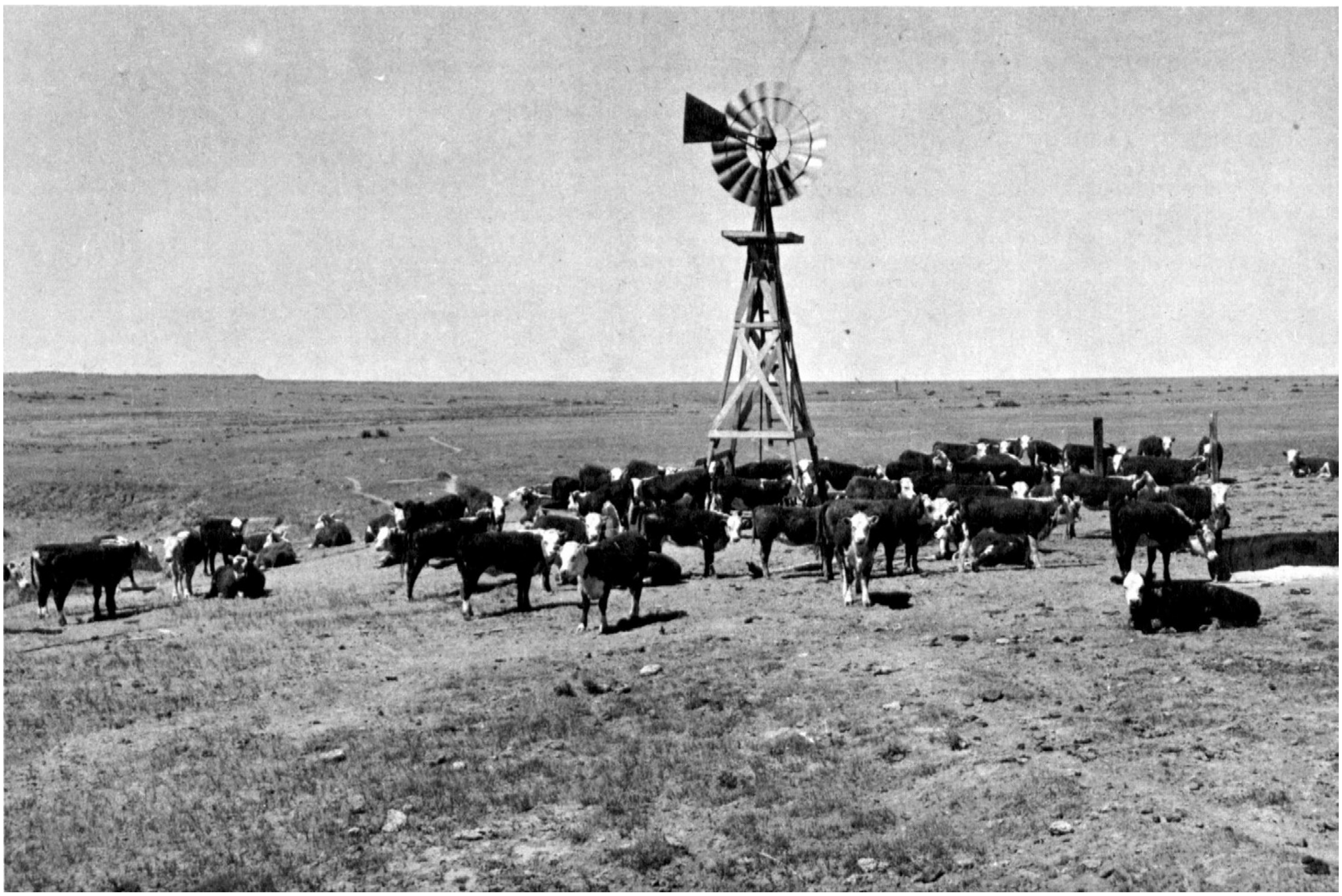
Series 1960, No. 28

Issued April 1966

SOIL SURVEY
PROWERS COUNTY
COLORADO



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
COLORADO AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Prowers County, Colo., will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid managers of irrigated tracts, who wish to plant windbreaks; add to soil scientists' knowledge of soils; and help prospective buyers and others in appraising a farm or other tract.

Locating the soils

At the back of this report is an index map and a soil map consisting of many sheets. The index map is numbered to correspond to the sheets of the soil map, so that the sheet showing any area can be located easily. On each map sheet, the soil boundaries are outlined and there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where it belongs. For example, an area on the map has the symbol BaB. The legend for the set of maps shows that this symbol identifies Baca clay loam, 0 to 3 percent slopes. That soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

In the "Guide to Mapping Units, Capability Units, and Range Sites" at the back of this report, each soil is listed in the alphabetic order of its map symbol. This guide gives the page where each soil is described, and the page of the capability unit and range site in which the soil has been placed. It also shows where to find the acreage of each soil, the yields that can be expected, and information about engineering uses of the soils.

Farmers and those who work with farmers can learn about the soils on a farm by reading the description of each soil and the description of the capability unit and other groups in which it has been placed. A convenient way of doing this is to turn to the soil map and list the soil symbols of a farm and then to use the "Guide to Mapping Units, Capability Units, and Range Sites" in finding the pages where each soil and its groupings are described.

Foresters and others interested in woodland can refer to the subsection "Woodland Management." In that subsection the kinds of trees suitable for windbreaks in irrigated areas are named, and some facts about management of windbreaks are given.

Game managers, sportsmen, and others concerned with wildlife will find information about the main kinds of wildlife and their food and cover in the subsection "Wildlife."

Ranchers and others interested in range will find the subsection "Use and Management of Range" helpful. In that subsection the soils of the county are placed in groups according to their suitability as rangeland, and the management of each group is discussed.

Engineers and builders will find in the subsection "Engineering Uses of Soils" tables that give engineering descriptions of the soils in the county; name soil features that affect engineering practices and structure; and rate the soils according to their suitability for several kinds of work.

Scientists and others who are interested can read about how the soils were formed and how they were classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Prowers County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the county.

* * * * *

Fieldwork for this survey was completed in 1960. Unless otherwise indicated, all statements in the report refer to conditions in the county at the time the survey was in progress. The soil survey of Prowers County was made as part of the technical assistance furnished by the Soil Conservation Service to the Prowers, Northeast Prowers, and Two Buttes Soil Conservation District.

Cover picture: Cattle on range in Prowers County.

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SOIL SURVEY OF PROWERS COUNTY, COLORADO

BY JAMES P. PANNELL, ROY J. LARSEN, M. BRUCE McCULLOUGH, RONALD E. MORELAND, AND STANLEY O. WOODYARD
SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH COLORADO AGRICULTURAL EXPERIMENT STATION

PROWERS COUNTY is in the southeastern part of Colorado (fig. 1) and has an area of 1,626 square miles. The Arkansas River, about 12 miles south of the Kiowa County line, crosses the county from west to east. This river and its tributaries drain all of the county. Lamar is the county seat.

The county is mainly agricultural, and 96,371 acres was irrigated in 1959. Irrigated crops provide the largest and most stable farm income. Dry-farmed crops, especially wheat, are grown extensively. Slightly less than half the county is in grass and is used for grazing.

The climate is generally mild. It is semiarid, and the annual precipitation is about 15 inches. The summers are long and have hot days and cool nights. In winter and spring, there are many windstorms of high velocity. Duststorms are common from February through April, especially in the drier years.

Much of the acreage used for dryfarming is subject to erosion by wind, and much of the soil has blown during years of drought. Crop failures are common during years of below-average precipitation.

The irrigated areas are used mainly to grow alfalfa, grain sorghum, sugar beets, barley, wheat, corn, onions, and cantaloups, or they are in irrigated pasture. Silting is common where the irrigation water is taken from ditches, for that water is muddy. Where drainage has been inadequate, some soils have become seeped and saline.

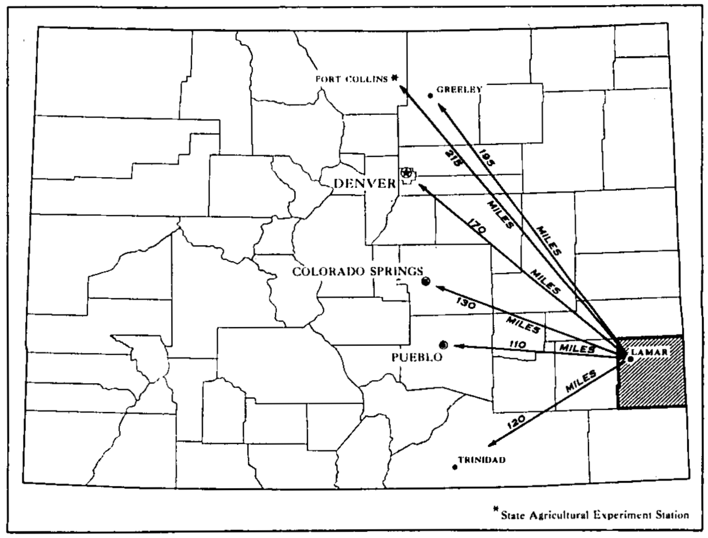

Figure 1.—**Location of Prowers County in Colorado.**

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Prowers County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Colby and Tivoli, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same

[1] DAVID M. COLEMAN, DONALD R. MARTIN, GLENN M. McCARTY, DONALD A. TETSELL, and EARNEST L. WESSWICK, Soil Conservation Service, assisted with the field survey.

texture belong to one soil type. Colby fine sandy loam and Colby silt loam are two soil types in the Colby series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Colby fine sandy loam, 1 to 3 percent slopes, is one of several phases of Colby fine sandy loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. They show this mixture of soils as one mapping unit and call it a soil complex. Other soils or land types are mapped as one unit because their differences are not significant in management. Such a unit is called an undifferentiated unit. Ordinarily, a complex or an undifferentiated unit is named for the major kinds of soil in it, for example, Colby-Ulysses complex, 1 to 3 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Loamy alluvial land, and are called land types rather than soils.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this report shows, in color, the soil associations in Prowers County, Colo. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The nine soil associations in Prowers County are shown in color on the general soil map at the back of this report and are described in the following pages. Five of these associations are on uplands and make up most of the county, and another large association is on the flood plains and low terraces of the Arkansas River. An association of shallow, gravelly breaks is widely scattered throughout the county, and one consisting of deep soils of the sandhills crosses the county south of the Arkansas River. A small association consisting of shallow to deep soils is in the southwestern part of the county.

1. Wiley-Colby Association

Deep, light-colored, medium-textured, nearly level or gently sloping soils

This association consists mostly of deep soils that developed in loess on the uplands. It is the largest association in the county and occurs north of the largely irrigated area and south of the sandhills. In most places slopes range from 0 to 5 percent, but some areas along drainageways are steeper. Figure 2 shows the main soils in this association and the underlying material.

Wiley and Colby silt loams are the dominant soils in this association. The Wiley soils, more extensive than the Colby, have a light-colored silt loam surface layer and a silty clay loam subsoil. The Colby soils have a light-colored silt loam surface layer and subsoil.

Also in the association are small areas of Baca, Goshen, and other soils and of Loamy alluvial land. Baca soils are in nearly level upland areas, and Goshen soils and

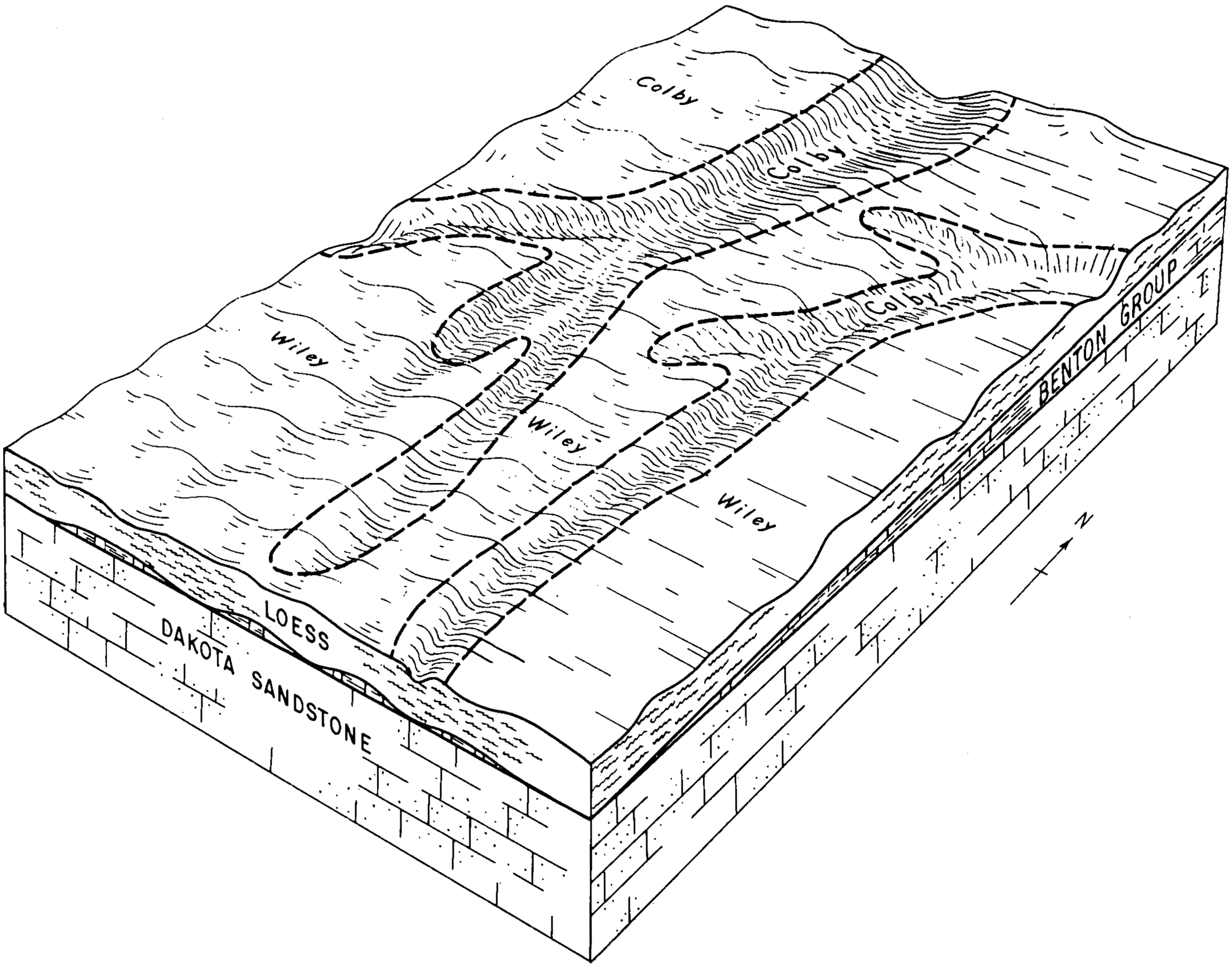

Figure 2.—**Main soils and underlying material in soil association 1.**

Loamy alluvial land are along the upland drainageways. Most of the other soils in the association were derived from limestone and shale and occur in areas where these formations crop out.

About three-fourths of the acreage of nearly level and gently sloping Wiley and Colby soils is under dryland cultivation, and the rest is in native grasses used for range. The principal crops are winter wheat, sorghum, and barley. Some small areas are irrigated by water pumped from wells. The kinds of crops irrigated are the same as those grown under dryland farming.

The soils in this association are highly susceptible to soil blowing if they are under dryland cultivation. On the slopes, water erosion is also a hazard. Drought and erosion cause many crop failures, and only when weather is favorable are good yields obtained. Under irrigation, the main problems are managing the irrigation water and maintaining fertility.

2. Richfield-Ulysses-Colby Association

Deep, dark-colored, medium-textured, nearly level soils

This association consists mostly of nearly level soils that developed in loess in areas of highest precipitation. A small acreage is gently sloping. Most of the association is in the southeastern part of the county, though a small area is in the northeastern corner. The association is extensive and is important agriculturally.

The main soils in this association are the Richfield, Ulysses, and Colby silt loams. The Richfield soils are moderately dark colored and have a silt loam surface layer and a blocky silty clay loam subsoil. The Ulysses soils have a moderately dark colored surface layer and a silt loam or light silty clay loam subsoil. The surface layer and subsoil of the Colby soils are light colored.

The Richfield soils predominate in the nearly level parts of the association, though there are some nearly level areas of Ulysses and Colby soils. Ulysses and Colby soils generally are gently sloping and have slopes of as much as 3 percent. Some lakebeds in areas of the Richfield soils are wet in periods of wet weather. Figure 3 shows the main soils in this association and the underlying material.

Also in the association are Goshen, Vona, and Otero soils. The Goshen soils occupy the upland drainageways, and Ulysses sandy loam and Vona sandy loam are at the edges of this association near the sandhills. In the southeastern part of the county, Otero sandy loam occupies small, steeper areas along intermittent drainageways and is on a few ridges.

Nearly all of this association is used for dryland farming. Wheat and sorghum are the main crops, and barley is grown in a small acreage. Under dryland farming, the main problems are conserving moisture and controlling wind erosion, but sloping areas are also susceptible to water erosion. In this association wind erosion is not so great a hazard as it is in the Wiley-Colby association, nor do crops fail so frequently.

In some areas wells have been dug and water is pumped for irrigation. In the irrigated areas some beets are grown, in addition to the same kinds of crops as are grown in dry-farmed areas. The main problems in irrigated areas are managing water and maintaining fertility.

Small areas in this association are in native grasses and are used for grazing.

3. Travessilla-Cascajo Association

Shallow, sandy or gravelly soils in rough, steep areas

The shallow, gravelly soils that make up most of this association occur in rough, steep areas and were derived mainly from sandstone and beds of gravel. The association is along Two Butte Creek, along Wild Horse Creek, and in the southwestern part of the county. It includes

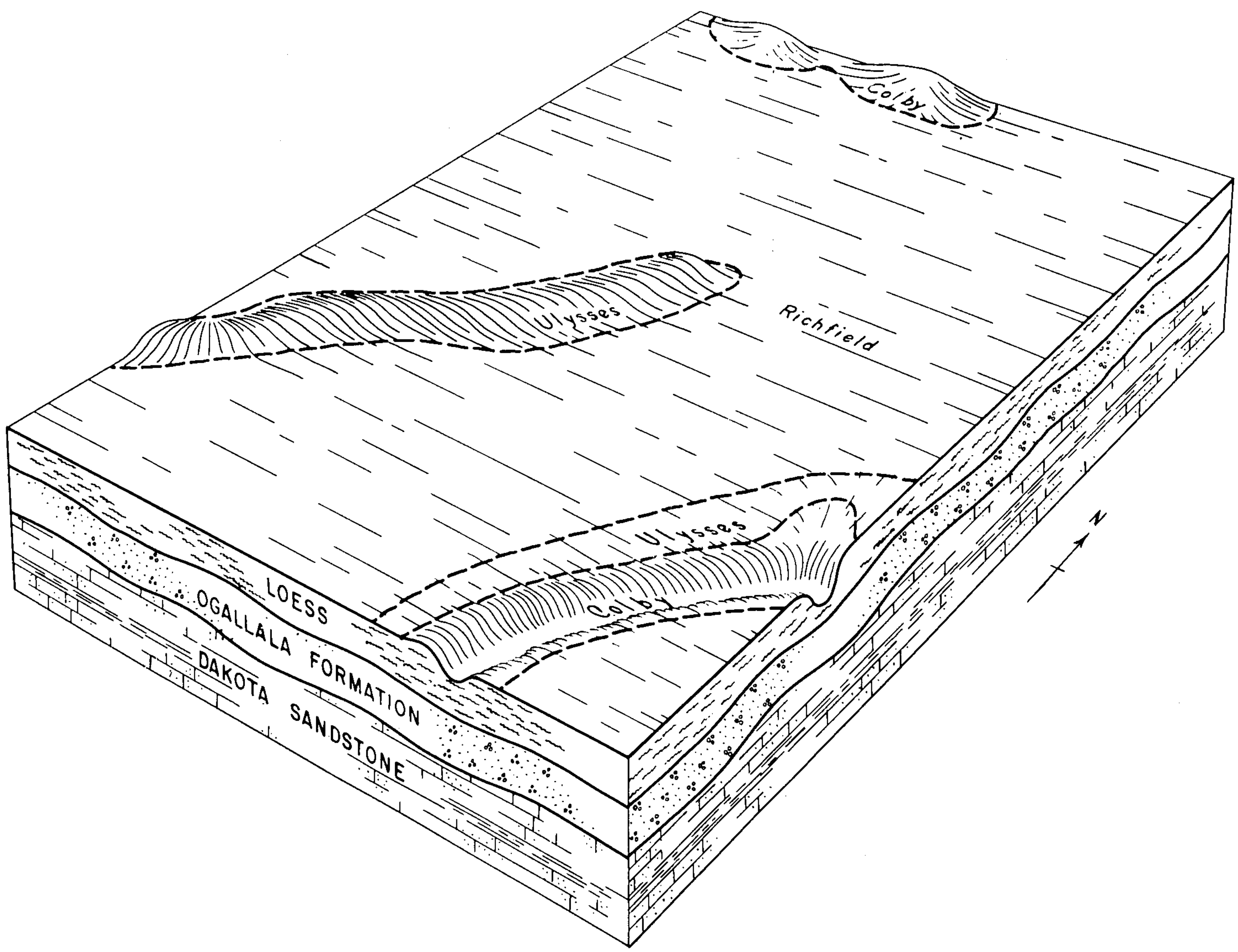

***Figure 3.*—Main soils and underlying material in soil association 2**

cliffs, gullies, and many outcrops of sandstone. The slopes generally range from 3 to 50 percent.

The main soils of this association are Travessilla sandy loam and Cascajo sandy loam. The Travessilla soils are shallow and have a sandy surface layer. In most places they are underlain by sandstone at a depth of less than 18 inches, and in some places sandstone is exposed at the surface. The Cascajo soils have a sandy loam surface layer and a loamy sand subsoil that is underlain by gravelly material. The Travessilla and Cascajo soils make up about 80 percent of this association.

Many other soils occur in this association. Renohill, Harvey, and Stoneham soils occupy the gentle slopes and are deeper to the parent material than the Travessilla and Cascajo soils. Most of the nearly level to gently sloping areas along the major drainageways consist of Lincoln and Colby soils and Loamy alluvial land. Small areas of Potter and Nihill soils also occur in the association.

Nearly all of this association is in native grass and is grazed. Controlling gully erosion is the main problem of range management. Small areas of the nearly level and gently sloping soils are dry farmed. On the dry-farmed soils the main problems are conserving moisture and controlling wind erosion.

4. Renohill-Wiley-Travessilla Association

Shallow to deep, gently sloping to steep soils

The pattern of soils in this association is complex. The soils differ greatly in texture, depth, and topography. There are moderately fine textured soils derived from interbedded sandstone and shale, deep silty soils derived from loess, and shallow sandy soils derived from sandstone. The association occurs in a single, fairly small area in the southwestern part of the county. It is predominantly gently sloping to rolling, but there are many steep slopes, breaks, and vertical cliffs in the areas occupied by Travessilla soils.

The main soils in this association are in the Renohill, Wiley, and Travessilla series. The Renohill soils have a loam or sandy loam surface layer and a clay loam subsoil. They were derived from sandstone and are underlain by sandstone and interbedded shale at a depth of 20 to 60 inches. The Wiley soils were derived from loess and have a silt loam surface layer and a light silty clay loam subsoil. The Travessilla soils are sandy loams that are shallow over sandstone. The Renohill and Wiley soils occupy slopes of 1 to 5 percent. The Travessilla soils are on breaks that have slopes of 5 to 50 percent, and there are many outcrops of sandstone. The nearly level Colby and Fort Collins soils occupy alluvial areas along the drainageways.

About half of this association is dry farmed, and about half is in native grasses. The dry-farmed areas are only on the more gentle slopes of the Wiley and Renohill soils and in some of the nearly level areas along drainageways. Wheat, sorghum, and barley are dry farmed. Controlling wind and water erosion and conserving moisture are the main problems of management. Crop yields are only moderate, even when the weather is most favorable, and the risk of crop failure is high. The problems of range management are proper distribution of grazing and controlling water erosion.

5. Tivoli-Vona Association

Deep soils of the sandhills

The deep sandy soils that make up this association developed in sand and other sandy material deposited by the wind. This association occurs south of the Arkansas River in a wide belt that extends across the county. It also occurs on the east side of Two Butte Creek and Big Sandy Creek. The topography ranges from gently sloping to steep. The dunes in the steep areas occur in a complex pattern and have no external drainage. Most of the soils are sand and loamy sand, but some sandy loam occurs.

The Tivoli soils are predominant in this association, but there are large areas of Vona soils. Figure 4 shows the relationship of the Tivoli and Vona soils to relief.

The Tivoli soils have a light-colored sand or loamy sand surface layer and subsoil. The Vona soils have a sandy loam or loamy sand surface layer and a sandy loam subsoil. Both the Tivoli and Vona soils are thick over the sand substratum. The Vona soils generally occur in a zone that is transitional between the sandhills and the hardlands. Slopes of these soils range from 1 to 5 percent. In some places the Tivoli soils have slopes of 1 percent, but in other places they are on steep complex dunes. Many of these dunes are bare of vegetation and are unstable. Because rainfall is higher in the eastern part of the county, the Tivoli soils in that part have a darker, much deeper surface layer than the Tivoli soils in the western part.

Nearly all the acreage of Tivoli soils and about half that of the Vona soils is in range. The part of the Vona soils not used as range is dry farmed. Sorghum is the main crop, but some broomcorn is grown in the eastern part of the county. Sand sage is the main range plant in this association.

The soils in this association are highly susceptible to erosion if they are dry farmed. The main problems of management are controlling wind erosion in dry-farmed areas and preventing overgrazing on the range. In the duned areas, blowouts are a serious problem and are difficult to revegetate.

6. Rocky Ford-Nepesta-Numa Association

Moderately fine textured, silted, irrigated soils

Most of this association consists of deep soils that developed in loess or similar material on uplands. These soils have had fine-textured material deposited, or silted, on them through the use of muddy irrigation water, but in other respects they are similar to the soils in the Wiley-Colby association. Soil association 6 is in two large areas north of the Arkansas River. It is mostly level to gently sloping.

Most extensive in this association are the Rocky Ford soils, but there are also areas of Nepesta and Numa soils. The surface layer of all these soils is partly the result of silting through irrigation. The Rocky Ford soils have a

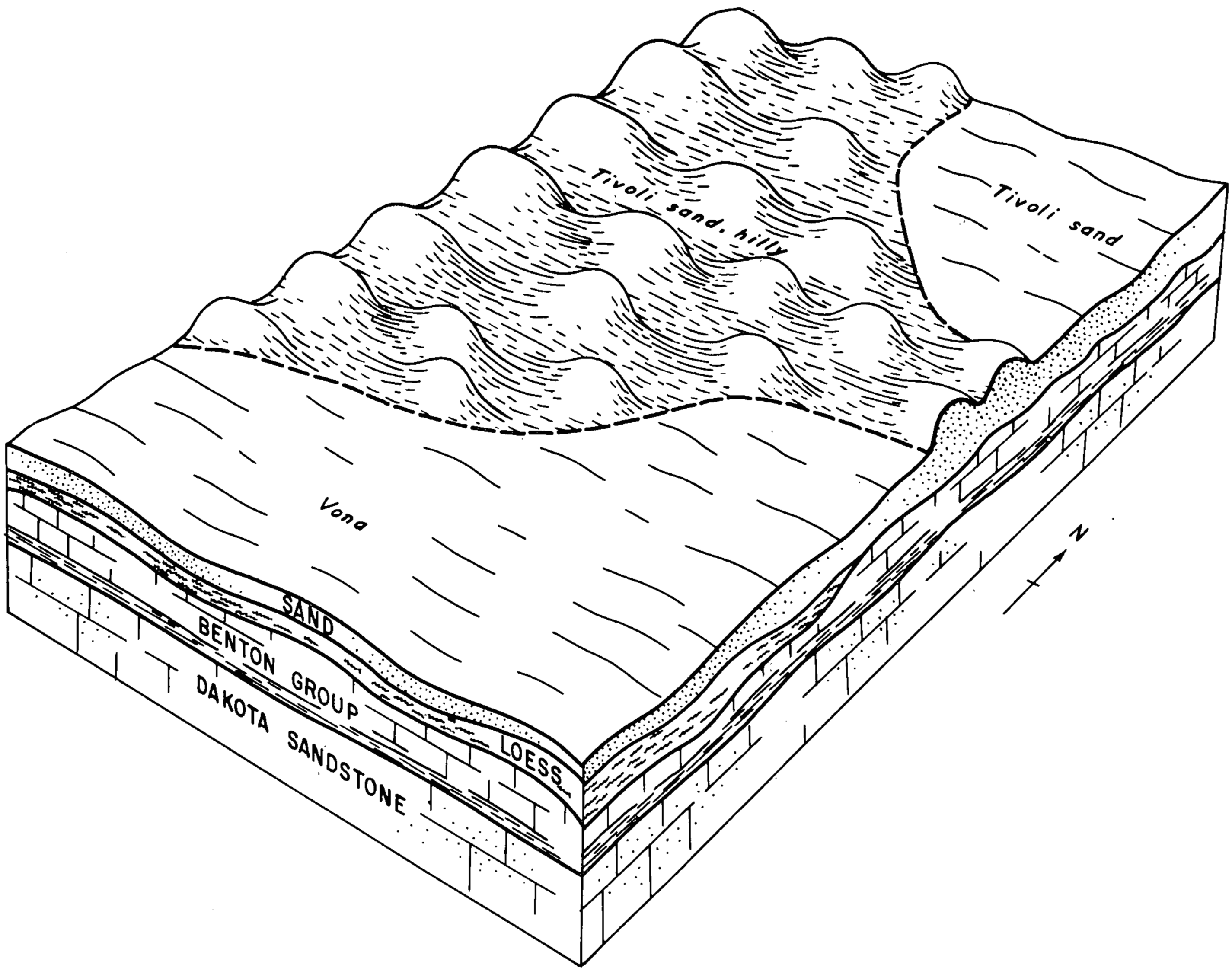

Figure 4.—**Main soils and underlying material in soil association 5.**

clay loam surface layer and a silt loam subsoil. The Nepesta soils generally have a surface layer and subsoil of silty clay loam. The Numa soils have a clay loam surface layer and a loam subsoil. Also in the association are smaller areas of soils that are moderately shallow over gravel, sand, or limestone.

Nearly all the acreage in this association is used for irrigated farming (fig. 5). The main crops are alfalfa, sorghum, wheat, barley, and corn. Some sugarbeets are also grown. Crop yields in this association are good if irrigation water is plentiful.

The main problems of management are handling the irrigation water, controlling water erosion on slopes, and maintaining soil fertility and tilth. Silting is also a problem, for it adds finer material to the surface soil, and, as a result, more timely tillage is required. In addition, salinity may be caused if irrigation water seeps from the laterals and from areas that are overirrigated.

7. Las-Glendive Association

Soils of the flood plains and low terraces

This association occupies the bottom lands and terraces in the valley of the Arkansas River and along its tributaries (fig. 6, p. 8). Most of the association is nearly level. The soils consist of alluvial materials that vary extremely in texture, depth, and drainage. These soils range from sand and gravel to clay.

The Las and Glendive soils are dominant in this association, and there are smaller acreages of Havre, Kornman, Las Animas, Lincoln, and Rocky Ford soils. The Las and Las Animas soils occur on the flood plains and normally have a moderately high or high water table. The salinity of these soils varies. The Las soils have a clay loam surface layer and a clay loam to clay subsoil. Although Las soils are normally affected by salt and a high water table, they are farmed intensively

Figure 5.—**Irrigated field of Rocky Ford soils in soil association 6.**

under irrigation in areas that have been drained. Some Las soils, however, are difficult to drain because they are clayey. Las Animas soils are stratified, sandy, and if drained, are very droughty. They are used mainly for range consisting of native grasses.

The Glendive, Havre, Kornman, Lincoln, and Rocky Ford soils are well drained to excessively drained. The Glendive and Kornman soils are sandy and have a low moisture-holding capacity, but they are cultivated under irrigation. The surface layer of the Kornman soils is deeper than that of the Glendive soils. The Havre and Rocky Ford soils are limy and medium textured. The Havre soils occur on low terraces and have a thin loamy surface layer and a subsoil that is stratified with sandy material. The Rocky Ford soils have a thick, moderately fine textured surface layer that consists of material brought in by irrigation water. The Lincoln soils occur along the stream channels and are likely to be flooded frequently. They are very sandy and gravelly and in most areas are covered with grasses, tamarisk, and cottonwood trees.

The Las, Glendive, Havre, Kornman, and Rocky Ford soils produce all crops suited to the area, including alfalfa, beets, corn, sorghum, small grains, onions, and melons. The principal problems of management are handling irrigation water, maintaining fertility, reducing siltation, improving drainage, and correcting salinity.

8. Arvada-Pultney-Minnequa Association

Moderately deep soils over thinly bedded limestone and shale

This association occurs on gently sloping and moderately sloping uplands in two small areas along the western edge of the county.

Arvada, Pultney, and Minnequa are the main soils, but there is also a large acreage of Manvel soils and smaller areas of Tyrone and Penrose soils. Figure 7 (p. 9) shows the main soils in this association and the underlying material. The Arvada soils occur in concave positions on the more gentle slopes. They have a clay loam surface layer and subsoil. The Pultney, Minnequa, and Manvel soils have a loam surface layer and a loam or clay loam subsoil. They are underlain by limestone and shale. The Penrose soils occur on the tops of ridges and in breaks on the landscape. Limestone is near the surface in these soils, or it crops out in many places.

Most of this association is in range grasses that are grazed, though a small part is dry farmed. The dry-farmed areas are highly susceptible to wind and water erosion. Yields are only fair, even when the weather is most favorable, and the risk of crop failure is great.

9. Baca-Campo-Wiley Association

Deep, moderately fine textured, gently sloping soils

Deep soils that developed in loess on uplands make up most of this association. The association is in two areas in the southern part of the county. It is nearly level to gently sloping in most places but is slightly steeper near drainageways.

The Baca, Campo, and Wiley soils are the main soils in this association, and the Fort Collins soils occur in a small acreage. The Baca soils make up about half of the association. They have a loam and clay loam surface layer and a clay loam subsoil. The Campo soils have a clay loam surface layer and a heavy clay loam subsoil. They occur in concave positions on the more gentle slopes. The Wiley soils generally occur in the more sloping areas and have a silt loam surface layer and a silty clay loam subsoil. The Fort Collins soils are gently sloping and occur along the edges of the loess mantle and along some of the drainageways.

Most of the acreage of the Baca and Campo soils, and about half that of the Wiley soils, is dry farmed. Wheat and sorghum are the main crops, and barley is grown on a smaller acreage. The risk of crop failure is not so great as on the Wiley-Colby association. Areas not dry farmed are in range consisting of native grasses. A small acreage is irrigated by water from the Two Buttes Reservoir and by water pumped from wells.

The main problems of management are controlling wind erosion and conserving moisture. Water erosion must also be controlled in sloping areas. The dry-farmed Wiley soils are highly susceptible to wind erosion. The main problems on irrigated soils are managing irrigation water and maintaining fertility.

Descriptions of the Soils

In this section the soil series in Prowers County are described in alphabetic order and a typical profile is described for each series. Each soil is then discussed, and those characteristics of its profile that are different from those of the typical profile are pointed out. Unless otherwise indicated, colors described are those for a dry soil.

A detailed description of a profile that is typical for each series is given in the section "Genesis, Classification, and Morphology of Soils." Terms that are used to describe the soils and that may not be familiar to the reader are defined in the Glossary at the back of the report.

The approximate acreage and proportionate extent of the soils are shown in table 1, and their location is shown on the detailed soil map at the back of the report.

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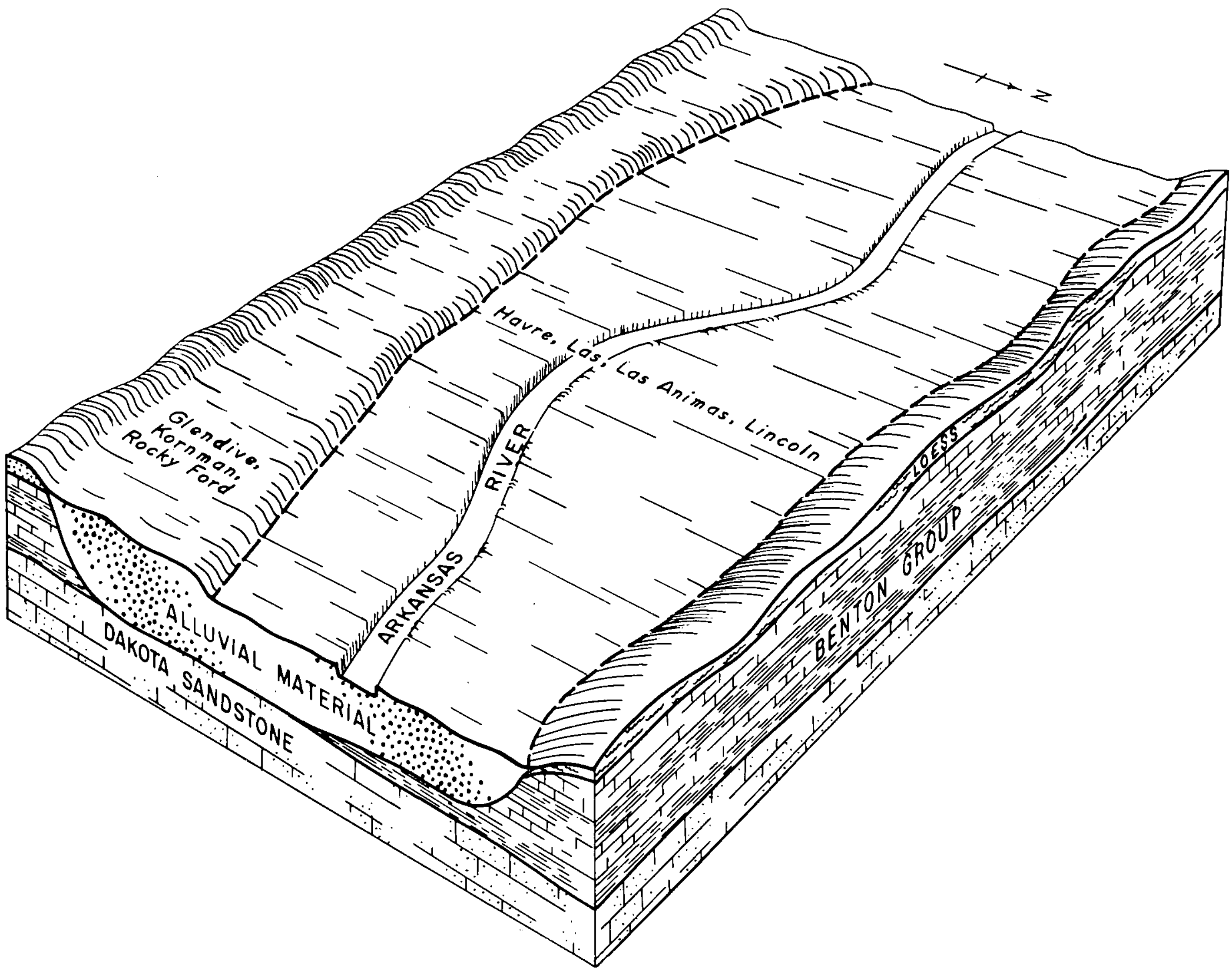

Figure 6.—**Soils on bottom lands and terraces, and the underlying material of soil association 7.**

In the soil descriptions the symbol in parentheses after the name of the soil identifies the soil on the detailed soil map. At the back of the report is given a list of the soils in the county and the dryland or irrigated capability unit and range site each is in.

Arvada Series

In the Arvada series are moderately fine textured and fine textured, alkaline soils developed in local alluvium that was derived from shale. The soils are in the west-central part of the county.

The surface layer is light brownish-gray clay loam that is firm when moist and extremely hard when dry. The subsoil is brown or grayish-brown clay loam or clay that has blocky structure. The substratum is normally massive, and in places it is underlain by shale at a depth of as much as 5 feet. It is extremely hard when dry. These soils contain much gypsum, and the surface layer and deeper layers are calcareous.

These soils vary mainly in their content of gypsum and other salts and in their depth to the underlying shale. In some places, particularly near the drainageways, shale is at a depth of as little as 2 feet.

Arvada soils occur with the Pultney soils but are deeper and finer textured than those soils.

Arvada soils are well drained. Water enters and percolates through these soils very slowly. Although the water-holding capacity is high, the high content of salts prevents these soils from giving up water to plants readily.

Arvada clay loam (1 to 3 percent slopes) (Ac).—This is an alkaline and saline soil in the west-central part of the county along the Bent County line. It lies below ridges occupied by other soils derived from shale.

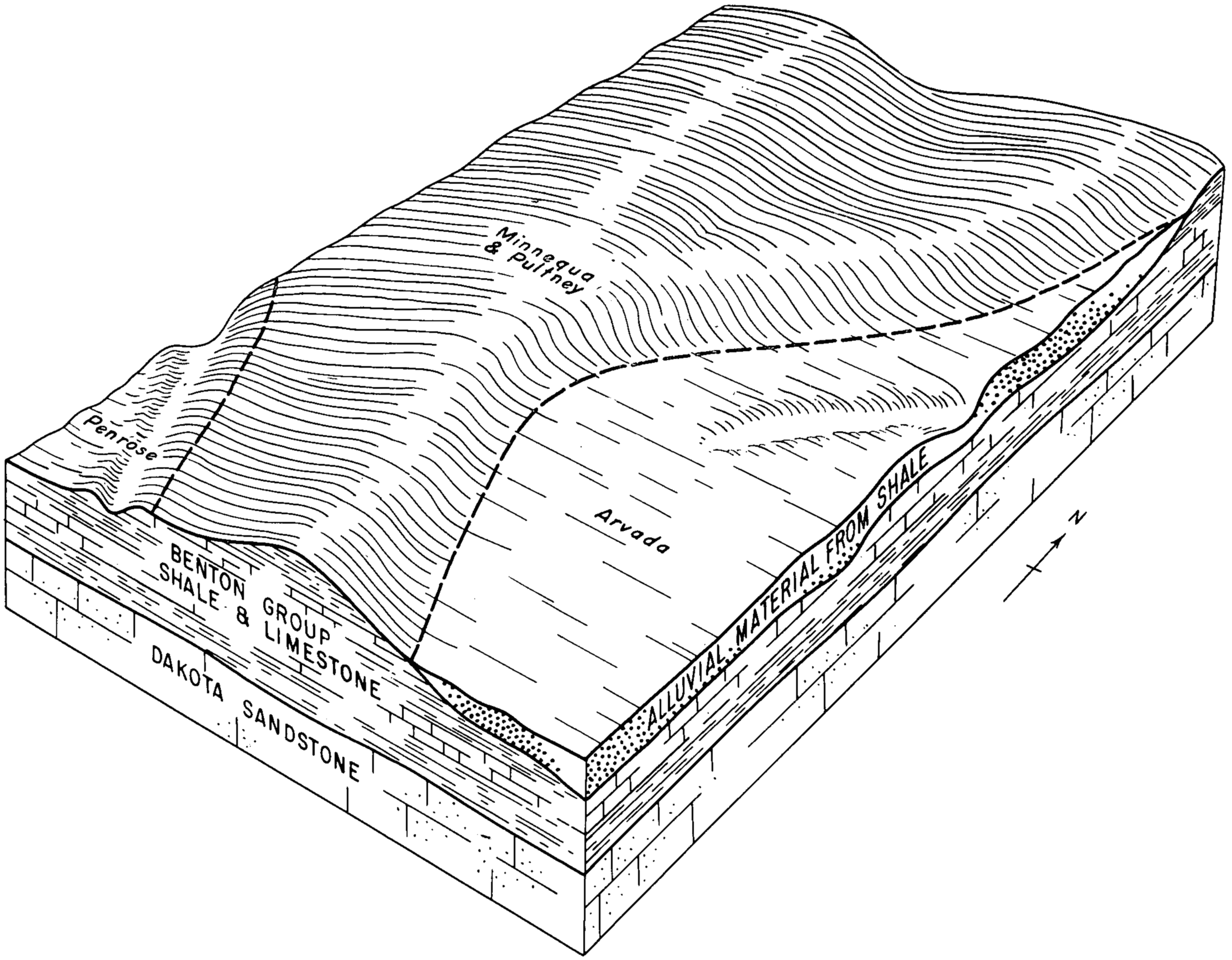

Figure 7.—**Main soils and underlying material in soil association 8.**

The surface layer of this soil generally is clay loam that supports little vegetation. The degree of erosion ranges from slight to moderate, which means that there is much variation in thickness of the surface layer. In about 40 percent of the area used for range, there are small patches of grayish-brown loam that support vegetation, and these are surrounded by clay loam on which the plant growth is sparse. Some areas of the soil are gullied.

This soil is alkaline and highly saline, difficult to work, and moderately low in natural fertility. It is used principally as range. The native vegetation is a patchy stand of alkali sacaton and galleta and a small amount of sideoats grama, blue grama, and buffalograss. Some areas are dry farmed, but stands are poor and crops usually fail. Because of the fine texture, dry-farmed areas of this soil are only slightly susceptible to further wind erosion. (Dryland capability unit VIe–1; Salt Flat range site)

Baca Series

The Baca series consists of deep, well-drained soils that developed in calcareous loess on the uplands. These soils are most extensive in the southern part of the county, but they occur in most parts of the county.

These soils have a surface layer that generally is only 4 to 7 inches thick. In range areas the surface layer is a pale-brown or brown, friable loam or clay loam that is dark brown when moist. The subsoil is brown to dark-brown silty clay loam or clay loam that is about 20 inches thick and of prismatic and blocky structure. It is hard when dry and friable when moist. White mottles of lime, about one-quarter of an inch in diameter, indicate a zone of lime accumulation just below the subsoil. The substratum is very pale brown silt loam. These soils are normally leached of lime to a depth of 6 to 14 inches.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Arvada clay loam	1, 623	0. 1
Baca clay loam, 0 to 3 percent slopes	87, 413	8. 4
Baca clay loam, 3 to 5 percent slopes	4, 551	. 4
Breaks-Alluvial land complex	8, 321	. 8
Campo clay loam, 0 to 3 percent slopes	12, 869	1. 2
Cascajo sandy loam, 3 to 25 percent slopes	21, 682	2. 1
Colby fine sandy loam, 0 to 1 percent slopes	577	. 1
Colby fine sandy loam, 1 to 3 percent slopes	132	(1)
Colby fine sandy loam, 0 to 3 percent slopes	8, 528	. 8
Colby fine sandy loam, 3 to 5 percent slopes	1, 432	. 1
Colby silt loam, 0 to 1 percent slopes	3, 479	. 3
Colby silt loam, 1 to 3 percent slopes	898	. 1
Colby silt loam, 0 to 3 percent slopes	99, 421	9. 5
Colby silt loam, 3 to 5 percent slopes	12, 820	1. 2
Colby silt loam, clay substratum, 0 to 1 percent slopes	284	(1)
Colby silt loam, sand substratum, 0 to 1 percent slopes	483	(1)
Colby-Ulysses complex, 1 to 3 percent slopes	6, 118	. 6
Dune land	2, 774	. 3
Fort Collins loam, 0 to 3 percent slopes	11, 896	1. 1
Fort Collins loam, 3 to 5 percent slopes	15, 397	1. 5
Fort Collins sandy loam, 3 to 5 percent slopes	7, 370	. 7
Glendive fine sandy loam, 0 to 1 percent slopes	1, 226	. 1
Glendive fine sandy loam, 1 to 3 percent slopes	726	. 1
Glendive fine sandy loam	2, 064	. 2
Glendive fine sandy loam, clay substratum	141	(1)
Glendive fine sandy loam, wet	241	(1)
Glendive and Havre fine sandy loams, 0 to 1 percent slopes	789	. 1
Glendive and Havre fine sandy loams, 1 to 3 percent slopes	191	(1)
Glendive and Havre fine sandy loams	2, 164	. 2
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes	1, 628	. 1
Glendive and Havre soils, sand substrata, 1 to 3 percent slopes	242	(1)
Glendive and Havre soils, sand substrata	3, 364	. 3
Goshen silt loam	6, 158	. 6
Harvey loam, 0 to 1 percent slopes	77	(1)
Harvey loam, 1 to 3 percent slopes	1, 561	. 1
Harvey loam, 0 to 3 percent slopes	5, 850	. 6
Harvey loam, 3 to 5 percent slopes	8, 197	. 8
Harvey loam, 5 to 9 percent slopes, eroded	2, 901	. 3
Havre loam	578	. 1
Kornman clay loam, 0 to 1 percent slopes	2, 000	. 2
Kornman clay loam, 1 to 3 percent slopes	1, 463	. 1
Kornman clay loam, clay substratum, 0 to 1 percent slopes	124	(1)
Kornman clay loam, sand substratum, 0 to 1 percent slopes	1, 691	. 2
Kornman clay loam, wet, 0 to 2 percent slopes	438	(1)
Las loam	5, 560	. 5
Las loam, clay substratum	1, 019	. 1
Las clay loam	7, 993	. 8
Las clay loam, clay substratum	1, 313	. 1
Las clay loam, saline	5, 166	. 5
Las clay loam, sand substratum	2, 691	. 3
Las clay loam, sand substratum, saline	1, 005	. 1
Las clay loam, wet, saline	589	. 1
Las sandy loam	912	. 1
Las Animas soils	11, 783	1. 1
Lincoln loam	172	(1)
Lincoln sand	11, 158	1. 1
Lismas clay loam	916	. 1
Lismas-Shale outcrop complex	261	(1)
Loamy alluvial land	1, 569	. 1
Manvel loam, 0 to 1 percent slopes	431	(1)
Manvel and Minnequa loams, 1 to 5 percent slopes	11, 086	1. 1
Nepesta clay loam, 0 to 1 percent slopes	4, 759	. 4
Nepesta clay loam, 1 to 3 percent slopes	1, 892	. 2
Nepesta clay loam, saline, 0 to 1 percent slopes	420	(1)
Nepesta clay loam, saline, 1 to 3 percent slopes	148	(1)
Nepesta clay loam, wet, 0 to 1 percent slopes	1, 348	. 1
Numa clay loam, 0 to 1 percent slopes	144	(1)
Numa clay loam, 1 to 3 percent slopes	4, 773	. 5
Numa clay loam, 3 to 5 percent slopes	1, 123	. 1
Numa clay loam, saline, 0 to 3 percent slopes	174	(1)
Numa clay loam, wet, 0 to 3 percent slopes	152	(1)
Otero sandy loam, 1 to 3 percent slopes	452	(1)
Otero sandy loam, 3 to 5 percent slopes	2, 107	. 2
Penrose loam, 1 to 5 percent slopes	1, 044	. 1
Penrose-Rock outcrop complex	3, 589	. 3
Potter and Nihill gravelly soils, 1 to 5 percent slopes	543	. 1
Potter and Stoneham gravelly loams, 5 to 35 slopes	4, 878	. 5
Pultney loam, 1 to 5 percent slopes	3, 613	. 3
Renohill loam, 1 to 3 percent slopes	3, 531	. 3
Renohill loam, 3 to 5 percent slopes	5, 452	. 5
Renohill loam, moderately shallow, 1 to 3 percent slopes	2, 785	. 3
Renohill loam, moderately shallow, 3 to 5 percent slopes	9, 229	. 9
Renohill sandy loam, 1 to 3 percent slopes	87	(1)
Renohill sandy loam, 3 to 5 percent slopes	637	. 1
Renohill sandy loam, moderately shallow, 1 to 3 percent slopes	266	(1)
Renohill sandy loam, moderately shallow, 3 to 5 percent slopes	6, 528	. 6
Renohill soils, eroded	317	(1)
Richfield silt loam, 0 to 1 percent slopes	41, 586	4. 0
Rocky Ford clay loam, 0 to 1 percent slopes	25, 038	2. 4
Rocky Ford clay loam, 1 to 3 percent slopes	41, 499	4. 0
Rocky Ford clay loam, 3 to 5 percent slopes	2, 067	. 2
Rocky Ford clay loam, clay substratum, 0 to 1 percent slopes	578	. 1
Rocky Ford clay loam, sand substratum, 0 to 1 percent slopes	324	(1)
Rocky Ford clay loam, sand substratum, 1 to 3 percent slopes	701	. 1
Rocky Ford clay loam, sand substratum, 3 to 5 percent slopes	238	(1)
Rocky Ford clay loam, over limestone, 1 to 3 percent slopes	551	. 1
Rocky Ford clay loam, over limestone, 3 to 5 percent slopes	208	(1)
Rocky Ford clay loam, saline, 0 to 1 percent slopes	420	(1)
Rocky Ford clay loam, saline, 1 to 3 percent slopes	600	. 1
Rocky Ford clay loam, wet, 0 to 1 percent slopes	2, 691	. 3
Rocky Ford clay loam, wet, 1 to 3 percent slopes	2, 788	. 3
Saline wet land	212	(1)
Terrace escarpments	525	. 1
Tivoli sand	37, 133	3. 6
Tivoli sand, hilly	15, 796	1. 5
Tivoli-Dune land complex	9, 437	. 9
Travessilla sandy loam	2, 055	. 2
Travessilla-Rock outcrop complex	18, 154	1. 7
Tyrone loam, 0 to 3 percent slopes	1, 373	. 1
Tyrone loam, 3 to 5 percent slopes	574	. 1
Tyrone soils, eroded	740	. 1
Ulysses sandy loam, 0 to 3 percent slopes	5, 210	. 5

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Area	Extent
	Acres	*Percent*
Ulysses silt loam, 0 to 3 percent slopes	23, 017	2. 2
Vona loamy sand, 1 to 3 percent slopes	2, 813	. 3
Vona loamy sand, 3 to 5 percent slopes	2, 098	. 2
Vona sandy loam, 1 to 3 percent slopes	16, 144	1. 5
Vona sandy loam, 3 to 5 percent slopes	6, 559	. 6
Vona soils, 1 to 3 percent slopes, eroded	2, 767	. 3
Vona soils, 3 to 9 percent slopes, eroded	1, 412	. 1
Wiley silt loam, 0 to 3 percent slopes	264, 614	25. 4
Wiley silt loam, 3 to 5 percent slopes	27, 085	2. 6
Wiley and Baca soils, 0 to 3 percent slopes, eroded	7, 451	7
Wiley and Baca soils, 3 to 5 percent slopes, eroded	510	[1]
Gravel pits	175	[1]
Total	1, 040, 640	100. 0

[1] Less than 0.05 percent.

The Baca soils are fairly uniform. In rangeland their surface layer normally is loam, but in cultivated areas the loam has been mixed with the finer textured subsoil, or it has been eroded away and clay loam is exposed. In some places, particularly in the southern part of the county, these soils are underlain by a reddish buried soil at a depth of 9 to 26 inches. This buried soil ranges from light silty clay loam to sandy loam and has varying amounts of gravel in it.

Baca soils occur with, and are similar to, the Campo soils but do not contain so much clay. They also occur with the Wiley and Colby soils, but they have more clay in the subsoil than either of those soils, are leached of lime in the upper part, and have stronger structure.

The native vegetation on Baca soils is mainly blue grama and buffalograss.

Baca clay loam, 0 to 3 percent slopes (BaB).—This is the most extensive Baca soil in the county. It is on nearly level and gently sloping uplands in almost all parts of Prowers County except the area south of Holly. Much of it has slopes of 0 to 1 percent, though slopes range up to 3 percent. This soil generally is in areas of more favorable rainfall, but where it is in the drier areas, it normally receives some runoff from surrounding soils.

Where this soil is used as range, its surface layer is thin and of loam texture. In many cultivated areas, however, the surface layer is clay loam because the thin layer of loam has been mixed with the subsoil or has been partly eroded away. In the southern part of the county, the surface layer is clay loam in most places.

Included in some areas mapped as this soil are small areas of Wiley silt loam that total 10 percent of the mapping unit. Also included, in the southern part of the county, are a few small areas of Campo clay loam.

The soil takes in water at a medium to slow rate. It has medium internal drainage and medium to moderately slow surface drainage. The water-holding capacity is high, and most of the water held in the soil is readily available to plants. The soil is moderately easy or easy to work, and it has moderately high natural fertility.

This soil is dry farmed, irrigated, and used for range. When weather is favorable, good yields of wheat and sorghum are produced. In many fields part of the surface layer has been lost through wind erosion. The soil is moderately susceptible to wind erosion, but this can be controlled easily by bringing clods up to the surface. Stubble-mulch tillage, stripcropping, contour farming, and terracing help to conserve moisture and control erosion. (Irrigated capability unit IIe-2; dryland capability unit IVc-1; Loamy Plains range site)

Baca clay loam, 3 to 5 percent slopes (BaC).—This soil has a thin surface layer and is leached of lime to a depth of 6 to 10 inches. Although most of the precipitation is absorbed, runoff may cause erosion during intense rains. Wind erosion is moderate to severe, depending on the plant cover. Included in areas mapped as this soil are small areas of Wiley soils.

About half of this soil is cultivated, and the rest is in native range grasses. Stripcropping, contour farming, and terracing help in controlling both wind and water erosion, but during dry years, emergency tillage may also be needed to control wind erosion. (Irrigated capability unit IIIe-1; dryland capability unit IVe-2 in climatic zone C, and VIe-2 in climatic zone D; Loamy Plains range site)

Breaks-Alluvial Land Complex (Bk)

This land is adjacent to upland stream channels; it is steeply sloping and has been cut by gullies in some places. It occurs throughout the county, normally in long narrow strips. Slopes generally range from 5 to 20 percent, but erosion has washed away the soils in many places, and vertical drops of 10 feet are common. Many small gullies and drops of 1 to 2 feet also occur, and the heads of some of the active gullies have been enlarged as shown in figure 8.

Because of the steep slopes and erosion, the soil material is not uniform. In uneroded areas the material resembles that of the Colby and Wiley soils. These uneroded areas have a loam surface layer and a loam or light silty clay loam subsoil and substratum.

Included with this land are sandy and gravelly soils that may make up as much as 10 percent of any area mapped. Also included are areas with small outcrops of sandstone and limestone and terrace edges that have a loam surface layer.

This land is used mostly as range, and it is best suited to that use. Natural fertility is medium. The native vegetation is blue grama, buffalograss, sideoats grama, and some yucca and sand sage. (Dryland capability unit VIe-2; Loamy Plains range site)

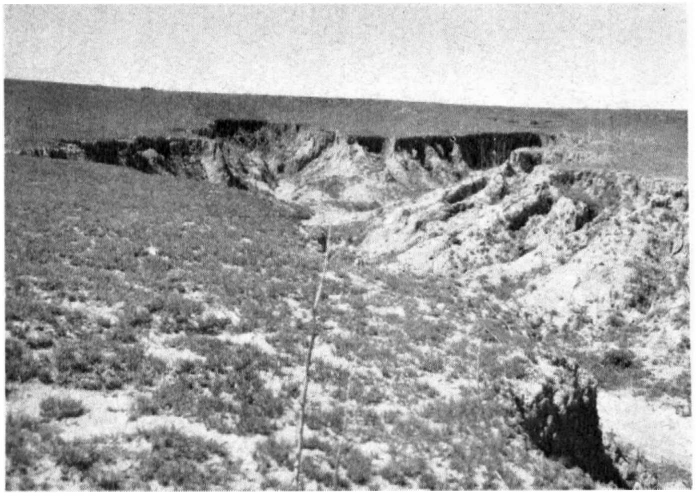

Figure 8.—**Large gully in Breaks-Alluvial land complex that has been enlarged at its head by erosion.**

Campo Series

The Campo series consists of deep, well-drained soils that developed in calcareous loess on uplands. These soils occur in all parts of the county. They are not extensive and generally are in areas that receive runoff from higher areas.

The surface layer of these soils is about 5 inches thick. It is light brownish gray when dry and dark grayish brown when moist. In most cultivated areas the surface layer is clay loam, but areas of range have a thin silt loam surface layer. The subsoil is dark grayish-brown heavy silty clay loam, clay loam, or light clay that has prismatic and blocky structure. These soils normally are leached of lime to a depth of 12 to 20 inches. Just below the subsoil is a zone of lime accumulation in which the lime is in the form of mottles about one-quarter of an inch in diameter. The substratum is pale-brown silt loam in most places and occurs at a depth of about 3 feet; but in a few places in the southern part of the county the substratum is a reddish-colored clay loam. Areas of Campo soils in range normally have a thin light-colored horizon below the surface layer. Cultivation generally mixes this thin layer with the surface layer.

Campo soils occur with Baca soils but are stronger in structure, finer in texture, and deeper to lime. They have a lighter colored surface layer than the Richfield soils and have more clay in the subsoil.

The native vegetation on Campo soils consists of blue grama and buffalograss.

Campo clay loam, 0 to 3 percent slopes (CaA).—This is the only Campo soil mapped in the county. It occurs on all the uplands except those in the eastern part of the county south of Holly. It is mainly in the south-central part near Two Buttes. The areas are nearly level or gently sloping. The slopes are less than 1 percent in most places, and in only a few places are they more than 2 percent. In some places this soil is in shallow depressions. The areas in depressions in the drier parts of the county generally receive runoff from adjacent soils. Two of these depressions in the northwestern corner of the county are large and resemble lakebeds. In these two depressions, the soil is finer textured and darker colored than the typical Campo soils, but it can be used in much the same way.

This soil is nearly uniform in characteristics. If it has been cultivated, part of the subsoil is generally mixed with the surface layer and the texture of the surface layer is silty clay loam. Where this soil is in range, the texture of the surface layer is typically silt loam.

Included in some areas mapped as this soil are small areas of Baca soils. Also included are small areas of Richfield soils that are east of Two Buttes.

This Campo soil takes in water slowly, and it has a very slowly permeable or slowly permeable subsoil. The water-holding capacity is high, and about half the water that is held is readily available to plants. The soil is moderately difficult to moderately easy to work and to manage, but it has high natural fertility.

Most of this soil is dry farmed or used for range, but some areas are irrigated. When weather is favorable, good yields of dry-farmed wheat and sorghum are produced. Crops adapted to the area also make high yields in irrigated areas. This soil is moderately susceptible to wind erosion, but erosion can be controlled easily by bringing clods up to the surface. (Irrigated capability unit IIs–1; dryland capability unit IVc–1; Loamy Plains range site)

Cascajo Series

The Cascajo series consists of excessively drained soils that are moderately shallow over mixed sandy and gravelly material of the Ogallala formation. These soils are on uplands, mostly in the southern and western parts of the county along Clay Creek and Two Butte Creek.

The surface layer of these soils is grayish-brown, very friable coarse sandy loam 4 to 8 inches thick. The subsoil is grayish-brown or brown coarse loamy sand or coarse sandy loam, and it contains some gravel. A layer of gravelly coarse loamy sand is at a depth of 12 to 30 inches. In the lower part of this layer is a zone where lime has accumulated. Below a depth of 30 inches is gravelly sand, gravel, or gravelly coarse loamy sand.

Water penetrates these soils at a moderately rapid rate. In most places these soils are leached of lime to a depth of 12 to 24 inches, but in some places they are calcareous at the surface.

These soils are variable in characteristics but tend to be gravelly and sandy. Gravel is on the surface in some places. In some small areas, gravelly sandy loam extends from the surface to a depth of 24 inches and is underlain by reddish-brown clay loam, sandy clay loam, or sandy loam.

Cascajo soils occur with Nihill soils. They are deeper to underlying gravel than those soils.

These soils are used mainly for range. A few small areas are in cultivated fields, although these soils are not suitable for cultivation. The native vegetation is buffalograss, blue grama, sideoats grama, yucca, and sand sage.

Cascajo sandy loam, 3 to 25 percent slopes (CdE).—This soil is extensive in the southwestern and southern parts of the county along Clay Creek and Two Butte Creek. Smaller areas occur along other drainageways in the southern part of the county.

This soil is gravelly and has rough, broken relief that easily distinguishes it from other soils. Outcrops of limestone and sandstone are common. Except in small areas, the many small draws, gullies, and ravines that drain this soil occur close together in a dendritic pattern. These drainageways form a complex pattern on the slopes. Included in some areas mapped as this soil are smaller areas of Nihill, Potter, and Stoneham soils.

This soil takes in water at a moderately rapid rate and has very rapid permeability in the subsoil. The water-holding capacity is very low, but most of the water held in the soil is readily available to plants. Light, frequent rains are therefore very beneficial to plants on this soil. Natural fertility is very low.

If it is dry farmed, this soil is hard to work and to manage. It is slightly susceptible to wind erosion and moderately susceptible to water erosion. Most drainageways are gullied, and some are severely gullied. (Dryland capability unit VIIs-1; Gravel Breaks range site)

Colby Series

The Colby series consists of well-drained, moderately shallow to deep soils that developed in calcareous loamy and silty material. These soils occur throughout the county.

The surface layer is silt loam or fine sandy loam that is light brownish gray and soft when dry and brown and very friable when moist. It is about 4 to 10 inches thick and has granular structure. The subsoil is silt loam that, in most places, extends to a depth of more than 5 feet. The upper part of the subsoil is lighter colored than the surface layer, and the lower part is brown. These soils are calcareous throughout.

The main variations in Colby soils are in the texture of the surface layer and in the depth to the contrasting substratum.

Colby soils have a profile similar to that of the Wiley soils. They have weaker structure than the Wiley soils and a slightly coarser textured subsoil. They are slightly coarser textured than the Ulysses soils and have a lighter colored surface layer.

The native vegetation in areas of silt loam is mostly blue grama and buffalograss, and in areas of fine sandy loam it is sand sage, little bluestem, and sand dropseed. Common on the terraces are snakeweed and little rabbitbrush.

Colby fine sandy loam, 0 to 1 percent slopes (CfA).—This soil occurs mostly in irrigated areas on nearly level stream terraces. It has a weakly stratified substratum in many places. In some places the substratum is below a depth of 30 inches and consists of sand.

Water penetrates this soil moderately rapidly, and surface drainage is moderately slow. The water-holding capacity is medium, and most of the water held in the soil is available to plants. Natural fertility is moderate, but additions of phosphorus are generally needed in fields planted to alfalfa or sugar beets.

A large part of this soil is under irrigation and is well suited to that use. The soil is easily worked and managed under irrigation. Land leveling improves uniformity in the spread of water. Barnyard manure and green-manure crops help in maintaining organic matter and fertility.

Small areas of this soil are dry farmed. In these areas stubble-mulch tillage and stripcropping should be used so that moisture is conserved and wind erosion is controlled. Other areas are in native range grasses and are well suited to grazing. (Irrigated capability unit IIs-2; dryland capability unit IVe-3; Loamy Plains range site)

Colby fine sandy loam, 1 to 3 percent slopes (CfB).—Most of this soil has slopes of 1 to 2 percent, but in places the slope ranges up to 3 percent.

Because this soil is more sloping than Colby fine sandy loam, 0 to 1 percent slopes, contour ditches and shorter irrigation runs are needed to obtain proper irrigation and to control erosion. Fewer vegetable crops are grown on this soil than on Colby fine sandy loam, 0 to 1 percent slopes.

Small areas of this soil are dry farmed. In these areas stubble-mulch tillage, contour farming, terracing, and stripcropping are needed to conserve moisture and to control erosion. Other small areas are in native range grasses and are well suited to grazing. (Irrigated capability unit IIe-3; dryland capability unit IVe-3; Loamy Plains range site)

Colby fine sandy loam, 0 to 3 percent slopes (CfAB).—This soil occurs mostly on uplands south of the sandhills, where the soils are deeper and more uniform in texture than those on stream terraces.

This soil is used mostly for dryland farming and for native range grasses. Sorghum is best suited to dry-farmed areas, though wheat can be grown if crop residue is kept on the surface to control soil blowing. Stubble-mulch tillage, contour farming, terracing, and stripcropping help to conserve moisture and to control erosion. Barnyard manure and green-manure crops in irrigated areas help to maintain the supply of organic matter. In irrigated areas land leveling may be needed to spread irrigation water more uniformly. (Irrigated capability unit IIe-3; dryland capability unit IVe-3; Loamy Plains range site)

Colby fine sandy loam, 3 to 5 percent slopes (CfC).—This soil occurs on uplands south of the sandhills. It is deep and has a substratum of uniform texture.

This soil is used both for range and dryland cultivation. It is well suited as range but is highly susceptible to erosion in dry-farmed areas. Stubble-mulch tillage, contour farming, and contour stripcropping help to conserve moisture and to control water and wind erosion. Terracing helps to conserve moisture and to control water erosion. Emergency tillage is often needed. (Dryland capability units IVe-6 in climatic zone C, VIe-2 in climatic zone D; Loamy Plains range site)

Colby silt loam, 0 to 1 percent slopes (CmA).—This soil occurs on nearly level stream terraces in the irrigated part of the county (fig. 9). The substratum commonly is weakly stratified loam and very fine sandy loam, and in some areas sand and gravel occur at a depth of 36 to 60 inches.

This soil takes in water at a medium rate. The water-holding capacity is high, and most of the water held in the soil is readily available to plants. Natural fertility is medium.

This soil is used for irrigated farming, dryland farming, and grazing. It is well suited to irrigated farming and to all crops normally grown in the county. The soil is easy to work, but land leveling may be needed to spread water more uniformly. The response to fertilization and to irrigation management is good.

Figure 9.—**Profile of Colby silt loam, 0 to 1 percent slopes.**

Dry-farmed areas are susceptible to wind erosion. Stubble-mulch tillage helps to maintain the content of organic matter, to conserve moisture, and to control erosion. Stripcropping helps to control wind erosion.

This soil is well suited to permanent grass. Areas in native grasses should not be plowed and used for dryfarming. (Irrigated capability unit I-1; dryland capability units IVe-1 in climatic zone C, VIe-2 in climatic zone D; Loamy Plains range site)

Colby silt loam, 1 to 3 percent slopes (CmB).—This soil is used for irrigated farming, dryfarming, and grazing. It is well suited to irrigated farming and to all the crops normally grown in the county. Land leveling may be needed to spread irrigation water more uniformly. The soil responds well to fertilization and to good management of irrigation water. The effect of slope can be reduced by planting row crops across the slope and almost on the contour. Ditches used to irrigate close-growing crops are normally about on the contour. Stubble-mulch tillage helps to maintain the content of organic matter, to conserve soil moisture, and to control wind and water erosion. Stripcropping helps to control wind erosion.

This soil is well suited to permanent grass, and those areas in native grass should not be used for dryland cultivation. (Irrigated capability unit IIe-2; dryland capability units IVe-1 in climatic zone C, VIe-2 in climatic zone D; Loamy Plains range site)

Colby silt loam, 0 to 3 percent slopes (CmAB).—This soil occurs mostly on uplands, and in this county it is the most extensive soil in the Colby series. The soil profile is more uniform on uplands than on terraces.

This soil is used for dryfarming, irrigated farming, and range. It is suitable for dryfarming only in areas of higher rainfall. Dry-farmed areas are highly erodible, and in some places blowouts and hummocks of accumulated soil make tillage difficult. Before some areas are cultivated, the blowouts and hummocks have to be smoothed with heavy machinery. Stubble-mulch tillage helps to maintain the content of organic matter, to conserve soil moisture, and to control erosion. Stripcropping helps to control wind erosion. Terracing and contour farming aid in conserving moisture and preventing erosion.

Some areas are irrigated by water pumped from wells and are well suited to that use. The soil responds well to fertilization and to good management of irrigation water. Land leveling may be needed to spread irrigation water uniformly. Ditches used to irrigate close-growing crops in gently sloping areas should be about on the contour. In irrigation management it may be necessary to separate gently sloping areas from the nearly level areas.

Many areas are in native range and are well suited to that use. (Irrigated capability unit IIe-2; dryland capability units IVe-1 in climatic zones B and C, VIe-2 in climatic zone D; Loamy Plains range site)

Colby silt loam, 3 to 5 percent slopes (CmC).—This soil occupies a large acreage in this county and occurs mostly on uplands. The soil profile is more uniform on uplands than on terraces. Rills and small gullies are common in cultivated areas. In some dry-farmed areas that have not been worked in some time, the soil has drifted and formed hummocks 1 to 3 feet high.

This soil is suited to permanent grass, and many dry-farmed areas should be seeded to grass. In irrigated areas of this sloping soil, the management should be especially good so that water erosion and water losses are reduced. Land leveling may be needed. If row crops are planted about on the contour, the effect of slope is reduced. Ditches used to irrigate close-growing crops also should be about on the contour. (Irrigated capability unit IIIe-1; dryland capability unit VIe-2; Loamy Plains range site)

Colby silt loam, clay substratum, 0 to 1 percent slopes (CoA).—Except for having a clay substratum at a depth of 30 to 60 inches, this soil has a profile similar to the one described for the series. In this county the soil is only in the valley of the Arkansas River. Small patches that have a sandy surface layer occur with this soil and are shown on the soil map by the symbol for sand spots.

Most of this soil is irrigated or is in native range grasses. It is suited to crops commonly grown in the county. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. Timely tillage helps to prevent excessive cloddiness and compaction. Because internal drainage is very slow, irrigation water should be managed carefully. Land leveling improves the uniformity in the spread of irrigation water. This soil is well suited to permanent grass. (Irrigated capability unit IIIs-1; dryland capability unit VIe-2; Loamy Plains range site)

Colby silt loam, sand substratum, 0 to 1 percent slopes (CsA).—Except for having the sand or gravel substratum below a depth of 20 to 30 inches, this soil has a profile similar to the one described for the series. Internal drainage is very rapid, and water-holding capacity is low to medium. Most of this soil is in the valley of the Arkansas River.

This soil is fairly well suited to irrigation farming if the water is well managed. It is too droughty for dryland farming. Under irrigation, this soil is suited to most crops grown in the county. Alfalfa, however, does not grow so well as it does on deeper soils, and it requires more frequent irrigation. If the irrigation runs are too long, much water percolates through the soil and is lost. Land leveling helps to spread the irrigation water uniformly, but the soil should be examined carefully to find out the depth of the sand before deep cuts are made. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIs–2; dryland capability unit VIe–2; Loamy Plains range site)

Colby-Ulysses complex, 1 to 3 percent slopes (CuB).—This complex occurs mainly on undulating uplands in the southeastern part of the county; a few small areas are in the northeastern corner. About 40 percent of the complex is Colby silt loam; 30 percent is Ulysses silt loam and sandy loam; 15 percent is Richfield silt loam; and 15 percent is Otero sandy loam.

The profiles of the soils in this complex differ from the ones described for the Colby and the Ulysses series in that sand generally is at a depth of 24 to 48 inches. In many places in cultivated fields, the surface soil has been winnowed and is sandy loam.

Water readily penetrates the soils of this complex. Permeability is medium in the subsoil. The water-holding capacity is generally high, and most of the water held in the soil is readily available to plants.

These soils are easy to work, but wind erosion is somewhat difficult to control under dryland cultivation. Stubble-mulch tillage helps to conserve moisture and to reduce wind erosion, and stripcropping helps to control wind erosion. In most places the slopes are too complex for contour farming or terracing. (Dryland capability unit IVe–1; Loamy Plains range site)

Dune Land (Du)

Dune land occupies large areas of the sandhills that do not have external drainage. It occurs with the Tivoli soils and is south of the Arkansas River and east of Two Butte and Big Sandy Creeks.

Dune land is made up of active sand dunes that have little or no vegetation. The sand is generally deep, but in a few places pockets have been eroded down to the finer textured underlying material. Water is absorbed rapidly, and permeability is very rapid. The water-holding capacity and natural fertility are very low.

This land is extremely difficult to manage. Landforms change because of the constantly shifting sand. The land is not suitable for grazing and is a hazard to surrounding land. It has been severely eroded by the wind and is susceptible to further erosion. Little or no vegetation grows, except during years of higher than normal rainfall, when some grass grows in the more favorable places. These areas should be stabilized. (Dryland capability unit VIIIe–1)

Fort Collins Series

The Fort Collins series consists of moderately deep to deep, well-drained soils that developed on uplands and terraces in calcareous loamy and gravelly material. These soils occur throughout the county but are most extensive in the southern part.

Fort Collins soils on uplands have a surface layer of loam or sandy loam that is grayish brown when dry and dark grayish brown when moist. The surface layer is friable and is about 6 inches thick. The subsoil is a clay loam about 10 to 20 inches thick. It is brown when dry and dark brown when moist. The subsoil grades to very pale brown gravelly sandy loam at a depth of about 30 inches. This horizon contains a large amount of lime and grades to sand and gravel at a depth of about 45 inches (fig. 10). Fort Collins soils are generally leached of lime to a depth of 7 to 15 inches, but cultivated areas may be calcareous to the surface.

These soils have many variations. They vary mainly in the thickness and texture of different horizons, in the amount of gravel in the profile, and in the characteristics of the parent material. On uplands these soils range from 24 to 48 inches in depth to gravel and sand. In some small areas they are underlain by material that is about 50 percent lime. The gravel in any horizon ranges from a small amount to enough for the horizon to be called gravelly. Loam and sandy loam types are mapped.

Fort Collins soils have a darker colored surface layer than Harvey soils, and their horizons have stronger structure. They are leached of lime in the upper part, and Harvey soils are not. Fort Collins soils are less

Figure 10.—**Profile of Fort Collins loam, 0 to 3 percent slopes. The pencils indicate horizon boundaries.**

gravelly, contain more clay, and have stronger structure than Cascajo soils.

Fort Collins loam, 0 to 3 percent slopes (FcB).—This soil occurs on nearly level terraces and gently sloping uplands. It has a profile similar to the one described for the series, except in areas on nearly level stream terraces. In these areas the soil is deeper than the one described; it is generally more than 5 feet deep. Also, it has a more silty profile, contains less sand and gravel throughout, and does not overlie gravel and sand. On the terraces this soil developed in silty alluvial material. It receives some runoff from adjacent areas and produces better crops and more grass than soils that receive less moisture.

This soil takes in water at a medium rate, and its subsoil is moderately slow in permeability. Water-holding capacity is medium to high, and most water held in the soil is readily available to plants. Natural fertility is medium.

This soil is used for range and for dryfarming. The native vegetation is mainly blue grama and buffalograss, but on terraces western wheatgrass and little rabbitbrush also grow. The soil is fairly well suited to dryfarming and produces good yields of wheat and sorghum when the weather is favorable. Stubble-mulch tillage and terracing and contour farming on the gentle slopes, help to conserve soil moisture and to control erosion. Stripcropping helps to control erosion. (Dryland capability unit IVc–1; Loamy Plains range site)

Fort Collins loam, 3 to 5 percent slopes (FcC).—This sloping soil has rapid internal drainage and medium water-holding capacity. Water runs off at a moderately rapid rate, and rills form in cultivated areas.

This soil is best suited to permanent grass, but in climatic zone C it produces fair yields of wheat and sorghum. The native vegetation is mainly blue grama and buffalograss. A cover crop should be planted in areas that are to be reseeded to grass. These areas should not be grazed until a stand of grass is established. In cultivated areas stubble-mulch tillage, contour farming, stripcropping, and terracing are needed to conserve moisture and to control erosion. Where cover is inadequate, wind erosion can be controlled by chiseling and listing. (Dryland capability units IVe–2 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Fort Collins sandy loam, 3 to 5 percent slopes (FnC).—This soil occurs only on uplands in the southwestern part of the county. Internal drainage is rapid, and water-holding capacity is low to medium.

This soil is mostly in range and is well suited to that use. It is mainly in sand sage, sideoats grama, blue grama, and yucca. Good management that prevents overgrazing encourages the growth of desirable grasses. (Dryland capability unit VIe–3; Sandy Plains range site)

Glendive Series

In the Glendive series are moderately shallow to deep, well-drained sandy soils that developed in calcareous material on terraces and bottom lands. These soils generally are in stratified alluvium, though some of them are in reworked, wind-deposited sandy material.

The surface layer of the soils is brown sandy loam that is 6 to 12 inches thick and is very friable when moist. The subsoil is sandy loam that is yellowish brown to pale brown when dry and dark yellowish brown or brown when moist. The substratum is stratified sandy loam or loamy fine sand, and in some places it overlies fine sand or sand and gravel at a depth of 36 to 60 inches. These soils are calcareous throughout.

Glendive soils vary mainly in the degree of stratification in the subsoil and the substratum and in the depth to, and the nature of, the underlying material. In some areas the subsoil and substratum are fairly uniform, but in others they consist of alternate layers of sandy loam, loamy sand, and sand. Soils that are 20 to 36 inches deep to sand are mapped as sand substratum phases. One soil is mapped as a clay substratum phase.

The Glendive soils are similar to the Kornman soils but have a sandy surface layer. They are coarser textured than the Havre soils and have a less sandy profile than the Lincoln soils.

The kinds of plants on Glendive soils depend largely on the degree and frequency of flooding. Some areas along the Arkansas River are in stands of cottonwood and tamarisk. Other areas are covered with sand sage. The most common grasses are switchgrass, blue grama, sand dropseed, and alkali sacaton.

Glendive fine sandy loam, 0 to 1 percent slopes (GaA).—This nearly level soil occurs in the major irrigated part of the county. Except for areas under irrigation, the soil may be occasionally flooded.

This soil generally has a fine sandy loam surface layer, is underlain by sand and gravel, and in some areas is highly stratified (fig. 11). Near Carlton, however, is an area that has a loamy fine sand surface layer. In this area the soil lacks gravel, is not highly stratified, and is more uniform throughout the profile than is normal for the Glendive soils.

This soil takes in water rapidly. The water-holding capacity is moderately low, and most of the water stored is readily available to plants.

If it is dry farmed, this soil is easy to work but is difficult to manage because wind erosion is hard to control. The hazard of wind erosion is severe. Stubble-mulch tillage and stripcropping help to conserve moisture and to control wind erosion. In many areas where the ground cover is inadequate for protection, emergency tillage is needed to control wind erosion.

Where it is irrigated, the soil produces good yields if the management of water is good. In some places land leveling is needed to spread the water more uniformly. Water is used most efficiently if the irrigation runs are not too long. Barnyard manure and green-manure crops help to maintain fertility and the content of organic matter. (Irrigated capability unit IIs–2; dryland capability units IVe–4 in climatic zone C, VIe–4 in climatic zone D; Sandy Bottom Land range site)

Glendive fine sandy loam, 1 to 3 percent slopes (GaB).—This gently sloping soil occurs in the irrigated part of the county along the valley of the Arkansas River. Water management on this soil is a little more difficult than it is on nearly level Glendive soils.

If management is good, this soil is fairly well suited to irrigation, and some areas are irrigated. Sorghum and small grains do well. Alfalfa does not do so well as on finer textured soils. Land leveling may be needed to spread water more uniformly, but it should not be done

Figure 11.—**Profile of Glendive fine sandy loam that shows a high degree of stratification.**

in windy periods. Short irrigation runs help to control loss of water. The grade of the irrigation furrows is reduced if row crops can be planted across the slope or about on the contour.

Some areas are dry farmed. Stubble-mulch tillage, contour farming, and stripcropping help to conserve moisture and to control erosion. In some places where the ground cover is inadequate for protection, emergency tillage is needed to control soil blowing. Range should not be overgrazed. (Irrigated capability unit IIIe–4; dryland capability units IVe–4 in climatic zone C, VIe–4 in climatic zone D; Sandy Bottom Land range site)

Glendive fine sandy loam (0 to 3 percent slopes) (GaAB).—This nearly level to gently sloping soil is on terraces. It is outside the major irrigated part of the county.

If management is good, this soil is fairly well suited to irrigation, and some areas are irrigated. It is irrigated with water pumped from wells. Water management is a little more difficult on this soil, however, than it is on nearly level Glendive soils. Sorghum and small grains do well, but alfalfa does less well than on finer textured soils. Land leveling may be needed to spread water more uniformly, though fields should not be leveled in windy periods. Short irrigation runs help to control water loss. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops should be on the contour.

Some areas are dry farmed. Stubble-mulch tillage, contour farming, and stripcropping help to conserve moisture and to control erosion. In some places where ground cover is not adequate for protection, emergency tillage is needed to control soil blowing. Range should not be overgrazed. (Irrigated capability unit IIIe–4; dryland capability units IVe–4 in climatic zone C, VIe–4 in climatic zone D; Sandy Bottom Land range site)

Glendive fine sandy loam, clay substratum (0 to 2 percent slopes) (Gc).—This soil occurs only in the valley of the Arkansas River and has a clay substratum at a depth of 30 to 60 inches. It has slower internal drainage than less clayey soils because of the clay substratum and therefore needs irrigation that is carefully controlled to prevent applying too much water.

Under good management, this soil is fairly well suited to irrigation. Most of the acreage is irrigated. Sorghum and small grains are well-suited crops, but alfalfa does not do so well as on finer textured soils. Because the clay substratum slows internal drainage, care is needed to prevent overirrigation. In some places land leveling is needed to apply the water more uniformly, but fields should not be leveled in windy periods. Short irrigation runs help to control water loss.

Some areas are dry farmed. Stubble-mulch tillage, contour farming, and stripcropping help to conserve moisture and to control erosion. In some places where the ground cover is not adequate for protection, emergency tillage is needed to control soil blowing. Range should not be overgrazed. (Irrigated capability unit IIIs–3; dryland capability units IVe–4 in climatic zone C, VIe–4 in climatic zone D; Sandy Bottom Land range site)

Glendive fine sandy loam, wet (0 to 1 percent slopes) (Gf).—This soil is similar to Glendive fine sandy loam, 0 to 1 percent slopes, but it has a fluctuating water table below a depth of 24 inches. Because the water table is beneficial to plants that have roots long enough to reach it, this soil is especially well suited to alfalfa. The water table is highest during the growing season because irrigation contributes to the ground water.

In some places land leveling is needed to spread the water more uniformly, but it should not be done in windy periods. In places where the ground cover is not adequate for protection, emergency tillage is needed to control wind erosion. Crop residue should be returned to the soil. Barnyard manure and green-manure crops help to maintain fertility and the content of organic matter. (Irrigated capability unit IIs–2)

Glendive and Havre fine sandy loams, 0 to 1 percent slopes (GhA).—This mapping unit is about 70 percent Glendive soil and 30 percent Havre soil. The Glendive soil is similar to Glendive fine sandy loam, 0 to 1 percent slopes, except that it has a loamy substratum at a depth of about 30 inches and its water-holding capacity is medium instead of moderately low. The Havre soil is similar to Havre loam, but it has a fine sandy loam surface layer.

These soils occur only in the part of the county that is irrigated from canals. Most areas are irrigated, but some small areas are dry farmed. In irrigated areas, land leveling may be needed to improve the application of water, but leveling should not be done in windy periods.

Emergency tillage is needed to control wind erosion in some places where the ground cover is not adequate for protection. Crop residue should be returned to the soil. Barnyard manure and green-manure crops help to maintain fertility and the content of organic matter.

In dry-farmed areas these soils should be managed to conserve moisture and to control wind erosion. Practices that help are stubble-mulch tillage and stripcropping. Range should not be overgrazed. (Irrigated capability unit IIs-2; dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Sandy Bottom Land range site)

Glendive and Havre fine sandy loams, 1 to 3 percent slopes (GhB).—This mapping unit is similar to the Glendive and Havre fine sandy loams, 0 to 1 percent slopes, but a larger proportion of the unit is Glendive soil that has a loamy substratum. These soils occur in that part of the county that is under the canal system, and they cover only a small acreage. They are more erodible than the nearly level Glendive and Havre fine sandy loams. Erosion causes small rills if the slopes are not protected.

Most areas of these soils are irrigated and are fairly well suited to irrigation if management is good. Suitable crops are sorghum, small grains, and alfalfa, but yields of alfalfa are lower than on finer textured soils. Land leveling is needed to spread water uniformly in some areas, but it should not be done in windy periods. Losses of water can be reduced by using short irrigation runs. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows can be reduced. Construct ditches on the contour for irrigating close-growing crops.

Some areas of these soils are dry farmed. Stubble-mulch tillage, contour farming, and stripcropping help to conserve moisture and to control erosion. In places where the ground cover is inadequate for protection, emergency tillage is needed to control soil blowing. Range should not be overgrazed. (Irrigated capability unit IIIe-4; dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Sandy Bottom Land range site)

Glendive and Havre fine sandy loams (0 to 3 percent slopes) (GhAB).—These soils are higher than the irrigation canals, but some areas are pump irrigated. The soils are more eroded on gentle slopes than on nearly level slopes. Runoff forms small rills in unprotected fields.

Under irrigation, sorghum and small grains are fairly well suited to these soils. Land leveling is commonly needed to spread the water more uniformly, but leveling should be avoided in windy periods. Water is used most efficiently if the irrigation runs are short. The grade of the irrigation furrows is reduced by planting row crops across the slope or nearly on the contour. Use contour ditches for irrigating close-growing crops.

Dry-farmed areas should be managed to conserve moisture and to control erosion. Practices that help are stubble-mulch tillage, stripcropping, and contour farming. In many areas where the ground cover is not adequate, emergency tillage is needed to control soil blowing. (Irrigated capability unit IIIe-4; dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Sandy Bottom Land range site)

Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (GnA).—This mapping unit is 70 percent Glendive soil and 30 percent Havre soil. The Glendive soil is similar to Glendive fine sandy loam, 0 to 1 percent slopes, and the Havre soil is similar to Havre loam, except that both of these soils overlie sand and gravel at a depth of 20 to 36 inches. These soils occur only in areas that are irrigated from the canal system.

Because these soils are moderately shallow to coarse-textured material, they have very rapid internal drainage and are droughty. The water-holding capacity is low, but most of the water stored is readily available to plants.

Good management of water is needed in irrigated areas. Water is used more efficiently if the irrigation runs are short. Deep cuts should not be made when land leveling is done. In dry-farmed areas, stubble-mulch tillage and stripcropping are effective in conserving moisture and controlling erosion. (Irrigated capability unit IIIs-4; dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Glendive soil is in Sandy Bottom Land range site, and Havre soil is in Loamy Plains range site)

Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (GnB).—About 80 percent of this gently sloping mapping unit is Glendive soil, and the rest is Havre soil. These soils have a gravel or sand substratum at a depth of 20 to 36 inches. They have very rapid internal drainage, are low in water-holding capacity, and are droughty. Most of the acreage is in range, though small areas are under dryland cultivation. Dry-farmed areas should be managed to control erosion and to conserve moisture. Practices that help are stubble-mulch tillage, contour farming, and stripcropping. Where the ground cover is not adequate for protection, emergency tillage is commonly needed to control wind erosion. (Dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Glendive soil is in Sandy Bottom Land range site, and Havre soil is in Loamy Plains range site)

Glendive and Havre soils, sand substrata (0 to 3 percent slopes) (GnAB).—These nearly level or gently sloping soils are higher on the slopes than the canal systems. They are underlain by gravel or sand at a depth of 20 to 36 inches. Because internal drainage is very rapid and the water-holding capacity is low, the soils are droughty.

These soils are irrigated, dry farmed, and used as range. In irrigated areas the management of water is important. If the irrigation runs are short, the water is used more efficiently. Where land leveling is needed, deep cuts should not be made.

These soils are suitable for dryfarming only in the zones of higher rainfall. Dry-farmed areas should be managed to control erosion and to conserve moisture. Practices that help are contour farming, stubble-mulch tillage, and stripcropping. In many places where the ground cover is not adequate for protection, emergency tillage is needed to control wind erosion. Native range grasses should not be overgrazed. (Irrigated capability unit IIIs-4; dryland capability units IVe-4 in climatic zone C, VIe-4 in climatic zone D; Glendive soil is in Sandy Bottom Land range site, and Havre soil is in Loamy Plains range site)

Goshen Series

The Goshen series consists of deep, well-drained soils developed in alluvial material from areas of loess. The soils are predominantly silt loams. They are in upland swales and occur in all parts of the county.

These soils have a thicker surface layer than most of the other soils of the county. Their surface layer is grayish-brown silt loam that is very friable, granular, and 12 to 20 inches thick. The subsoil is a dark grayish-brown silt loam or light silty clay loam that has subangular blocky structure. The substratum is brown or pale-brown silt loam or light silty clay loam.

These soils take in water at a medium rate. In some places they are calcareous at the surface, and in other places they are leached to a depth of as much as 30 inches.

Goshen soils occur with the Baca and Wiley soils, but they have a darker and thicker surface layer than those soils. Also their profile is less well developed. They have a thicker surface layer than the Ulysses soils, and they occur in swales.

The native vegetation is buffalograss, blue grama, and western wheatgrass.

Goshen silt loam (0 to 2 percent slopes) (Go).—This soil occupies fairly broad areas of upland swales in all parts of the county. It receives runoff from surrounding areas, and in places it is cut by a shallow drainageway.

This soil has fairly uniform profile characteristics. It varies mainly in the thickness of the surface layer and in depth to lime.

Included in the areas mapped as this soil are areas of Baca, Ulysses, and Wiley soils and Loamy alluvial land. These included areas total as much as 20 percent of the mapping unit.

This soil takes in water at a medium rate, and the subsoil is moderately permeable. The water-holding capacity is high, and most of the water is readily available to plants. Natural fertility is high.

This soil is dry farmed, irrigated, and used as range. When the weather is favorable, good yields of wheat and sorghum are produced. The soil is easy to work and to manage. The dry-farmed areas are susceptible to moderate wind erosion, and in places part of the surface layer has been eroded by wind. Water erosion is slight and occurs along some of the small drainageways. Stubble-mulch tillage and stripcropping help to conserve moisture and to control erosion.

Irrigated areas of this soil produce good yields of all crops grown in the area. Land leveling helps to spread irrigation water more uniformly. Barnyard manure and green-manure crops help to improve tilth and to maintain the content of organic matter.

The native vegetation is blue grama and buffalograss. The areas in range should not be overgrazed. (Irrigated capability unit IIe–2; dryland capability units IIIc–1 in climatic zone B, IVc–1 in climatic zones C and D; Overflow range site)

Harvey Series

The Harvey series consists of deep soils over calcareous loamy material. These soils are well drained. They are on uplands throughout the county, mainly in gravelly areas near major drainageways.

Generally, the surface layer is friable loam that is grayish brown or pale brown when dry and is 4 to 6 inches thick. The subsoil is loam, slightly lighter colored than that in the surface layer, and it grades to a very strongly calcareous loam. In places sandy or gravelly material is below a depth of 42 inches.

Depth to the zone of lime accumulation ranges from 12 to 40 inches. In a few places the surface layer is sandy loam. Gravel in any horizon ranges from a small amount to about 10 percent.

The Harvey soils are less silty and more gravelly than the Colby soils, and they have a zone of lime accumulation that is lacking in the Colby soils. They are less gravelly and have a less well developed profile than the Stoneham soils.

The Harvey soils are used for irrigated farming and dry farming. Some areas are in permanent grass. The native vegetation is blue grama and buffalograss.

Harvey loam, 0 to 1 percent slopes (HaA).—This soil occupies a small acreage that is at elevations lower than the canal system.

This soil takes in water at a medium rate. The permeability of the subsoil is moderate. The water-holding capacity is high, and most of the water stored is readily available to plants. Natural fertility is medium.

This soil is easy to work, but it is highly susceptible to erosion and is difficult to manage if it is dry farmed. In areas that are dry farmed, stubble mulching and stripcropping are needed to conserve moisture and to control wind erosion.

This soil is well suited to irrigation and to all the crops grown in the area. In places land leveling is needed to spread the irrigation water more uniformly. Barnyard manure and green-manure crops help to maintain the fertility and content of organic matter. Areas in range should not be plowed. (Irrigated capability unit I–1; dryland capability units IVe–1 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Harvey loam, 1 to 3 percent slopes (HaB).—This soil occupies a small acreage that is at elevations lower than the canal system. It is gently sloping. Rill erosion occurs on many of the slopes.

This soil is irrigated, dry farmed, and used for grazing. It is well suited to irrigation farming and to all the crops normally grown in the area. It responds well to fertilization and to good management of irrigation water. In some places land leveling is needed to spread the irrigation water more uniformly. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. In most places ditches for irrigating close-growing crops are nearly on the contour.

The dry-farmed areas are highly susceptible to wind erosion. Stubble-mulch tillage helps to maintain the content of organic matter, to conserve soil moisture, and to control erosion. Stripcropping helps to prevent wind erosion. This soil is well suited to permanent grass. Areas in native range should not be plowed. (Irrigated capability unit IIe–2; dryland capability units IVe–1 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Harvey loam, 0 to 3 percent slopes (HaAB).—This soil occupies nearly level to gently sloping areas higher than the canal system. Most of it is north of Holly. Included with this soil are many areas in which gravel and pockets of sand occur. Also included are areas of soils that are shallower than this soil.

Dry-farmed areas should be managed to control erosion and to conserve moisture. Practices that help are terracing, contour farming, and stubble-mulch tillage. Stripcropping helps to control wind erosion. Stubble-mulch tillage helps to maintain the content of organic matter.

Some areas are well suited to irrigation and are irrigated by using water pumped from wells. This soil responds well to fertilization and to good management of the irrigation water. In some nearly level areas, land leveling is needed to spread the water more uniformly. In gently sloping areas ditches used to irrigate close-growing crops should be about on the contour. For irrigation purposes, the gently sloping areas may need to be managed separately from nearly level areas. This soil is well suited to grass, and many areas are in range. (Irrigated capability unit IIe-2; dryland capability units IVe-1 in climatic zones B and C, VIe-2 in climatic zone D; Loamy Plains range site)

Harvey loam, 3 to 5 percent slopes (HaC).—This soil has more rapid surface drainage than the nearly level Harvey soils. As a result, some water erosion occurs in cultivated areas.

Included with this soil are many areas where there are pockets of sand and gravel. Also included are areas where sand or gravel is at a depth of about 24 inches.

This soil is not suitable for dryfarming, and areas that have been dry farmed should be seeded to grass. Areas in range should be protected from overgrazing. (Dryland capability unit VIe-2; Loamy Plains range site)

Harvey loam, 5 to 9 percent slopes, eroded (HaD2).—This soil has rapid surface drainage, and rill and gully erosion have occurred in many places. Some of the gullies are 3 to 4 feet deep.

This soil should be reseeded to grass wherever seeding is feasible. Stock should not graze the reseeded areas until a stand of grass is established. Overgrazing should then be prevented so that erosion does not recur. (Dryland capability unit VIe-2; Loamy Plains range site)

Havre Series

In the Havre series are soils that are moderately shallow to deep over highly stratified material. These soils are well drained and calcareous. They are on bottom lands and low stream terraces. Most of the acreage that is not cultivated is subject to occasional flooding.

The surface layer of these soils is very friable, granular loam or sandy loam 6 to 10 inches deep. It is light brownish gray when dry and dark grayish brown when moist. The subsoil is loam stratified with fine sandy loam or light clay loam and is about the same color as the surface layer. The substratum is similar to the subsoil. In places it grades to more stratified material below a depth of 3 feet.

The texture of the individual layers in the profile ranges from light clay loam to loamy sand.

The Havre soils that are only 20 to 36 inches deep are mapped with the Glendive soils as sand substrata phases of Glendive and Havre soils. The profile of Havre soils is similar to that of the Glendive and Rocky Ford soils. The Havre soils are slightly less sandy than the Glendive soils. They are more sandy, much more stratified, and have a coarser textured surface layer than the Rocky Ford soils. The Havre soils are much less sandy than the Lincoln soils, and they are less subject to flooding that damages crops.

Some areas of the Havre soils are dry farmed, and others are irrigated. Still other areas are in permanent grass. The native vegetation is switchgrass, alkali sacaton, blue grama, some inland saltgrass, tamarisk, and cottonwood trees.

Havre loam (0 to 1 percent slopes) (Hm).—Where it has not been leveled and farmed, this soil is undulating over short distances because the meanders of old stream channels cross it. In some places on the bank of the Arkansas River, the soil is subject to erosion because the river cuts into the bank. In most places this soil is subject to occasional flooding. It is slightly saline in some places.

This soil is easy to work and takes in water at a moderately rapid rate. The permeability of the subsoil is moderately rapid. Natural fertility is moderate. Where this soil has been leveled and irrigated, good yields are obtained. Leveling is generally needed in other areas so that the irrigation water is spread more uniformly. Barnyard manure and green-manure crops help to maintain fertility and the content of organic matter. In the small dry-farmed areas, stubble mulching and stripcropping help to conserve moisture and to control erosion. The areas in range should not be overgrazed. (Irrigated capability unit IIs-3; dryland capability units IVe-1 in climatic zone C, VIe-2 in climatic zone D; Loamy Plains range site)

Kornman Series

The Kornman series consists of moderately shallow to deep and normally excessively drained soils that developed on stream terraces in the valley of the Arkansas River. These soils tend to be droughty. They have been irrigated with muddy irrigation water. Silt and clay from the irrigation water have accumulated in the soils, and consequently, the surface layer is fine textured.

The surface layer is clay loam that is dark grayish brown when moist and is about 12 inches thick. It is hard when dry and firm when moist. The subsoil, or horizon just below the silted surface layer, is brown sandy loam or loamy fine sand that is loose when dry and loose or very friable when moist. It is normally about 15 to 20 inches thick. The substratum consists normally of loamy fine sand or stratified sandy loam. These soils are calcareous throughout.

These soils vary mainly in texture, in the thickness of the silted surface layer, and in the characteristics of the substratum. The surface layer is normally clay loam, but it is loam in some areas that have received less silt. Its thickness ranges from about 8 to 18 inches. Some of these soils have a substratum of gravel, sand, or clay.

Kornman soils occur with the Glendive soils. Their profile is similar to that of the Glendive soils, but they have a finer textured surface layer than those soils. They are less sandy throughout than the Lincoln soils and have a surface layer that is silted instead of one of loamy sand or sandy loam. They are coarser textured than the Rocky Ford soils.

All of the acreage of Kornman soils is irrigated. Crop yields are high if water management is good and droughtiness can be overcome.

Kornman clay loam, 0 to 1 percent slopes (KcA).—This soil is deep and has a silted surface layer. In areas that have been leveled, the surface layer is thicker in some places than in others. The substratum is loamy fine sand or stratified sandy loam.

This soil takes in water at a slow to medium rate. Permeability of the subsoil is rapid. The water-holding capacity is medium or moderately low, and most of the water held is readily available to plants. This soil is moderately difficult to easy to work, and it has medium natural fertility.

All of this soil is irrigated, and the surface layer tends to get thicker and finer textured as more silt is deposited. If droughtiness is to be overcome, this soil needs to be irrigated more frequently than soils that have a finer textured subsoil and substratum. Land leveling helps to spread the water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. Timely tillage of this soil is important, for it prevents excessive cloddiness and compacting. (Irrigated capability unit IIs-3)

Kornman clay loam, 1 to 3 percent slopes (KcB).—The surface layer of this soil is coarser textured than that of Kornman clay loam, 0 to 1 percent slopes, and this soil has not been quite so deeply silted. In many of the steeper areas, plowing has mixed part of the sandy subsoil with the silted surface layer. Water erosion is slight.

Because this soil is droughty, it should be irrigated more frequently than soils that have a finer textured subsoil and substratum. Land leveling helps to spread the irrigation water uniformly. Ditches for irrigating close-growing crops are on a contour. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. On this soil timely tillage is important because it prevents excessive cloddiness and compacting. (Irrigated capability unit IIIe-3)

Kornman clay loam, clay substratum, 0 to 1 percent slopes (KmA).—This soil is on low terraces along the Arkansas River. It has a clayey substratum, generally at a depth of about 37 inches, but in some areas at a depth of 30 to 60 inches. Because of this clayey layer, internal drainage is slow and the water-holding capacity is greater than in the Kornman soils that have a less clayey substratum.

This soil should be carefully irrigated so that over-irrigation and seepage are prevented. Land leveling helps to spread the water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. On this soil timely tillage is important because it prevents excessive cloddiness and compacting. (Irrigated capability unit IIIs-1)

Kornman clay loam, sand substratum, 0 to 1 percent slopes (KnA).—This soil is on bottom lands or low terraces that are nearer the channel of the Arkansas River than those occupied by other Kornman soils. Its subsoil is more stratified than that of the other Kornman soils. Because this soil has a substratum of sand and gravel at a depth of 20 to 36 inches, internal drainage is more rapid than that of the less sandy Kornman soils, and consequently, the water-holding capacity is low.

This soil is droughty and loses the water that penetrates deeply into its gravelly substratum; therefore, it needs to be irrigated more frequently and more carefully than soils that have a finer textured subsoil and substratum. Land leveling helps to spread the irrigation water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. On this soil timely tillage is important because it prevents excessive cloddiness and compacting. (Irrigated capability unit IVs-1)

Kornman clay loam, wet, 0 to 2 percent slopes (KwA).—This soil is distinguished from the other Kornman soils by a fluctuating water table at a depth below 24 inches. The water table is highest during the growing season, when irrigation water is added to the ground water. The ground water is beneficial to plants, such as alfalfa, that have roots long enough to reach it. Generally, the surface layer is clay loam, but in some areas it is loam.

Because it is droughty for shallow-rooted crops, this soil should be irrigated more frequently than soils that have a finer textured subsoil and substratum. Land leveling helps to spread the irrigation water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. On this soil timely tillage is important because it prevents excessive cloddiness and compacting. (Irrigated capability unit IIw-1)

Las Series

The soils of the Las series are moderately deep to deep, imperfectly drained, and saline. They developed in loamy to clayey alluvium that in some places is stratified with sandy loam. They occur only on the bottom lands and low terraces of the Arkansas River and its major tributaries. These soils have a high water table if they are not artificially drained. They are difficult to drain because they are nearly level; drainage outlets need a sloping grade.

The surface layer of these soils is grayish brown and is 10 to 20 inches thick. In many places where these soils have been irrigated with muddy river water, the surface layer is finer textured than typical because silt and clay have been deposited. Generally, the subsoil is grayish-brown to dark-gray loam or clay loam, but in some places it is clay. In some areas the loam or clay loam is weakly stratified. The subsoil is hard when dry and firm when moist and is at a depth of 36 to 40 inches. The substratum is generally stratified loam or clay loam, but in many places it is sandy and gravelly between a depth of 36 and 60 inches. In the lower part of the soil profile are rust-colored mottles. Mottling is at a depth of only 12 inches in some places, but it is only in the sandy substratum in other areas. These soils are calcareous throughout.

These soils vary widely in salinity, in texture of the surface layer and the substratum, and in degree of stratification throughout the profile. The surface layer is loam, clay loam, or sandy loam. In some places the substratum is clay. In other places it is sand at a depth of 20 to 36 inches. Salinity ranges from slight to severe.

Las soils have a profile that is similar to that of the Las Animas soils, but they are more coherent, are much more clayey, and are better drained. They are not so well drained as the Havre soils and are more saline.

Areas of these soils that are in native range support a dense stand of alkali sacaton, inland saltgrass, switchgrass, sedges, and rushes. These soils produce high yields of native grasses suitable for pasture.

Las loam (0 to 1 percent slopes) (La).—This soil has a subsoil that is normally clay loam, though in some areas it is stratified loam. The soil is slightly to moderately saline. It is less saline in the places where drainage ditches have been established, and in those places the water table is not so high.

This soil takes in water at a medium rate, but permeability of the subsoil is slow. The water-holding capacity is high, and the water stored is readily available to plants, except in the more saline areas. This soil is easy to work and has high natural fertility.

This soil is used both for irrigated crops and for permanent grass. It is well suited to irrigation if it is drained, leached of salts, and well managed. Yields of most crops grown on this soil are high. Sugar beets, sorghum, and truck crops are grown on a large acreage. In cultivated areas a drainage system is generally used to lower the water table enough for plant growth, and this drainage system must be maintained. Land leveling helps to spread irrigation water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve soil tilth. (Irrigated capability unit IIw–2; dryland capability unit VIw–1; Salt Meadow range site)

Las loam, clay substratum (0 to 1 percent slopes) (Lb).—This soil has a substratum of wet, mottled clay at a depth of 36 to 60 inches. Therefore, internal drainage is very slow. In some places the clay is underlain by sand.

Sorghum, sugar beets, and truck crops are grown on a large acreage and do well on this soil. This soil is also good for range, and it produces high yields of meadow grasses. It is difficult to drain; drainage must be established or maintained, however, to keep the water table low enough for the growth of crops. Careful management of irrigation water is necessary to prevent overirrigation. Land leveling helps to spread the water uniformly. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIw–1; dryland capability unit VIw–1; Salt Meadow range site)

Las clay loam (0 to 1 percent slopes) (Lc).—This soil is silted and has a surface layer of heavy clay loam because muddy irrigation water has been used to irrigate the fields. It is more difficult to work than the Las loams, and it takes in water at a slower rate.

If it is managed well, this soil produces high yields of sorghum, sugar beets, alfalfa, and truck crops. In most irrigated areas, drainage ditches keep the water table low enough for the growth of crops. It is necessary to maintain these drainage ditches. Land leveling helps to spread the irrigation water uniformly. Maintaining good tilth is important; timely tillage prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve soil tilth. (Irrigated capability unit IIw–2; dryland capability unit VIw–1; Salt Meadow range site)

Las clay loam, clay substratum (0 to 1 percent slopes) (Ld).—This soil has a substratum of clay at a depth of 36 to 60 inches. Therefore, internal drainage is very slow.

This soil is irrigated for crops and is used for range. Sorghum, sugar beets, and truck crops are grown on a large acreage and do well. The soil is also good for range and produces high yields of meadow grasses. It is hard to drain, but drainage must be established or maintained to keep the water table low enough for the growth of crops. Careful management of the irrigation water is necessary to prevent overirrigation. Land leveling helps to spread the water uniformly. Timely tillage is important because it prevents excessive cloddiness or compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIw–1; dryland capability unit VIw–1; Salt Meadow range site)

Las clay loam, saline (0 to 1 percent slopes) (Lm).—This soil is much more clayey than is normal for Las soils. In some areas used for pasture, the surface layer is loam instead of clay loam, and in cultivated areas where muddy irrigation water has deposited silt and clay, the surface layer is a finer textured clay loam. The subsoil and substratum have a uniform texture of about 60 percent clay. Throughout this clayey material are seams of salt, and sand occurs below a depth of 48 inches in some places.

Internal drainage is very slow, and salinity is moderate to severe. The water-holding capacity is high, but the water stored is not available to some plants and cannot be used by others.

This soil is difficult to work and to manage because it is saline, fine textured, and hard to drain. It is hard to drain and to leach of salts because it is flat and has a clayey subsoil and substratum. The irrigated areas are best suited to salt-tolerant crops. In most irrigated areas, open ditches supply drainage and keep the water table low enough for the growth of crops. It is necessary to maintain these ditches. Timely tillage is important because it prevents cloddiness and compacting. Barnyard manure and green-manure crops help to maintain tilth and fertility. (Irrigated capability unit IVw–1; dryland capability unit VIw–1; Salt Meadow range site)

Las clay loam, sand substratum (0 to 1 percent slopes) (Ln).—This soil has a substratum of sand and gravel at a depth of 20 to 36 inches. It is easier to drain than soils that do not have a substratum of coarse material. The water-holding capacity is medium, and most of the water stored is readily available to plants.

On this soil good management of irrigation water is important to prevent the loss of water by deep penetration. The irrigation runs should be fairly short. Land leveling is important to help spread the irrigation water uniformly, but deep cuts should not be made until the depth of the soil is determined. Yields of alfalfa are limited in areas where this soil is shallow. Timely tillage is important because it prevents excessive cloddiness or compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIw–2; dryland capability unit VIw–1; Salt Meadow range site)

Las clay loam, sand substratum, saline (0 to 1 percent slopes) (Lo).—This soil has a profile similar to that of Las clay loam, saline, but it is underlain by sand, generally at a depth of 24 to 48 inches. It is therefore easier to drain if enough grade can be established for the drainage outlets.

Alfalfa does not grow well on this fine-textured, saline soil, but areas in range produce high yields of meadow grasses. Some areas are so wet and saline that it is necessary to drain and leach the soil of salts before the areas can be farmed. Good management of irrigation water is needed to prevent seepage from recurring and salinity from becoming worse. Land leveling helps to spread the water uniformly. Timely tillage is important because it helps to prevent cloddiness. Barnyard manure and green-manure crops improve tilth and help to maintain the content of organic matter. (Irrigated capability unit IVw-1; dryland capability unit VIw-1; Salt Meadow range site)

Las clay loam, wet, saline (0 to 1 percent slopes) (Lp).—This soil is mainly on the north side of the river valley just below the sloping uplands. Although its profile is similar to that of Las clay loam, saline, this soil is poorly drained and so wet and saline that it cannot be farmed without major reclamation. The subsoil and substratum are heavy clay and have seams of salt and gypsum throughout. In some places sand is below a depth of 48 inches.

This soil is very slowly permeable and has a water table that is at or near the surface for most of the year. Many sedges, rushes, and cattails grow here. Yields of meadow grasses are high. (Dryland capability unit VIw-1; Salt Meadow range site)

Las sandy loam (0 to 1 percent slopes) (Ls).—The surface layer of this soil is 6 to 12 inches thick and is loamy sand in some places. The sandy texture resulted when flooding streams or the wind deposited sand from nearby sandy soils. In most areas the substratum is clay, but some areas are underlain by sand at a depth of about 48 inches. This soil takes in water at a moderately rapid rate. It is easy to work.

Land leveling helps to spread the water uniformly, and the irrigation runs should not be too long. Because this soil is susceptible to erosion by wind, a cover crop is necessary in some cultivated areas where the ground cover is not adequate for protection. The areas in range produce fair yields of meadow grasses. (Irrigated capability unit IIIs-3; dryland capability unit VIw-1; Salt Meadow range site)

Las Animas Series

The Las Animas series consists of generally flat, poorly drained, saline soils that developed in stratified alluvium. These soils are predominantly sandy. They are on nearly level bottom lands in the valley of the Arkansas River and its major tributaries. The water table is high, and the soils are moderately to severely saline.

The surface layer is dark grayish brown to dark gray when moist and is about 4 to 8 inches thick. The subsoil is dark-gray to dark grayish-brown sandy loam or loamy sand that is stratified and stained with rust-colored mottles. These soils normally overlie sand and gravel at a depth of 20 to 36 inches. The sandy substratum is mottled because drainage is poor. These soils are calcareous throughout.

These soils vary widely in texture. In general the texture of the surface layer is clay loam to sandy loam, but in small areas it is loamy sand. In some areas the substratum is loamy, and in other areas the lower part of the profile contains thin, discontinuous layers of clay.

Las Animas soils occur with the Las, Lincoln, and Glendive soils. They are more sandy than the Las soils and are not so well drained. They are similar to the Lincoln and Glendive soils, except that they are saline and have a high water table.

The native vegetation is alkali sacaton, inland saltgrass, sedges, and rushes. Cottonwood trees grow in some areas that are close to the stream channel and subject to more frequent flooding.

Las Animas soils (0 to 1 percent slopes) (Lt).—These soils are on nearly level or flat bottom lands. Generally they lack drainage, because establishing enough grade is not feasible. The surface layer is predominantly loam and clay loam, but in some large areas it is sandy loam.

These soils take in water at a medium to rapid rate, depending on the texture of the surface layer. The water table is too high for most crops, but it is beneficial to meadow grasses.

These soils are best suited to meadow grasses and are used mostly for growing them. Meadow hay is cut in many areas, and the grasses produce high yields of forage for grazing. The native range plants are salt tolerant. (Dryland capability unit VIw-1; Salt Meadow range site)

Lincoln Series

Soils of the Lincoln series are excessively drained, very droughty, and sandy. They are on nearly level bottom lands and low terraces along the Arkansas River and other major streams in the county. They are flooded during periods of high water.

In most places the surface layer is brown or grayish-brown loamy sand or light sandy loam about 5 to 10 inches thick. Normally, the subsoil and substratum are loamy sand or loamy fine sand that in many places is stratified with thin lenses of sandy loam and sand.

These soils vary mainly in the texture of the surface layer and in depth to a contrasting substratum of sand and gravel. The texture of the surface is loam to loamy sand or sand. Depth to the underlying sand and gravel ranges from about 16 to more than 60 inches.

Lincoln soils have a profile that is similar to that of the Glendive soils, but they are more sandy and more droughty than the Glendive soils. They are more sandy than the Las Animas soils and are much better drained. Unlike the Las Animas soils, they are free of salts.

These soils are a good source of gravel and sand for concrete and road fill. The native vegetation varies greatly from place to place and depends upon the frequency and amount of flooding. Cottonwood trees and tamarisk grow in many areas along the river and major streams. Sand sage grows in other areas. The grasses are mainly switchgrass, alkali sacaton, Indiangrass, tall bluestem, and sand dropseed.

Lincoln loam (0 to 1 percent slopes) (Lu).—This soil occurs only in the valley of the Arkansas River. It has been silted until the texture of its surface layer is loam. Muddy irrigation water and flooding streams have deposited silt and clay upon it. The surface layer is 6 to 8 inches thick.

The water-holding capacity of this soil is very low, but it is slightly higher than that of Lincoln sand. Most of the water stored is available to plants. This soil is easy to work and has very low natural fertility. Some areas are irrigated, but most areas are in native vegetation and are used for grazing. This soil is a good source of gravel and sand. (Irrigated capability unit IVs-1; dryland capability unit VIIs-2)

Lincoln sand (0 to 1 percent slopes) (Lv).—In many places the surface layer of this soil is loamy sand or sandy loam, and in many small depressions or old stream channels, it is even finer textured.

Included in areas mapped as this soil are many areas that have gravelly sand throughout the profile. Other included areas are shallow over gravel.

This Lincoln soil is a good source of gravel and sand. It is not suitable for cultivation and is mostly in native vegetation. (Dryland capability unit VIIs-2)

Lismas Series

In the Lismas series are soils that are shallow or very shallow over shale. The soils developed in material weathered from the shale. They occur in small areas in the uplands, everywhere in the county except in the southeastern part.

These soils have a surface layer of light yellowish-brown to olive-brown clay loam about 5 inches thick. The subsoil is olive-yellow to olive-brown silty clay loam that overlies shale. This shale contains a large amount of gypsum. It occurs within 18 inches of the surface, and in most places it is partly weathered to a depth of a few inches.

The soils vary mainly in their depth to underlying shale. Depth to shale ranges from 5 to 18 inches.

Lismas soils have a profile similar to that of the Pultney soils, but they are more clayey than those soils. They are also shallower over shale.

The native vegetation depends largely upon the condition of the range, which is poor in most places. The dominant vegetation consists of snakeweed, pricklypear, and annual weeds. In a few places some alkali sacaton and blue grama grow.

Lismas clay loam (3 to 5 percent slopes) (Lw).—This soil has a few large outcrops of shale. It takes in water at a slow rate. Permeability of the subsoil is slow, and the water-holding capacity and natural fertility are very low. The water held in the soil is not readily available to plants.

This soil is difficult to work and manage and is not suitable for cultivation. It should be left in grass, but a few areas are cultivated along with other soils. This soil is eroded in places where vegetation is inadequate and where it has been cultivated. Generally, in places where the condition of the range is poor, small gullies occur. (Dryland capability unit VIe-5; Shaly Plains range site)

Lismas-Shale outcrop complex (9 to 25 percent slopes) (Lx).—The Lismas soil in this complex is similar to Lismas clay loam, except that it is steeper and generally shallower to shale. Shale crops out on about half of the acreage. In some small areas the slopes are steeper than 25 percent and are called breaks. Erosion has been severe, and there are many gullies in the steeper areas.

Areas of this complex are used only for range, but the soils are poorly suited to that use. The dominant vegetation is snakeweed and annual weeds. (Dryland capability unit VIIs-3; Shale Breaks range site)

Loamy Alluvial Land (Ly)

This land type consists of deep soil material on the narrow loamy bottoms of upland depressions throughout the county. It receives additional water from adjacent areas that in most places are steep. The areas are in swales that have been dissected by meandering stream channels. The texture is loam or silt loam in most places. The areas range from about 150 to 300 feet in width. The slopes range from 0 to 3 percent.

Loamy alluvial land is used mainly for range and dryfarming, but it is best suited to range. Because it is in frequently flooded depressions, it is highly productive as the result of the additional moisture it receives. Dry-farmed areas are moderately erodible, and in some places there are small gullies. (Dryland capability unit VIe-2; Overflow range site)

Manvel Series

In the Manvel series are deep, well-drained soils of uplands. These soils developed in silty material weathered from limestone and interbedded shale, which are at a depth of 40 to 60 inches. A few small fragments of limestone occur throughout the profile. These soils are highly calcareous. They occur throughout the county, except in the southeastern part.

The surface layer is very friable loam that is 4 to 6 inches thick. It is pale brown when dry and brown when moist. The subsoil is loam that is slightly lighter colored than the surface layer. It grades to the substratum of light yellowish-brown loam that is underlain by bedrock.

These soils are fairly uniform in profile characteristics. In some areas the surface layer is very fine sandy loam and the substratum is very fine sandy loam or light clay loam.

The Manvel soils have a profile similar to that of the Minnequa soils, but the profile is thicker over bedrock. They are more calcareous than the Colby soils and contain fragments of limestone.

The native vegetation is blue grama, buffalograss, and snakeweed.

Manvel loam, 0 to 1 percent slopes (MaA).—This soil occurs in small areas. Its surface drainage is medium. Permeability in the subsoil is moderate. The water-holding capacity is high, and most of the water stored is available to plants. Natural fertility is low. This soil is easy to work, but it is difficult to manage because wind erosion is hard to control.

Some areas of this soil are dry farmed, and others are used for range. The areas in climatic zone C can be cultivated if intensive management is used to control erosion, but they are only fairly suitable for cultivated crops. (Dryland capability units IVe-1 in climatic zone C, VIe-2 in climatic zone D; Loamy Plains range site)

Manvel and Minnequa loams, 1 to 5 percent slopes (MmC).—This mapping unit is about 50 percent Manvel loam and about 50 percent Minnequa loam. Some areas shown on the soil map consist entirely of Manvel loam, others are Minnequa loam, and still others consist of both soils. The slopes are mainly less than 5 percent, but in many areas near drainageways or limestone breaks, slopes of 5 to 9 percent occur. In most of these steeper areas, there are small gullies and rills caused by erosion.

For these soils the rate of water intake is medium, and permeability of the subsoil is moderate. Surface drainage is medium to rapid. The water-holding capacity is low where the soils are shallow over bedrock, and high where they are deeper. Most of the water is readily available to plants. Natural fertility is low.

These soils are used both for dryfarming and permanent grass. They are not suitable for cultivation, however, because of the hazard of erosion, the limestone and shale near the surface, the steep slopes, and the dry climate. The dry-farmed areas are difficult to manage because erosion is hard to control. Erosion has cut small rills in many of the sloping dry-farmed areas. (Dryland capability unit VIe-2; Loamy Plains range site)

Minnequa Series

In the Minnequa series are well-drained soils that are calcareous. These soils are moderately shallow over loamy material weathered from limestone and shale. Limestone or shale is at a depth of 20 to 40 inches. These soils occur throughout the county.

Generally, the surface layer of these soils is loam that is 4 to 6 inches thick and is pale brown when dry and brown when moist. The subsoil is slightly lighter colored loam to a depth of about 14 inches. This loam grades to loam that is very pale brown when dry and light yellowish brown when moist. The subsoil is underlain by limestone. Throughout the profile are small fragments of limestone.

These soils are fairly uniform in profile characteristics, but they vary in depth to bedrock. Also, in some areas the surface layer is very fine sandy loam.

In this county the Minnequa soils are mapped only with the Manvel soils. Their profile is similar to that of the Manvel soils, but they are shallower over bedrock.

The native vegetation consists of blue grama, buffalograss, and a considerable amount of snakeweed and annual weeds.

Nepesta Series

The Nepesta series consists of deep soils on uplands in the irrigated part of the county north of the river valley. These soils developed in loamy material, but they are silted with finer textured material deposited by muddy irrigation water. Normally, these soils are well drained, but some areas are seeped.

The surface layer is dark grayish-brown, calcareous silty clay loam about 8 to 20 inches thick. It is compact and is hard when dry. The subsoil is grayish-brown silty clay loam, but it is less clayey than the surface layer. It has prismatic and blocky structure, is hard when dry, and is 15 to 20 inches thick. The content of lime is high in the horizon just below the subsoil. This horizon grades to the substratum of silt loam, which is pale brown when dry.

These soils vary in texture and in the thickness of the silted surface layer. In many areas that are heavily silted, the surface layer is clay or silty clay; in other areas that are less heavily silted, it is heavy loam.

Nepesta soils occur with the Rocky Ford soils. Their profile is similar to that of the Rocky Ford and Numa soils, but their subsoil is finer textured and has a more blocky structure. Also they have less lime in the horizon just below the subsoil than have the Numa soils.

All of the acreage of Nepesta soils is irrigated.

Nepesta clay loam, 0 to 1 percent slopes (NmA).—The surface layer of this soil is silted. It is generally about 8 to 15 inches thick, but in some of the most nearly level areas or at the lower end of a field, it is as much as 20 inches thick. The surface layer tends to get thicker and finer textured as silt is deposited. This soil has been altered in many places by land leveling, deep tillage, and other farming practices. In some areas it is calcareous throughout because it is silted and has been deeply tilled. In other areas it has a noncalcareous horizon below the silted surface layer. The substratum is gravelly in some small areas.

This soil takes in water slowly. Internal drainage is medium, and surface drainage is moderately slow. The water-holding capacity is high, and most of the water stored is readily available to plants. Natural fertility is high. The fine texture of the surface layer makes this soil moderately difficult to work.

All of this soil is irrigated, and crops normally grown in the area can be grown on it. Subsoiling and chiseling help to improve the penetration of water, and land leveling helps to spread the irrigation water uniformly. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and improve tilth. (Irrigated capability unit IIs-1)

Nepesta clay loam, 1 to 3 percent slopes (NmB).—This soil is silted and has a thinner surface layer in most areas than the other Nepesta soils in the county. In most places it has slopes of 1 to 2 percent.

Surface drainage is medium, and at times slight water erosion occurs. In some small areas the water table is too high for deep-rooted crops. The water table is highest during the growing season, when irrigation water is added to the ground water. Other areas are seeped and slightly saline. On the map in the back of this report are symbols for these wet spots that may need drainage.

All of this soil is irrigated, and crops normally grown in the area can be grown on it. Subsoiling and chiseling help to improve the penetration of water, and land leveling helps to spread the irrigation water uniformly. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Water in seeped areas can be removed by drainage. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIe-1)

Nepesta clay loam, saline, 0 to 1 percent slopes (NpA).—This soil is distinguished from other Nepesta soils in the county by its severe salinity. White salts have accumulated in the surface layer and subsoil. In areas mapped as this soil, the salinity occurs mostly in spots and is more severe in the subsoil than in the surface layer. If this soil is not artificially drained, the water table is too high during the growing season for any crop except a shallow-rooted one.

This soil should be managed intensively. It is not suited to most crops until it has been drained and reclaimed. After a drainage system has been provided, land leveling is necessary for spreading the irrigation water uniformly in some areas. Chiseling and subsoiling help to improve the penetration of water. Barnyard manure and green-manure crops improve tilth and help to maintain fertility and the content of organic matter. Timely tillage is important because it prevents cloddiness and compacting. (Irrigated capability unit IIIw-3)

Nepesta clay loam, saline, 1 to 3 percent slopes (NpB).—The silted surface layer of this soil is slightly thinner than that in the nearly level areas of Nepesta soils. This soil is severely saline; white salts have accumulated in the surface layer and subsoil and are in spots or patches in most fields. In most places salinity is more severe in the subsoil than in the surface layer, and only crops that are salt tolerant can be grown. If this soil is not artificially drained, the water table is high. The water table is highest during the growing season, when irrigation water is added to the ground water. Growing crops may be damaged severely if the water table rises into the root zone. Slight water erosion occurs at times.

This soil should be managed intensively, and it is not suited to most crops until it has been drained and leached of salts. After a drainage system has been established, land leveling may be necessary to spread irrigation water uniformly. Chiseling and subsoiling help to improve the penetration of water. Barnyard manure and green-manure crops improve tilth and help to maintain the content of organic matter and fertility. Timely tillage is important because it prevents cloddiness and compacting. (Irrigated capability unit IIIw-4)

Nepesta clay loam, wet, 0 to 1 percent slopes (NsA).—This soil has a high water table in some places. The water table is highest during the growing season, when a large amount of irrigation water is added to the ground water. The soil is seeped in other places and is slightly saline.

Most crops grown in the area can be grown on this soil, but it is necessary to drain this soil or to maintain existing drainage if deep-rooted crops are grown. Subsoiling is necessary to improve the penetration of water in some areas. Land leveling helps to spread the irrigation water uniformly. Barnyard manure and green-manure crops improve tilth and help to maintain fertility. Timely tillage is important to prevent excessive cloddiness and compacting. (Irrigated capability unit IIw-1)

Nihill Series

The Nihill series consists of well-drained soils that are shallow over beds of limy gravel. These soils are gravelly and developed on uplands.

The surface layer is gravelly loam that is about 4 inches thick and is light brownish gray when dry. It is underlain by very pale brown very gravelly loam. Within a depth of about 18 inches, this loam grades to material that is about 90 percent gravel. These soils are calcareous, and in places the underlying material contains much lime. Permeability is very rapid.

These soils vary in the amount of gravel in their profile and in the amount of lime in their substratum. They also vary in the depth to material that is essentially gravel.

Nihill soils occur with Potter and Stoneham soils. They are more permeable than the Potter soils and do not have a lime-cemented substratum. Nihill soils are shallower than the Stoneham soils, are more gravelly, and have a less well developed profile.

The native vegetation consists of blue grama, sideoats grama, buffalograss, and yucca.

In this county the Nihill soils are not mapped separately but are mapped with the Potter soils.

Numa Series

The Numa series consists of deep soils on uplands below the canal system north of the river valley. These soils developed in strongly calcareous, medium-textured material. They are silted because they have been irrigated with muddy water that has deposited fine-textured material. Generally, silting has been most severe in the more nearly level areas. In most places these soils are well drained, but in some places seepage occurs.

The surface layer is dark grayish-brown clay loam in most areas and is 6 to 12 inches thick. The subsoil is yellowish-brown or pale-brown loam and contains a small amount of gravel and some lime concretions. In the horizon just below the subsoil, the content of lime is high; some of the lime is in the form of concretions, and some of it is disseminated. The substratum is loam or sandy clay loam. These soils are calcareous throughout.

These soils vary considerably in texture. The amount of gravel varies from place to place, but generally the amount increases with increasing depth. The content of gravel does not vary enough, however, to affect cultivation. In some areas that have been less heavily silted, the surface layer is loam.

These soils have a profile similar to those of the Harvey and Nepesta soils. Their surface layer is thicker and finer textured, however, than that of the Harvey soils, and their subsoil is coarser textured and less blocky than that of the Nepesta soils. Their lower layers contain more lime than those of the Rocky Ford soils.

All of the acreage of Numa soils is irrigated, and crop yields are high.

Numa clay loam, 0 to 1 percent slopes (NtA).—This soil has a surface layer that tends to build up as muddy irrigation water deposits more silt and clay upon it. In places it has been considerably affected or altered by land leveling and deep tillage. This soil takes in water at a slow or moderately slow rate. Permeability of the subsoil is medium. The water-holding capacity is high, and most of the water stored is readily available to plants. The fine texture of the surface layer makes this soil moderately difficult to work. Natural fertility is moderately high.

All of this soil is irrigated, and crops normally grown in the area can be grown on it. Land leveling helps to spread the irrigation water uniformly, and subsoiling and chiseling help to improve the penetration of water. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIs-1)

Numa clay loam, 1 to 3 percent slopes (NtB).—This soil has a profile similar to that of Numa clay loam, 0 to 1 percent slopes, but its surface layer is silted only to about the thickness of the plow layer (fig. 12). Also, it has slightly more rapid surface drainage. Water erosion is

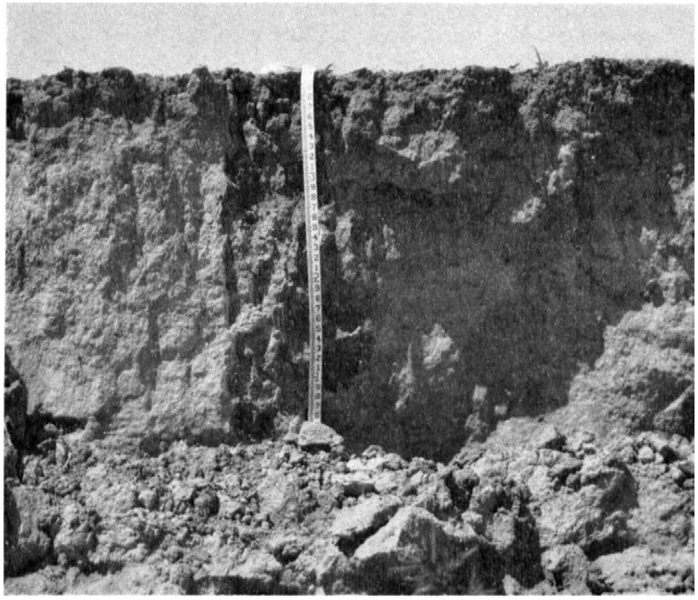

***Figure 12.*—Profile of Numa clay loam, 1 to 3 percent slopes, showing the darkened, silted plow layer.**

slight. Frequent plowing has mixed part of the light-colored subsoil with the darker colored surface layer.

All of this soil is irrigated, and crops normally grown in the area can be grown on it. Land leveling helps to spread the irrigation water uniformly, and subsoiling and chiseling help to improve the penetration of water. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIe–1)

Numa clay loam, 3 to 5 percent slopes (NtC).—The surface layer of this soil is thinner than that of the less sloping Numa soils. It is silted to about the thickness of the plow layer. Runoff is more rapid than on the more gently sloping and nearly level Numa soils, and at times, erosion is slight or moderate.

All of this soil is irrigated, and most of the crops normally grown in the area can be grown on it. Land leveling helps to spread the irrigation water uniformly, and subsoiling and chiseling help to improve the penetration of water. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIe–2)

Numa clay loam, saline, 0 to 3 percent slopes (NuB).—This soil is moderately or severely saline, and the salts can seriously retard the growth of crops. White salts have accumulated on the surface and in the subsoil. In this soil the water table is high enough and seepage is great enough to damage crops severely. The water table is highest when a large amount or irrigation water has been added to the ground water during the growing season. Internal drainage is slow.

This soil needs intensive management. Drainage and the leaching of salts are necessary. After drainage has been provided, land leveling may be necessary to spread the irrigation water uniformly. In some places subsoiling and chiseling are necessary to improve the penetration of water. Timely tillage is important because it prevents cloddiness and compacting. Barnyard manure and green-manure crops help to improve tilth and to maintain the content of organic matter. (Irrigated capability unit IIIw–4)

Numa clay loam, wet, 0 to 3 percent slopes (NwB).—This soil has slight seepage and a water table high enough to retard the growth of deep-rooted crops. The water table is highest in summer, when irrigation water is added to the ground water. This soil is slightly saline, but the salinity affects only crops that are not salt tolerant. The steeper areas are slightly eroded.

Management of this soil should be slightly more intensive than that of the better drained Numa soils. Drainage is needed. Only salt-tolerant crops can thrive on this soil, but most of the crops commonly grown in the county can be grown. In some places subsoiling is needed to improve the penetration of water, and land leveling helps to spread the irrigation water uniformly. Barnyard manure and green-manure crops improve tilth and help to maintain fertility. Timely tillage is important because it prevents excessive cloddiness and compacting. (Irrigated capability unit IIw–3)

Otero Series

In the Otero series are deep, well-drained soils that developed on uplands in calcareous sandy material. The underlying material is mostly Tertiary outwash, but it includes some wind-deposited or reworked sandy material.

The surface layer of these soils is thin, very friable sandy loam that is about 4 to 8 inches thick and is light brownish gray when dry. The subsoil is pale-brown sandy loam to a depth of about 12 to 25 inches. The substratum is highly variable in texture; it ranges from coarse loamy sand to light clay loam. Throughout the profile, particularly in the coarser textured material of the substratum, the content of fine gravel varies. These soils are highly calcareous throughout.

These soils vary mainly in the texture of the surface layer and substratum. Generally, their surface layer is sandy loam, but many areas in which the surface layer is loamy sand are included.

Otero soils have a subsoil that is structureless instead of blocky like that of the Vona soils. Unlike the Vona soils, they are calcareous throughout. Otero soils have a coarser textured subsoil than the Stoneham soils, and their substratum contains less gravel.

The native vegetation on these soils consists of sideoats grama, blue grama, buffalograss, sand dropseed, sand sage, and yucca.

Otero sandy loam, 1 to 3 percent slopes (OtB).—This soil is in fairly small areas scattered throughout the uplands in the southern part of the county. It is mostly in areas bordering drainageways.

Included in some areas mapped as this soil are areas of Cascajo or Vona soils. The included areas total as much as 10 percent of the mapping unit.

This soil takes in water at a moderately rapid rate. The permeability of the subsoil is rapid. The water-holding capacity is low to medium, and most of the water held is readily available to plants. Natural fertility is low.

This soil is dry farmed and used for permanent grass. The areas in climatic zones B and C can be dry farmed, but on this soil a great deal of care is needed to control wind erosion. In climatic zone D, this soil is best suited to range. This soil is easy to work, but it is difficult to manage because of the severe hazard of erosion. (Dryland capability units IVe–4 in climatic zones B and C, VIe–3 in climatic zone D; Sandy Plains range site)

Otero sandy loam, 3 to 5 percent slopes (OtC).—This soil is moderately susceptible to erosion and is not suitable for cultivation. Cultivated areas should be reseeded to grass in the places where seeding is feasible. The reseeded areas should not be grazed until a stand of grass is well established. If these areas are managed well, the grass will not be overgrazed and the range will not deteriorate. (Dryland capability unit VIe–3; Sandy Plains range site)

Penrose Series

In the Penrose series are well-drained soils that are shallow over limestone. These soils developed on uplands and are highly calcareous throughout.

The surface layer of these soils is light brownish-gray loam about 5 inches thick. The subsoil is pale-brown channery loam. This loam grades to lighter colored, highly calcareous channery loam that is generally underlain by bedrock at a depth of 10 to 18 inches. Some areas, however, are shallower to limestone.

These soils vary mainly in the depth to bedrock and in the kind of underlying bedrock. In some areas the bedrock is limestone interbedded with shale. In places as much as 40 percent of the material on the surface and throughout the profile consists of limestone fragments.

Penrose soils are shallower over limestone than the Minnequa soils. Their profile is similar to that of the Travessilla soils, but the underlying bedrock is limestone instead of sandstone.

The native vegetation consists of blue grama, sideoats grama, buffalograss, snakeweed, and yucca.

Penrose loam, 1 to 5 percent slopes (PaC).—This soil is underlain by shale and interbedded limestone (fig. 13) in some places. Water enters at a medium rate but does not penetrate to a great depth. The water-holding capacity and natural fertility are very low. This soil is used mostly for range and is best suited to that use. Some small areas are in dry-farmed fields, but those areas should be reseeded to grass where seeding is feasible. (Dryland capability unit VIe–2; Loamy Plains range site)

Penrose-Rock outcrop complex (3 to 25 percent slopes) (Pk).—The Penrose soil in this complex has a profile similar to that of Penrose loam, 1 to 5 percent slopes, but more fragments of limestone are on the surface and throughout the profile. Also rock crops out on 30 to 50 percent of the acreage. This complex is used entirely for range. (Dryland capability unit VIIs–4; Limestone Breaks range site)

Figure 13.—**Profile of Penrose loam, 1 to 5 percent slopes, showing shale and interbedded limestone.**

Potter Series

Soils of the Potter series are shallow over lime-cemented or mortar-bed material. They developed on uplands, mostly in the northern part of the county.

Potter soils have a surface layer of light brownish-gray gravelly fine sandy loam that is only about 4 inches thick. The surface layer grades to light-gray gravelly loam or fine sandy loam. Hard, indurated gravel that is cemented with lime is at a depth of about 9 inches. The content of gravel ranges from 10 to 50 percent, and in many places bedrock is exposed. These soils have very slow permeability and are calcareous throughout.

In this county the Potter soils are not mapped separately but are mapped with the Nihill and Stoneham soils. They are shallower than the Nihill soils and have a more strongly cemented substratum than those soils.

The native vegetation consists of blue grama, sideoats grama, buffalograss, and yucca.

Potter and Nihill gravelly soils, 1 to 5 percent slopes (PnC).—The soils of this mapping unit generally occur in small areas throughout the northern part of the county (fig. 14). The part of the acreage made up of Potter soils is slightly larger than that made up of Nihill soils. The

Figure 14.—Profile of Nihill gravelly loam.

surface drainage is very rapid. The water-holding capacity and natural fertility are very low. Although these soils are not suitable for cultivation, some small areas are cultivated. Grass should be reseeded in the places where reseeding is feasible. (Dryland capability unit VIIs–1; Gravel Breaks range site)

Potter and Stoneham gravelly loams, 5 to 35 percent slopes (PsE).—The soils of this mapping unit are in rough broken areas along drainageways, mainly in the northern part of the county. Generally, they have very low water-holding capacity. They are moderately eroded to severely eroded. In many areas water erosion has caused gullies, head cuts, short abrupt breaks, and vertical slopes.

Included in the areas mapped as these soils are areas of Nihill soils. Also included are many areas of a steep, eroded soil formed in deep loess.

The soils of this mapping unit are used for range. They are suitable only for that purpose. (Dryland capability unit VIIs–1; Gravel Breaks range site)

Pultney Series

The Pultney series consists of well-drained soils that are moderately shallow to moderately deep over yellowish-brown gypsiferous shale. These soils are on uplands. They occur in small, scattered areas through all of the county except that area south of Holly.

These soils have a surface layer of loam or clay loam that is about 5 to 10 inches thick and is light grayish brown to yellowish brown when dry. The subsoil is clay loam or light silty clay loam that is yellowish brown to pale brown when dry. The substratum is yellowish-brown clay loam. These soils are calcareous throughout. They have a considerable amount of crystalline gypsum in the subsoil and substratum, and they are underlain by gypsiferous shale and interbedded limestone at a depth of 20 to 60 inches. The subsoil is saline. Water penetrates these soils at a medium to slow rate.

Pultney soils occur with the Lismas soils, but they are deeper over shale than those soils. Their profile is somewhat similar to that of the Minnequa soils, but it contains more gypsum. Also, the Pultney soils were derived from shale and have more clay in the subsoil and substratum than the Minnequa soils.

The native vegetation consists of blue grama, buffalograss, western wheatgrass, alkali sacaton, and yucca.

Pultney loam, 1 to 5 percent slopes (PuC).—This soil occurs in fairly small areas scattered throughout the uplands, except south of Holly. It is gently rolling. Generally, the areas are long and narrow and border shallow drainageways in the uplands. In the geologic past a cap of loess covered this soil, but much of the loess has been removed through erosion.

This soil varies in profile characteristics. In some areas the surface layer formed in loess and is about 10 inches thick over material derived from shale. In those areas the surface layer normally is loam, but in other areas the surface layer is clay loam. The amount of gypsum in the profile varies.

This soil occurs with the Minnequa, Lismas, Colby, and Wiley soils. Some areas mapped as this soil include areas of Minnequa soils and small areas of Lismas soils. The inclusions of Minnequa soils make up as much as 10 percent of the mapping unit.

This soil takes in water at a medium to slow rate. Surface drainage is moderately rapid. Permeability of the subsoil is slow. The water-holding capacity is medium to high and depends on the depth to shale. About half of the water held is readily available to plants. Natural fertility is low.

This soil is best suited to permanent grass, but part is dry farmed and part is used for range. In many of the dry-farmed areas, this soil is so severely eroded that much of the surface layer is gypsiferous clay loam. (Dryland capability unit VIe–5; Shaly Plains range site)

Renohill Series

The Renohill series consists of well-drained, moderately shallow to deep soils that developed on uplands in sandstone and interbedded shale, principally of the Dakota formation. These soils occur in the southwestern part of the county.

The surface layer is very friable loam or sandy loam about 5 to 10 inches thick. It is dark grayish brown when moist. The subsoil is generally clay loam that is brown when moist and has subangular blocky structure. It is about 15 to 30 inches thick and is hard when dry and firm when moist. Below the subsoil, finely divided lime and small nodules have accumulated in a zone. The substratum is loam or clay loam and is underlain by sandstone or shale at a depth of 20 to 60 inches. These soils generally are noncalcareous in the upper layers, and chips of sandstone are scattered throughout their profile.

The main variations in these soils are in the texture of the horizons and in the depth to sandstone or shale. In some places the subsoil is sandy clay loam instead of clay loam. In most places the depth to the sandstone is 36 to 60 inches. Areas of these soils that are 20 to 36 inches deep are mapped as moderately shallow phases.

Renohill soils have a profile somewhat similar to that of Fort Collins soils. They are somewhat finer textured and less gravelly than Fort Collins soils and developed from a different kind of material. Renohill soils are less silty than Baca soils and developed from weathered sandstone or shale instead of calcareous loam.

These soils are used for dryfarming and for range. Areas large enough to cultivate are suitable for dryfarming if there is enough moisture and slopes are not too steep.

The native vegetation on the loams is blue grama and buffalograss. On the sandy loams it is blue grama, buffalograss, little bluestem, and some sand sage and scattered cedar trees. The shallow soils have more cedar trees than the deep ones.

Renohill loam, 1 to 3 percent slopes (RaB).—This soil is 36 to 60 inches deep over sandstone, but in some places shallower Renohill soils are included. Also included are areas that have a clay loam surface layer.

Water penetrates this soil at a medium rate, but the permeability of the subsoil is slow. The water-holding capacity is high, and most of the water held in the soil is readily available to plants. The soil is easy to work and has high natural fertility.

This soil is used for dryfarming and for range. It produces fair yields of wheat and sorghum if the weather is favorable. Stubble-mulch tillage helps to maintain the content of organic matter and to conserve soil moisture. Contour farming and terracing help to control water erosion and to conserve moisture. Stripcropping aids in controlling wind erosion. If ground cover is not adequate, emergency tillage may be needed to control wind erosion. This tillage brings to the surface clods that resist the wind. This soil makes good range and is well suited to grass. (Dryland capability unit IVc–1; Loamy Plains range site)

Renohill loam, 3 to 5 percent slopes (RaC).—This sloping soil is 36 to 60 inches deep over sandstone. Surface runoff is moderately rapid. Water erosion is slight in dry-farmed areas, and rills occur in some places.

This soil is suitable for dryfarming in zones of higher rainfall, but intensive management is needed to control erosion. Stubble-mulch tillage helps to maintain the content of organic matter and to conserve soil moisture. Stripcropping helps to control wind erosion. If the ground cover is not adequate for protection, emergency tillage may be needed to prevent wind erosion. This tillage brings to the surface clods that resist the wind. This soil makes good range, for it is well suited to grass. (Dryland capability units IVe–2 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Renohill loam, moderately shallow, 1 to 3 percent slopes (RbB).—This soil is 20 to 36 inches deep over sandstone. Its water-holding capacity is medium, and the water held in the soil is readily available to plants. Some sandstone crops out and interferes with tillage.

This soil is suitable for dryfarming only in the zones of higher rainfall, but in these zones some areas are too small, too shallow, and have too many rock outcrops for successful cultivation. The cultivated areas should be managed to conserve moisture and to control erosion. Stubble-mulch tillage helps to maintain the content of organic matter and to conserve soil moisture. Contour farming and terracing help to control water erosion and to conserve moisture. Stripcropping aids in controlling wind erosion. If there is not enough ground cover for protection, emergency tillage may be needed to bring to the surface clods that resist the wind. This soil makes good range and is well suited to grass. (Dryland capability units IVc–1 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Renohill loam, moderately shallow, 3 to 5 percent slopes (RbC).—This soil is only 20 to 36 inches deep over sandstone. It has more sandstone fragments on the surface and throughout the soil than have deeper, less sloping Renohill soils. Because the soil is shallow, the water-holding capacity is only medium. Rock crops out in many places and interferes with tillage. Included with this soil near stream channels are small areas that have slopes of more than 5 percent.

Because this soil is moderately shallow and sloping and has rock outcrops, it is not suitable for dryfarming. Areas that are now dry farmed should be seeded to grass, and grazing should not be permitted until a stand of grass is established. Then the grazing ought to be regulated to prevent overgrazing. (Dryland capability unit VIe–2; Loamy Plains range site)

Renohill sandy loam, 1 to 3 percent slopes (RdB).—This soil is generally 36 to 60 inches deep over sandstone, but is deeper to sandstone than normal on small foot slopes at the base of sandstone breaks. Cedar trees are scattered in some areas.

Water penetrates this soil at a medium rate, and permeability is medium in the subsoil. The water-holding capacity is medium to high, and most water held in the soil is readily available to plants. This soil is easy to work and has medium natural fertility.

This soil is used mostly for range, but some areas are dry farmed. Many small areas that are intermingled with areas of shallow soils are not suitable for dryfarming. Sorghum is the best-suited crop in dry-farmed areas, but wheat grows fairly well if management is good. Stubble-mulch tillage, contour farming, terracing, and stripcropping help to conserve soil moisture and to control erosion. Emergency tillage, such as listing, may be needed to prevent wind erosion if the ground cover is not adequate for protection. This soil is well suited to permanent grass. (Dryland capability unit IVe–3; Sandy Plains range site)

Renohill sandy loam, 3 to 5 percent slopes (RdC).—This soil is generally 36 to 62 inches deep over sandstone, but sandstone crops out in a few places. Surface runoff is moderately rapid, and it slightly erodes the soil in dry-farmed areas. Included in mapped areas of this soil along drainageways or on foot slopes are small areas with slopes of more than 5 percent.

Most of this soil is used for native range grasses, though a few areas are dry farmed. The soil is suitable for dryfarming only if the areas are large enough for cultivation and are in zones of higher rainfall. Intensive management is needed to conserve moisture and to control erosion. Sorghum is the crop best suited to dryland cultivation, but wheat grows fairly well if management is good. Stubble-mulch tillage, contour farming, terracing, and stripcropping help to conserve soil moisture and to control erosion. Emergency tillage, such as listing, may be needed to prevent wind erosion in areas where there is not enough ground cover for protection. This soil is well suited to permanent grass. (Dryland capability units IVe–6 in climatic zone C, VIe–3 in climatic zone D; Sandy Plains range site)

Renohill sandy loam, moderately shallow, 1 to 3 percent slopes (RhB).—In most places this soil is 20 to 36 inches deep over sandstone, but in some places sandstone crops out and interferes with tillage. Because it is moderately shallow, this soil has low water-holding capacity. Most of the water held in the soil is readily available to plants.

Most of this soil is used for range, but some areas are dry farmed. Sorghum is the crop best suited to dryfarming, though wheat grows well if management is good. Stubble-mulch tillage, contour farming, terracing, and stripcropping help to conserve moisture and to control erosion. Emergency tillage, such as listing, may be needed to control wind erosion in places where the ground cover is not adequate for protection. This soil is well suited to permanent grass. (Dryland capability units IVe–3 in climatic zone C, and VIe–3 in climatic zone D; Sandy Plains range site)

Renohill sandy loam, moderately shallow, 3 to 5 percent slopes (RhC).—This soil is generally 20 to 36 inches deep over sandstone, but sandstone crops out in many places and severely hinders tillage. Sandstone fragments are common on the surface and throughout the profile. The water-holding capacity is moderately low.

This soil is not suitable for dryfarming, because it is sloping, is moderately shallow, and has rock outcrops. Practices are needed to prevent overgrazing and the deterioration of the range. In some areas seeding of grasses suited to this soil may be needed. (Dryland capability unit VIe–3; Sandy Plains range site)

Renohill soils, eroded (1 to 12 percent slopes) (Rk2).—Except for the surface layer, these soils have a profile similar to the one described for the series. The surface layer has been moderately to severely eroded, and there are many gullies that prevent tillage. The surface layer is sandy loam. The depth to sandstone is generally 20 to 60 inches, but the sandstone crops out in many places. The steeper slopes are likely to be more severely eroded because they have rapid runoff.

These soils are used as range. Reseeding is needed so that a better cover of grass is established. Grazing should be prevented from the time of reseeding until a stand is established, and then should be regulated to prevent overgrazing and consequent erosion. (Dryland capability unit VIe–3; Sandy Plains range site)

Richfield Series

In the Richfield series are deep soils that developed in calcareous loess in the zones of higher rainfall. These soils are in the eastern part of the county. They are important for agriculture.

The surface layer of these soils is grayish-brown silt loam that is about 6 inches thick. When it is moist, the surface layer is very dark grayish brown and is very friable. The subsoil is grayish-brown clay loam or silty clay loam that is 10 to 20 inches thick and has prismatic to blocky structure. A zone of lime accumulation lies just below the subsoil. In most places the lime is in the form of white nodules that are a quarter of an inch in diameter. The substratum is brown silt loam. These soils are normally leached of lime to a depth of 13 to 17 inches.

These soils vary mainly in the depth to lime and in the thickness of the horizons. In many places there is a buried soil deep in the profile. The buried soil is dark-gray, calcareous silt loam. In some places the Richfield soils are underlain by reddish Tertiary outwash. The outwash is at so great a depth, however, that it does not affect the use and management of the soils.

These soils contain more clay than the Ulysses soils, and they have a better developed profile. They are deeper to lime than the Baca soils and have a lighter colored surface layer.

The native vegetation is blue grama and buffalograss.

Richfield silt loam, 0 to 1 percent slopes (RmA).—This soil occurs on uplands in large areas south of Holly and east of Two Butte Creek. It also occupies small areas in the extreme northeastern part of the county. In most places this soil is nearly level, but in a few places the slopes are slightly more than 1 percent. This soil occurs in an area of favorable rainfall and is of major importance to agriculture in the county.

Included with this soil is a small acreage of Ulysses silt loam. Small areas of Richfield clay loam are also included.

This soil takes in water at a medium rate. The surface drainage and the permeability of the subsoil are slow. The water-holding capacity is high, and most of the water held is readily available to plants. Natural fertility is high.

Most of this soil is dry farmed, but a small acreage is in permanent grass. When the climate is favorable, this soil produces good yields of wheat and sorghum. Yields are generally better in the dry-farmed areas of this soil than in dry-farmed areas of most other soils in the county. This soil is moderately easy to work and to manage. Erosion in the dry-farmed areas is slight. It is easily controlled by stubble mulching and stripcropping, and those practices also conserve moisture.

Recently some areas of this soil have been irrigated by using water pumped from wells. In those areas yields are high and any crop that is suited to the climate does well. (Irrigated capability unit I–1; dryland capability unit IIIc–1; Loamy Plains range site)

Rocky Ford Series

Soils of the Rocky Ford series are moderately shallow to deep, calcareous, and medium textured. They are on terraces of the Arkansas River and its major tributaries and on uplands north of the valley of the Arkansas River. All of these soils are irrigated with water from the canal system and are silted.

The surface layer of these soils is dark grayish-brown clay loam and is 10 to 15 inches thick. It is hard when dry and firm when moist. The subsoil, or horizon underlying the silted surface layer, is brown silt loam that is slightly hard when dry and friable when moist. This silt loam grades to lighter colored silt loam. These soils are calcareous throughout.

Generally, the surface layer is heavily silted because the muddy water used to irrigate this soil has deposited silt and clay. In many places where water tends to pond at the lower end of a field, the soil is more deeply silted than it is in the other areas. In many of the steeper areas, the surface layer is coarser than it is in nearly level areas. In some of these areas, plowing has mixed part of the lighter colored subsoil with the surface layer in many places. In places land leveling or deep tillage has greatly altered or affected some of the soils.

Crop yields are high, but some of these soils need more careful management than others because they are shallow over limestone or sand and gravel. The main problems are managing irrigation water, maintaining fertility, and controlling erosion on the steeper soils.

Rocky Ford clay loam, 0 to 1 percent slopes (RoA).—This is a highly productive soil. Generally, its substratum is silt loam to a depth of more than 5 feet, but in many places on stream terraces, the substratum is sand below a depth of 3 feet. In some places on stream terraces, a layer of sandy loam about 18 to 24 inches thick is below the silted part of the profile. Land leveling and deep tillage have altered this soil in some places.

This soil takes in water slowly. Permeability of the subsoil is medium. The water-holding capacity is high, and most of the water stored is readily available to plants. The fine texture of the surface layer makes this soil moderately difficult to work. Natural fertility is high.

All of this soil is irrigated, and all of the crops normally grown in the area can be grown on it. Land leveling helps to spread the irrigation water uniformly. Subsoiling and chiseling help to improve the penetration of water. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIs–1)

Rocky Ford clay loam, 1 to 3 percent slopes (RoB).—The surface layer of this soil is not silted quite so deeply as it is in the nearly level areas. In some small areas on the uplands, limestone is at a depth of 3 to 5 feet. Water runs off this soil at a moderately rapid rate. Slight water erosion occurs at times, especially in the steeper areas.

All of this soil is irrigated, and all the crops normally grown in the area can be grown on it. Land leveling helps to spread the irrigation water uniformly. Subsoiling and chiseling help to improve the penetration of water. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIe–1)

Rocky Ford clay loam, 3 to 5 percent slopes (RoC).—This soil is on the uplands. Generally, it is silted to about the thickness of the plow layer. In many of the steeper areas, the surface layer is coarser textured than it is in nearly level areas, and it has not been silted to so great a depth. Limestone is at a depth between 3 and 5 feet in some small areas. In some places seepage has occurred, and this soil is saline. These wet, saline spots are shown on the map by symbols for wet spots and saline spots. Generally, water runs off at a moderately rapid rate, and at times moderate erosion takes place.

All of this soil is irrigated. Most of the crops normally grown in the area can be grown on it, but sugar beets and truck crops are not grown. This soil should be more intensively managed than a less sloping soil. The saline and seeped areas need drainage. Subsoiling and chiseling help to improve the penetration of water, and land leveling helps to spread the irrigation water uniformly. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIe–2)

Rocky Ford clay loam, clay substratum, 0 to 1 percent slopes (RpA).—This soil is on low terraces of the Arkansas River. It has a substratum of massive clay at a depth between 30 and 60 inches. This substratum is mottled and has spots where salts have accumulated. It has a marked influence on drainage and permeability. Internal drainage is very slow. This soil is slightly saline. Salts are visible on the surface after the soil is irrigated.

All of this soil is irrigated, and shallow-rooted crops are the best suited. Land leveling helps to spread the irrigation water uniformly. Chiseling and subsoiling help to improve the penetration of the water. If the irrigation water is managed carefully, seepage can be prevented. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. Timely tillage is important because it prevents excessive cloddiness or compacting. (Irrigated capability unit IIIs–1)

Rocky Ford clay loam, sand substratum, 0 to 1 percent slopes (RsA).—This soil is mainly on terraces along the Arkansas River. It is underlain by sand and gravel at a depth of 20 to 36 inches. The water-holding capacity is medium to low, but most of the water stored is available to plants. This soil is moderately difficult to work. Its natural fertility is moderately high.

All of the acreage is irrigated, and this soil is suited to most crops grown in the area. Yields of alfalfa are lower than on deeper soils, but alfalfa can be grown if this soil is irrigated more frequently than deeper soils. Water penetrates this soil deeply and is lost if the irrigation runs are too long. Land leveling helps to spread the water uniformly, but deep cuts should not be made until the depth of the soil is determined. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. (Irrigated capability unit IIIs–2)

Rocky Ford clay loam, sand substratum, 1 to 3 percent slopes (RsB).—This soil of uplands has a surface layer that is less deeply silted than that of nearly level Rocky Ford soils. The soil is silted to about the thickness of the plow layer. A substratum of sand and gravel is at a depth of 20 to 36 inches. The coarse material in the substratum is very rapidly permeable, and water is easily lost through it. The water-holding capacity is medium to low, but most of the water stored is available to plants. Runoff is moderately rapid. Slight rill erosion occurs on the slopes.

All of the acreage is irrigated, and this soil is suited to most crops grown in the area. Yields of alfalfa are lower than on deeper soils. Land leveling helps to spread the water uniformly, but deep cuts should not be made until the depth of the soil is determined. Water is used most efficiently if this soil is irrigated frequently and lightly. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Barnyard manure and green-manure crops improve tilth and help to maintain the content of organic matter. (Irrigated capability unit IIIe-3)

Rocky Ford clay loam, sand substratum, 3 to 5 percent slopes (RsC).—This soil of uplands has a sandy and gravelly substratum. The surface layer is silted to only about the thickness of the plow layer, and its texture is generally slightly coarser than that of the surface layer in less sloping Rocky Ford soils. Surface drainage is also more rapid than on the less sloping soils. Slight erosion occurs at times when this soil is not protected. The sandy and gravelly substratum is at a depth of 20 to 36 inches. The coarse material in the substratum is very rapidly permeable, and water is easily lost through it. The water-holding capacity is medium to low, but most of the water stored is available to plants.

All of the acreage is irrigated, and this soil is suited to most crops grown in the area. The yields of alfalfa are lower, however, than they are on deeper soils. Good management of irrigation water is important in controlling erosion and preventing the loss of water. Water is used most efficiently if this soil is irrigated frequently and lightly. Land leveling helps to spread the water uniformly, but deep cuts should not be made until the depth of the soil over sand is determined. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. Barnyard manure and green-manure crops improve tilth and help to maintain the content of organic matter. (Irrigated capability unit IVe-2)

Rocky Ford clay loam, over limestone, 1 to 3 percent slopes (RtB).—This soil occurs only on uplands and is underlain by limestone at a depth of 20 to 36 inches. The surface layer is silted to about the thickness of the plow layer. It is mostly heavy loam to light clay loam and is lighter textured than that of most Rocky Ford soils.

Because it is shallow over limestone, this soil has medium surface drainage and very slow internal drainage. The water-holding capacity is low to medium, and most of the water stored is readily available to plants. This soil is easy to moderately difficult to work and has low natural fertility.

This soil is best suited to small grains and sorghum, and all of it is irrigated. Yields of alfalfa are lower than on deeper soils. Deep cuts should be avoided when leveling this land. Good management of irrigation water prevents loss of water from runoff and seepage. If row crops are planted across the slope, the grade of the irrigation furrows is reduced. Barnyard manure and green-manure crops improve the tilth and fertility. (Irrigated capability unit IVs-2)

Rocky Ford clay loam, over limestone, 3 to 5 percent slopes (RtC).—This soil is underlain by limestone at a depth of 20 to 36 inches. The limestone restricts the depth to which roots and water can penetrate. The water-holding capacity is low to medium. Surface runoff is rapid. Rill erosion occurs at times on the slopes.

All of this soil is irrigated. The soil is best suited to small grains and other close-growing crops. Yields of alfalfa are lower than on deeper soils because of the bedrock near the surface. Good management of irrigation water is important in controlling loss of water by erosion and seepage. Some land leveling may be needed to spread the water uniformly in a few places, but deep cuts should be avoided. Irrigation runs should be short. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are nearly on the contour. (Irrigated capability unit IVe-1)

Rocky Ford clay loam, saline, 0 to 1 percent slopes (RuA).—This soil is moderately to severely saline; white salts have accumulated on the surface and in the subsoil, generally in spots. Because of this salinity, most of the water stored in the soil is not available to plants and the growth of crops is seriously retarded. The salts may remain for some time after the soil has been drained. In areas where this soil is not artificially drained, seepage occurs or there is a high water table. The water table is highest during the growing season, when a large amount of irrigation water is added to the ground water. In some small areas, limestone is at a depth of about 30 inches.

This soil is used entirely for irrigation farming, but it is not suited to many crops until it has been drained and leached of salts. It should be managed intensively. After drainage has been established, land leveling may be necessary to spread the irrigation water uniformly. Chiseling and subsoiling help to improve the penetration of water. Barnyard manure and green-manure crops improve tilth and help to maintain the fertility and content of organic matter. Timely tillage is important because it prevents cloddiness and compacting. (Irrigated capability unit IIIw-3)

Rocky Ford clay loam, saline, 1 to 3 percent slopes (RuB).—This soil is on uplands. It is moderately to strongly saline. White salts accumulate on the surface and in the subsoil, generally in spots, and they severely limit the growth of crops. In areas where artificial drainage has not been provided, seepage occurs or there is a high water table. Seepage is greater in summer, when irrigation water is used. In some areas a substratum of limestone is between a depth of 20 and 60 inches. This substratum slows or prevents the leaching of salts and the draining away of seepage water. Generally, internal drainage is slow.

This soil is used entirely for irrigation farming, but it is not suitable for many crops until it has been drained and leached of salts. It should be intensively managed. After drainage has been provided, land leveling may be necessary to spread irrigation water uniformly. Chiseling and subsoiling help to improve the penetration of water. If row crops are planted nearly on the contour or across the slope, the grade of the irrigation furrows is reduced.

In most places ditches for irrigating close-growing crops are nearly on the contour. Barnyard manure and green-manure crops improve tilth and help to maintain fertility and the content of organic matter. Timely tillage is important because it prevents cloddiness and compacting. (Irrigated capability unit IIIw-4)

Rocky Ford clay loam, wet, 0 to 1 percent slopes (RwA).—This soil has such a high water table, or seepage has occurred to such a degree, that deep-rooted crops are damaged. The water table is highest during the growing season, when irrigation water is used extensively. The slight salinity of this soil may retard the growth of crops that are not salt tolerant. A drainage system should be provided, or existing drainage should be maintained.

This soil is suited to most crops grown in the area. In some areas subsoiling is necessary to increase the penetration of water. Land leveling helps to spread the irrigation water uniformly. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops improve tilth and help to maintain fertility. (Irrigated capability unit IIw-1)

Rocky Ford clay loam, wet, 1 to 3 percent slopes (RwB).—This soil occurs only on uplands and generally has slopes of 1 to 2 percent. In the places where the slopes are more than 2 percent, this soil is silted to about the thickness of the plow layer. Because the water table is high in some areas and much water seeps into the soil in other areas, the growth of some deep-rooted plants is retarded. The water table is highest during the growing season, when irrigation water is added to the ground water. Water erosion is slight in places where the soil is not protected. This soil is slightly saline.

This soil is suited to most crops grown in the area. In some areas subsoiling is necessary to improve the penetration of water. Land leveling helps to spread the irrigation water uniformly. If row crops are planted across the slope or nearly on the contour, the grade of the irrigation furrows is reduced. In most places ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness and compaction. Barnyard manure and green-manure crops improve tilth and help to maintain fertility. (Irrigated capability unit IIw-3)

Saline Wet Land (Sa)

Saline wet land occupies concave areas in upland swales that are at lower elevations than the canal system. It consists of poorly drained saline-alkali soils that have been subject to seepage for many years. This land is rough and hummocky as a result of the poor drainage, and it has slopes of 0 to 3 percent. The surface layer is loam or clay loam and is underlain by silty clay loam.

Surface drainage is medium, and internal drainage is very slow. The water-holding capacity is high, but the water held is not readily available to plants. Salinity is severe; salts have accumulated in the subsoil and substratum. This land is wet from seepage, at least during the summer.

This land is used mainly for grazing. It is too wet and too salty for successful production of crops, except in the places where it is intensively drained and reclaimed. The present vegetation is mostly inland saltgrass and kochiaweed and other annual weeds. (Dryland capability unit VIw-1; Salt Meadow range site)

Stoneham Series

In the Stoneham series are well-drained soils that are moderately shallow over sand and gravel. Sand and gravel are at a depth of 20 to 48 inches. These soils developed in calcareous material that contains a small amount of gravel.

The surface layer of these soils is grayish-brown gravelly loam or fine sandy loam about 4 inches deep. The subsoil is brown heavy loam or clay loam. It is hard when dry and friable when moist. The subsoil is underlain by a strongly calcareous layer that grades to gravelly loam at a depth of about 14 inches. The gravelly loam, in turn, is underlain by light gravelly loam or by sand and gravel. These soils are leached of lime to a depth of a few inches.

These soils vary mainly in the depth to sand and gravel and in the amount of gravel in the upper layers. The amount of gravel ranges from a trace to about 15 percent.

Stoneham soils occur only with the Potter soils. They have a thinner profile than the Fort Collins soils and are slightly coarser textured than those soils. They are deeper and have a better developed profile than the Nihill soils, and they are also less gravelly.

The native vegetation on these soils is mainly blue grama, sideoats grama, and buffalograss, but it includes some yucca and sand sage.

Terrace Escarpments (Tc)

Strips of sandy and gravelly soils at the edge of terraces make up these escarpments. Slopes range from 4 to 10 percent. The soil material is variable in texture, but it is generally sandy loam or gravelly sandy loam that overlies gravelly or medium-textured material at a depth below 20 inches. It is moderately eroded and has a few gullies. Surface drainage is rapid and internal drainage is medium. The water-holding capacity is low to medium, and natural fertility is low.

This land is used mostly as range and is suited to that use. The native vegetation is sand sage and some blue grama and buffalograss. (Dryland capability unit VIIs-1; Gravel Breaks range site)

Tivoli Series

In the Tivoli series are deep, excessively drained, sandy soils that developed in calcareous, wind-deposited sand. These soils occur in large areas along the Arkansas River and its major tributaries. Because they are excessively drained, they are droughty.

The surface layer of these soils is generally grayish-brown, loose loamy sand or sand. The subsoil is brown or light yellowish-brown sand or loamy sand that is loose when dry. The substratum is loose sand or loamy sand. These soils are leached of lime to a depth of about 30 inches or more.

In the eastern part of the county, some of these soils have a surface layer of loamy fine sand that is thicker and darker than normal for Tivoli soils. In some nearly level areas, the sand is less than 5 feet thick over alluvial terrace material.

Tivoli soils occur with Dune land. In contrast to Dune land, they have a surface layer that is slightly darkened by organic matter and are covered by vegetation. They are coarser textured than the Vona soils and are leached of lime to a greater depth.

The native vegetation is mainly sand sage and little bluestem. There is some blue grama and buffalograss. Also some dryland sedge is in the eastern part of the county.

Tivoli sand (0 to 5 percent slopes) (Td).—This soil occurs in the sandhills along the south side of the valley of the Arkansas River and along the east side of the major tributaries. In a few areas where this soil occurs near Carlton and Holly, alluvial terrace material is within 5 feet of the surface. In a few other small areas, limestone is within 5 feet of the surface, and there are occasional limestone outcrops. Included in some areas mapped as this soil are areas of Vona loamy sand that total as much as 10 percent of the mapping unit.

Water penetrates this soil rapidly, but the water-holding capacity is very low. The soil is droughty and is low in natural fertility.

This soil is not suitable for cultivation, because it is droughty and highly erodible. It is suited to range and is used mainly for that purpose, but some areas are dry farmed or irrigated. In the few dry-farmed areas, this soil generally makes up only a small part of the field, and other soils make up the rest. A small acreage is irrigated. Erosion is most severe in dry-farmed areas of this soil, in severely overgrazed areas, and in any area that lacks a plant cover. (Dryland capability unit VIIe-2; Deep Sand range site)

Tivoli sand, hilly (ThE).—This soil is in areas where the relief is complex and dunelike. Small blowouts are common. In contrast with other Tivoli soils, this soil generally does not include areas of Vona soils. Within short distances, the slopes range from nearly level to as steep as 30 percent. The dunes are as high as 10 to 30 feet above the valleys. This soil is highly erodible in places where the cover of vegetation has been removed. (Dryland capability unit VIIe-1; Choppy Sands range site)

Tivoli-Dune land complex (Tm).—This complex is in the sandhills of the valley of the Arkansas River and east of Two Butte and Big Sandy Creeks. The soils are generally rough and dunelike. Some areas are 30 to 70 percent Tivoli soils, and other areas are 30 to 70 percent Dune land. In recent years the acreage of Dune land has been increasing.

The soils of this complex are used mostly as range, but some of the acreage is dry farmed. The soils are not suitable for cultivation or for grazing. Because they are highly erodible, they have blown badly in dry-farmed areas. Dune land is severely eroded, and the dunes shift frequently. Not grazing this land helps to establish a stand of plants on the dunes. (Dryland capability unit VIIe-1 and the Choppy Sands range site for the Tivoli soil; dryland capability unit VIIIe-1 for Dune land, and not placed in a range site)

Travessilla Series

The soils of the Travessilla series are on uplands and are shallow to very shallow over sandstone. They are predominantly sandy. Bedrock is exposed in many places.

The surface layer of these soils is pale-brown to grayish-brown sandy loam or loam. The subsoil, where present, is yellowish-brown, yellow, or reddish-brown fine sandy loam or stony fine sandy loam. These soils are generally about 10 inches thick over sandstone, but sandstone crops out in many places. The soils are calcareous throughout.

The soils vary mainly in the depth to sandstone, which in places is as much as 18 inches from the surface. They also vary in the number of sandstone outcrops and in the number of sandstone fragments on the surface.

Travessilla soils occur with the Renohill soils, but are much shallower than those soils. In contrast to the Penrose soils, they are developing in material weathered from sandstone.

The native vegetation is blue grama, buffalograss, sideoats grama, little bluestem, yucca, and cedar trees.

Travessilla sandy loam (3 to 9 percent slopes) (Tn).—This soil occupies only a small acreage. It is mainly in the area of sandstone breaks in the southwestern corner of the county.

In any area mapped as this soil, sandstone crops out on approximately 10 percent of the acreage. Included in some areas mapped as this soil are areas of Renohill sandy loam that total as much as 15 percent of the mapping unit.

This soil takes in water at a moderately rapid rate, but the water cannot penetrate into the underlying sandstone. The water-holding capacity and natural fertility are very low.

This soil is used mostly for range and is best suited to that use. Some of the small areas are included in dry-farmed fields, though this soil is not suitable for cultivation. (Dryland capability unit VIe-3; Sandy Plains range site)

Travessilla-Rock outcrop complex (Tr).—This complex is mainly in the area of sandstone breaks in the southwestern corner of the county. It contains most of the acreage of Travessilla soils in Prowers County. About 50 percent of the acreage is Travessilla sandy loam, and 50 percent is sandstone outcrops. The profile of the Travessilla soil is similar to that of Travessilla sandy loam, but it is slightly shallower.

This complex consists largely of rough, broken areas that include many nearly vertical cliffs, 50 feet high or more, and many ledges and buttes. All of the larger areas contain gullied drainageways. On the foot slopes and in small valleys are small areas of a deeper soil. (Dryland capability unit VIIs-5; Sandstone Breaks range site)

Tyrone Series

The Tyrone series consists of deep, well-drained soils that developed on uplands in material weathered from shale and limestone. These soils are predominantly loam or clay loam.

The surface layer is loam that is light brownish gray when dry and is about 3 to 7 inches thick. The subsoil is clay loam or silty clay loam that is about the same color as the surface layer. It is very friable when moist and has blocky structure. A zone of lime accumulation lies just below the subsoil. The lime is in the form of small nodules and has accumulated in seams. The substratum is pale-brown or pale-yellow loam or light clay loam. This soil is highly calcareous. Small fragments of limestone occur throughout the profile.

These soils vary slightly in texture and in the thickness of the horizons. In some cultivated fields where tillage has mixed part of the subsoil with the surface soil, the surface layer is clay loam.

Tyrone soils occur with the Minnequa soils. Their profile is similar to that of the Minnequa soils, but it is deeper, has a subsoil that is more clayey, and has more blocky structure. The Tyrone soils are similar to the Wiley soils but are more saline, contain some limestone fragments, and developed in shaly soil material instead of loess. The native vegetation is blue grama and buffalograss.

Tyrone loam, 0 to 3 percent slopes (TyB).—This soil occurs in fairly small areas, mostly in the western part of the county. It takes in water at a medium rate. The permeability of the subsoil is moderately slow. The water-holding capacity is high, and most of the water stored is readily available to plants. Natural fertility is medium. In some places this soil is slightly saline.

This soil is easy to work, but it is somewhat difficult to manage because erosion is hard to control. It is dry farmed or used as range. The soil is best suited to range, but cultivated areas in a favorable climatic zone produce fair yields of wheat and sorghum. If it is not protected, this soil is highly erodible. Contour farming and terracing help to control water erosion and to conserve moisture. Stubble-mulch tillage and stripcropping help to control wind erosion. In the places where ground cover is not adequate for protection, emergency tillage is needed to control wind erosion. This soil is well suited to grass. The areas in range should be kept in range. (Dryland capability unit IVe–1; Loamy Plains range site)

Tyrone loam, 3 to 5 percent slopes (TyC).—Water runs off of this soil at a moderately rapid rate and causes slight rill erosion in cultivated fields. This soil is suitable for dryfarming only in climatic zone C. It should be managed to control erosion and to conserve moisture. Contour farming and terracing help to prevent water erosion and also to conserve moisture. Stubble-mulch tillage and stripcropping help to control wind erosion. In some areas where the ground cover is not adequate for protection, emergency tillage may be necessary to control wind erosion.

This soil is well suited to grass; the areas in range should be kept in range. In climatic zone D, dry-farmed fields should be reseeded to grass after a cover crop has been planted to stabilize the soil. The soil should be protected from grazing until a stand of grass is established. (Dryland capability units IVe–2 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Tyrone soils, eroded (0 to 5 percent slopes) (Tw2).—These soils have been severely eroded, mainly by wind. In many areas drifting soil material has accumulated in hummocks 1 to 3 feet high. In sloping areas slight rill erosion is common. Most of the acreage is idle but is within areas under dryland cultivation.

A cover crop should be planted to stabilize the soils, and then suitable grasses can be reseeded in the places where seeding is feasible. Until a stand of grass is established, grazing should not be allowed. Until the soils are reseeded, they can be protected from erosion by the use of cover crops and emergency tillage. (Dryland capability unit VIe–2; Loamy Plains range site)

Ulysses Series

The Ulysses series consists of deep, well-drained, medium-textured soils that developed on uplands in calcareous loess. These soils are important agricultural soils in the county and occur in the eastern part.

The surface layer of these soils is very friable silt loam or sandy loam about 7 inches thick. It is grayish brown when dry and very dark grayish brown when moist. The subsoil is brown to dark grayish-brown silt loam or silty clay loam that has prismatic to blocky structure. Accumulated in a zone just below the subsoil are small nodules of lime about one-quarter of an inch in diameter. Generally the substratum is pale-brown silt loam. In most places these soils are leached of lime to a depth of 5 to 15 inches.

These soils are fairly uniform in profile characteristics. The surface layer ranges from 5 to 10 inches in thickness. In some cultivated fields these soils are calcareous to the surface.

Ulysses soils have a profile that is similar to that of Richfield and Colby soils. They occur with Richfield soils and have a less clayey, less blocky subsoil than those soils. They have a darker colored surface layer than the Colby soils, which are not leached of lime.

In areas of silt loam, the native plants are blue grama and buffalograss. In areas of sandy loam, the native plants are sideoats grama, little bluestem, blue grama, sand sage, and yucca.

Ulysses sandy loam, 0 to 3 percent slopes (UnB).—This soil occurs on nearly level to gently sloping uplands. It takes in water a little more rapidly than does Ulysses silt loam, 0 to 3 percent slopes. The water-holding capacity is high, and most of the water stored is readily available to plants. Natural fertility is high.

Most of this soil is dry farmed or irrigated, but a small acreage is in range. Although the soil is easy to work, care must be taken to control wind erosion. High yields of wheat and sorghum are produced under dryfarming. Moisture can be conserved and erosion controlled by stubble mulching, contour farming, and stripcropping. In years of drought, a cover crop may be needed to protect the soil. (Irrigated capability unit IIe–3; dryland capability units IIIe–2 in climatic zone B, IVe–3 in climatic zones C and D; Sandy Plains range site)

Ulysses silt loam, 0 to 3 percent slopes (UsB).—This nearly level or gently sloping soil is the most extensive Ulysses soil in the county. It has medium surface drainage and high water-holding capacity; most of the water stored is readily available to plants.

Recently a large amount of this soil has been brought under pump irrigation. The soil is well suited to irrigation and produces high yields of crops. Land leveling helps to spread the irrigation water more uniformly.

Fertilization and good management of water increase yields.

This soil is also well suited to dryfarming and produces good yields of wheat and sorghum. Stubble-mulch tillage, contour farming, and stripcropping help to conserve moisture and to control erosion. In some places where the ground is bare, emergency tillage is needed to control wind erosion. (Irrigated capability unit IIe–2; dryland capability units IIIc–1 in climatic zone B, IVc–1 in climatic zones C and D; Loamy Plains range site)

Vona Series

In the Vona series are deep, well-drained to excessively drained soils that developed on uplands in calcareous, moderately sandy material. These soils are predominantly sandy loams. They occur in the fringe areas of the sandhills, along the Arkansas River and its major tributaries.

The surface layer is very friable, grayish-brown sandy loam or loamy sand about 9 to 12 inches thick. The subsoil is brown to dark-brown sandy loam or fine sandy loam that is very friable when moist and has prismatic and blocky structure. A weak zone of lime accumulation occurs below the subsoil, generally at a depth of about 24 inches. The texture of the substratum varies but commonly is fine sandy loam. These soils are generally noncalcareous to a depth of about 20 inches.

In these soils the main variations are in the texture and thickness of the surface layer, in the depth to limy material, and in the characteristics of the underlying material. The depth to limy material ranges from 15 to 28 inches, except in many eroded areas where the soil is calcareous at the surface. In some places, especially near the Tivoli soils, the substratum is loamy sand. The substratum is loam in other areas, especially where the Vona soils grade to the silty hardlands.

Vona soils occur with the Tivoli soils but are finer textured and have a better developed profile than those soils. They are less limy than the Otero soils and have a more blocky subsoil.

The native vegetation on the Vona soils is little bluestem, sand sage, yucca, blue grama, buffalograss, and sand dropseed.

Vona loamy sand, 1 to 3 percent slopes (VaB).—This soil has a substratum of loamy sand. In places there are small inclusions of Tivoli sand.

This Vona soil takes in water at a rapid rate. Permeability in the subsoil is moderately rapid. The water-holding capacity is low, but most of the water held in the soil is readily available to plants. Natural fertility is low.

This soil is used mostly for range, but in a few areas it is dry farmed. It is best suited to sorghum, though some broomcorn is grown. Under dryfarming, the soil is easy to work, but it is difficult to manage because of the hazard of wind erosion. In places where vegetation is sparse, this soil is extremely erodible. A cover of stubble or other residue is needed when the surface is not protected by a growing crop. Stubble-mulch tillage helps to control wind erosion. If the ground cover is not adequate for protection, listing may be needed to prevent soil blowing. (Dryland capability units IVe–5 in climatic zone B, VIe–3 in climatic zones C and D; Sandy Plains range site)

Vona loamy sand, 3 to 5 percent slopes (VaC).—This sloping soil has a substratum of loamy sand. The water-holding capacity is low, but most of the water held in the soil is readily available to plants.

This soil is not suitable for cultivation, because it is droughty, highly susceptible to erosion, and in places has steep slopes. The areas that have been dry farmed should first be stabilized by growing a cover crop and then seeded to grasses that are well suited to sandy soils such as this one. The reseeded areas should not be grazed until a stand of grass is established. Areas already in range need protection from overgrazing. (Dryland capability unit VIe–3; Sandy Plains range site)

Vona sandy loam, 1 to 3 percent slopes (VoB).—This soil has a profile like the one described for the series. Generally, it occurs in the transitional zone between the sandhills and the hardlands.

This soil takes in water at a moderately rapid rate. Permeability of the subsoil is moderately rapid. The water-holding capacity is moderately low to moderately high; the capacity depends on the texture of the substratum. Most of the water stored is readily available to plants.

This soil is used mainly for dryfarming and as range, but a small acreage is irrigated. It is fairly suitable for dryfarming in the zones of higher rainfall. If it is used for dryland crops, the soil is easy to work but difficult to manage because wind erosion is hard to control. Among the practices needed to control blowing and to conserve moisture are stubble-mulch tillage, stripcropping, and contour farming. Emergency tillage aids in controlling erosion if the ground cover is not adequate. When other crops are not growing, a cover crop may be planted to keep the soil from blowing.

In irrigated areas the management of water needs to be intensive. In some places land leveling is needed so that the water can be spread more uniformly. Short irrigation runs make the most efficient use of irrigation water. If row crops are planted across the slope or about on the contour, the grade of the irrigation furrows can be reduced. Ditches used to irrigate close-growing crops are also nearly on a contour. (Irrigated capability unit IIIe–4; dryland capability units IIIe–1 in climatic zone B, IVe–4 in climatic zone C, VIe–3 in climatic zone D; Sandy Plains range site)

Vona sandy loam, 3 to 5 percent slopes (VoC).—The water-holding capacity of this soil is moderately low to moderately high. Most of the water stored is readily available to plants.

This soil is suitable for dryfarming only in the zone of highest rainfall. In dry-farmed areas, practices that help to control wind erosion and to conserve moisture are needed. Some of these practices are stubble-mulch tillage, stripcropping, and contour farming. Emergency tillage also is needed to control erosion in places where ground cover is not adequate for protection. When this soil is not in crops, cover crops may be planted to control soil blowing.

This soil is also suited to range. In zones of low rainfall, a cover crop should be planted first to stabilize the soil, and then grass can be seeded. Areas that have been seeded should not be grazed until a stand of grass is established. (Dryland capability units IVe–4 in climatic zone B; VIe–3 in climatic zones C and D; Sandy Plains range site)

Vona soils, 1 to 3 percent slopes, eroded (VsB2).—The soils of this mapping unit have characteristics of both Vona loamy sand, 1 to 3 percent slopes, and Vona sandy loam, 1 to 3 percent slopes. In some places drifting sand has accumulated in dunes 1 to 2 feet high; in other places the dunes are as much as 10 feet high. In many places sand has drifted so badly that ordinary machinery cannot be used.

These soils are not suited to farming. Although they have been dry farmed, much of the acreage is now idle. The soils are highly erodible and should be seeded to grass wherever seeding is feasible. (Dryland capability unit VIe-3; Sandy Plains range site)

Vona soils, 3 to 9 percent slopes, eroded (VsD2).—The soils of this unit have characteristics of both Vona loamy sand, 1 to 3 percent slopes, and Vona sandy loam, 1 to 3 percent slopes, except that they have stronger slopes and are susceptible to severe wind erosion. In some places drifting sand has accumulated in dunes that are 1 to 3 feet high, and in many other places the dunes are as high as 8 feet.

These soils have been dry farmed, but they are now mostly idle because of the severe hazard of erosion. They are not suited to cultivation and should be seeded to grass. (Dryland capability unit VIe-3; Sandy Plains range site)

Wiley Series

The Wiley series consists of deep, well-drained soils that developed on uplands in calcareous loess. These soils are nearly level to gently sloping. They are in the drier parts of the county and occupy large areas. These are the most extensive soils in the county.

The surface layer of these soils is thin, friable silt loam 3 to 8 inches thick. It is grayish brown when dry and dark grayish brown when moist. The subsoil is brown silty clay loam or silt loam and has prismatic to blocky structure. Just below the subsoil, small, soft nodules of lime have accumulated. The substratum is very pale brown silt loam. Generally, these soils are calcareous within 6 inches of the surface. In cultivated areas they are calcareous throughout the profile.

The Wiley soils are nearly uniform in profile characteristics, but the texture of the surface layer and subsoil vary slightly. In many cultivated areas, particularly in the southern part of the county, the surface layer is light silty clay loam. The subsoil is heavy silt loam in many areas immediately south of the sandhills and in the northern part of the county.

The Wiley soils occur with the Colby and Baca soils, but they have a better developed profile than the Colby soils and a less well developed profile than the Baca soils. The subsoil of the Wiley soils contains more clay than that of the Colby soils and less than that of the Baca soils. Lime has not leached from the subsoil of the Wiley soils as it has from the Baca.

Wiley silt loam, 0 to 3 percent slopes (WaB).—This is the most extensive Wiley soil in the county; the largest areas occur in the northern part. The soil has nearly uniform characteristics throughout the profile (fig. 15). Included with this soil are some areas of Baca soils that total as much as 5 percent of the acreage mapped and other areas of Colby soils that total as much as 10 percent.

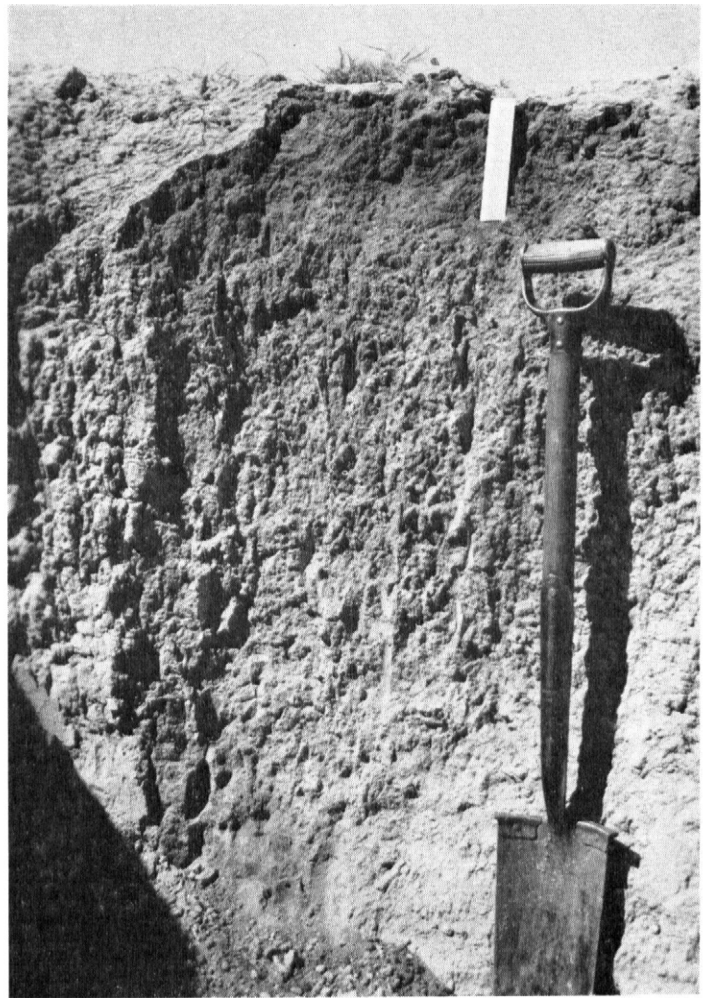

Figure 15.—**Profile of Wiley silt loam, 0 to 3 percent slopes. The subsoil has prismatic to blocky structure at a depth of 6 to 25 inches.**

Water penetrates this soil at a medium rate. The water-holding capacity is high, and most of the water stored is readily available to plants. Natural fertility is medium.

This soil is used mostly for dryfarming and range. If it is dry farmed, the soil is easy to work, but it is somewhat difficult to manage because wind erosion is hard to control. Because the hazard of wind erosion is serious, this soil needs to be intensively managed for control of wind erosion. In the gently sloping areas, some water erosion occurs and small rills form on the slopes. Contour farming and terracing help to control water erosion and to conserve moisture. Stubble-mulch tillage and strip-cropping help to control wind erosion. In some places where the ground cover is not adequate for protection, emergency tillage is needed to control wind erosion. In dry-farmed areas, good yields are produced only in the most favorable years. Areas in range should be kept in range, for this soil is well suited to grass.

In recent years some of the nearly level areas of this soil have been irrigated by pumping water to them from wells. The soil is well suited to irrigation and responds well to good management of irrigation water. Land leveling may be needed to spread the water more uniformly. In the gently sloping areas, ditches for irrigating close-growing crops should be nearly on the contour. For irrigation purposes, it may be necessary to separate the nearly level areas from the gently sloping ones.

This soil responds well to fertilization and produces high yields of crops. It is well suited to grass, and many areas are in range. (Irrigated capability unit IIe–2; dryland capability unit IVe–1; Loamy Plains range site)

Wiley silt loam, 3 to 5 percent slopes (WaC).—This soil has more rapid surface drainage than have nearly level soils. It is suitable for dryfarming only in the zones of higher rainfall. The dry-farmed areas are more susceptible to water erosion than those in range. In many of the dry-farmed areas, rills have formed.

Contour farming and terracing help to control water erosion and to conserve moisture. Stubble-mulch tillage and stripcropping help to control wind erosion. In some places where the ground cover is not adequate for protection, emergency tillage may be necessary to control wind erosion. This soil is well suited to grass. The areas in range should be kept in range.

Some small areas of this soil are irrigated. Good management of the irrigation water is important in controlling erosion. In some places land leveling is necessary so that the irrigation water can be spread more uniformly. If row crops are planted across the slope or about on a contour, the grade of the irrigation furrow is reduced. Generally, ditches used to irrigate close-growing crops are nearly on the contour. (Irrigated capability unit IIIe–1; dryland capability units IVe–2 in climatic zone C, VIe–2 in climatic zone D; Loamy Plains range site)

Wiley and Baca soils, 0 to 3 percent slopes, eroded (WbB2).—These soils have a profile similar to those of Wiley silt loam, 0 to 3 percent slopes, and Baca clay loam, 0 to 3 percent slopes, except that they are moderately to severely eroded. Generally, erosion has removed the original surface layer and part of the subsoil. In some places tillage has brought lime nodules to the surface. In some areas where the soils have not been worked for some time, drifting soil material has accumulated in hummocks 1 to 3 feet high.

Erosion can be controlled if these soils are well managed. Contour farming and terracing will help to control water erosion and to conserve moisture. Stubble-mulch tillage and stripcropping can be used to control wind erosion. In places where the ground cover is not adequate for protection, emergency tillage is needed to control wind erosion. This soil is well suited to grass. Areas in range should be kept in range. (Dryland capability unit IVe–1; Loamy Plains range site)

Wiley and Baca soils, 3 to 5 percent slopes, eroded (WbC2).—Erosion has removed the original surface layer of these soils and part of the subsoil. In other respects the profile is similar to the profiles of uneroded Wiley and Baca soils that have slopes of 3 to 5 percent. In many areas tillage has brought lime nodules to the surface. In some areas where the soils have been worked for some time, drifting soil material has accumulated in hummocks 1 to 3 feet high. In other areas rills have been caused by water erosion.

Most of the acreage is dry farmed or idle. Suitable grasses should be seeded in areas where seeding is feasible, but a cover crop ought to be planted first to stabilize the soils. In areas that are not seeded, the soils should be protected from further erosion by such practices as planting a cover crop or using emergency tillage. (Dryland capability unit VIe–2; Loamy Plains range site)

Managing the Soils of Prowers County

The soils of Prowers County are used for dryland crops, irrigated crops, and range. This section explains how the soils may be managed for these main purposes, and also for planting trees, providing habitats for wildlife, and building highways, farm ponds, and similar engineering structures.

The method of presenting information is that of grouping soils similar in kind of management they need, describing the group, and then suggesting suitable practices.

Dryland Management of Soils

This section contains three main parts. First described are the general practices of management appropriate for all soils used for dryland production of crops. Then the nationwide system of capability classification is explained and is followed by a detailed discussion of the dryland capability units in Prowers County. Finally, predicted average acre yields are given for the principal crops at two levels of management.

Suitable Management Practices for Dryland

Shortage of rainfall and wind erosion are the major problems of management on dryland in this county. Most of the soils are highly susceptible to wind erosion when they are dry farmed and do not have an adequate cover. The soils are erodible because they contain a large amount of silt, lack stable structure, and have a high content of lime. Clods do not readily form in such soils, and their surface layer blows unless it is protected by growing vegetation or by crop residue. Wind erosion is most serious in the areas that receive the least rainfall, since it is in these areas that it is most difficult to maintain an adequate cover of vegetation.

The problem of wind erosion has increased as more of the range has been plowed for crops. Many areas of range were plowed in the midforties when rainfall was above average for several years and wheat was bringing a comparatively high price. Since then, only a small acreage has been reseeded to grass or has reseeded naturally. Restoring a grass cover is a slow process where rainfall is low. The best years for reseeding are those having the largest supply of moisture, but these are also the years that favor the growing of wheat and sorghum. Many farm operators prefer to grow crops in the years of favorable moisture, rather than to seed the land to grass and retire it from cultivation.

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When a soil is exposed to the wind, many of the fine particles of silt and clay are picked up and moved out of the area. In sandy soils this shifting and blowing back and forth results in loss of most of the particles of silt and clay, and eventually it causes the surface layer to be coarser textured than it was originally. Severe wind erosion may permanently change a soil. All of the surface layer may be removed, and as a result, a large part of the organic matter and plant nutrients may be lost.

The effects of wind erosion are not confined to the soil. After a severe blow, fences and roads are likely covered by drifted soil material (fig. 16). Machinery is often covered and damaged. Soil material drifts and piles up behind weeds and bits of stubble. Fields covered by the small hummocks thus formed must be smoothed, and heavy machinery is needed to do this.

If dry-farmed areas adjacent to range are exposed to the wind, soil material drifts onto the range and covers and kills the grass along the margin. In some areas the grass has been damaged as far back from the edge as 300 feet. Once the grass is destroyed, the area grows up to annual weeds and grass is hard to reestablish.

Soil material blowing from dryland makes it difficult to maintain irrigation canals. Soil material and weeds from the dryland fill the ditch. The weeds have to be burned out, and the canal cleaned with a dragline.

The effects of water erosion are less easily noticed than those of wind erosion, but water erosion is also a hazard on most cultivated land that is sloping and not protected by growing crops or crop residue. When rain falls too fast for the soil to absorb it, rills form, crops are washed out, and soil material is deposited in low places or carried away in streams.

Erosion can be controlled by a number of practices, alone or in combination. Generally, a combination of practices is most effective. Stubble-mulch tillage, for example, is a method of cultivation that helps to control erosion on dryland. It has advantages when used alone, but the benefits are greater if it is used in combination with stripcropping, summer fallow, or similar desirable practices.

***Figure 16.*—A fence and road covered by soil material blown from an unprotected field.**

The management practices needed on one soil may not be appropriate for another. Generally, however, the objectives of management are to control erosion, conserve moisture, maintain the supply of plant nutrients, and improve tilth. The general practices employed to accomplish this are explained in the following paragraphs.

Cropping systems.—Choice of a good cropping system can do much to conserve moisture and control erosion. The system most used in Prowers County is summer fallow to store moisture for a crop of wheat. Sorghum is sometimes planted after the wheat in this system. Wheat and sorghum are the main dryland crops, but barley, broomcorn, and rye are also grown and may be substituted for wheat in the cropping system.

The cropping system in this county needs to be somewhat flexible. The sequence of crops depends to a large extent on the amount of moisture available in the soil at planting time. If the soil does not contain enough moisture for wheat to germinate, or if the wheat is planted and blown out by wind, sorghum is often planted in spring. Wheat is normally planted in September or October and harvested in July. Sorghum can replace wheat if the fall-planted wheat blows out in spring. The planting time for sorghum is late in May through June, and harvest comes fairly late in the fall.

Summer fallowing is a part of the cropping system. Crops are grown in alternate years, and when the soils are not protected by a growing crop, they are "summer fallowed," or managed so that weeds are controlled and moisture is conserved for the next crop. Many areas of sandy soils are not summer fallowed, because they do not hold much moisture. If summer fallowing is to be effective, other practices that help to conserve moisture and to control erosion must be used with it.

Tillage.—In this county tillage is one of the principal means by which a farmer manages his soils. He tills the soils to prepare a seedbed, to control weeds, to provide clods that protect the soils from erosion, and to conserve moisture.

The timeliness of tillage is important. If the soils are tilled when too wet or too dry, the structure is likely to deteriorate. Also, if the soils are tilled when too wet, they are likely to become hard and compacted. Tilling soils that are summer fallowed should be done in a way that leaves residue on the surface. If the soils are not protected by residue or by a growing crop, emergency tillage may be necessary for controlling erosion. This consists of chiseling or listing the soils so that the surface is roughened and clods are formed that resist blowing.

Tillage can control erosion only if the aggregates produced are large enough to remain in place. Experiments have shown that particles or lumps 0.84 millimeter or 0.033 inch in diameter, or larger, are resistant to wind erosion. Soil aggregates of this size are called clods. The ease with which clods are formed, and their stability, depends on the texture of the soil. Soils such as the Vona and Tivoli are sandy and contain only a small amount of clay. They do not produce clods when worked and are therefore highly erodible. Soils that are extremely high in silt and are calcareous do not produce stable clods. The Wiley and Colby silt loams are examples of calcareous silty soils that are highly erodible.

Too much tillage is costly. Also, it breaks down the desirable structure of the surface layer. As a result, the surface layer tends to puddle and crust or to become floury and loose. Reducing the amount of tillage is one of the easiest and most effective ways of protecting the soils.

Stubble-mulch tillage is effective on dryland. The crop residue is managed so that the soils have a protective cover when they are not protected by a growing crop. This cover conserves moisture, maintains the content of organic matter, and reduces erosion. Stubble-mulch tillage keeps much of the crop residue on the surface and anchors it to the soils so that they will not blow away. The residue increases the ability of the soils to absorb moisture and protects them from wind and the impact of beating raindrops.

Capability Grouping and Dryland Management

Capability classification is a method of grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on the limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere 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 stony, and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIIe-1 or IVe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

Dryland capability grouping and climatic zones.—In this county, effective rainfall is progressively less from east to west. Since the amount of rainfall is extremely important in dryland crop production, the practices of management used must be planned according to the rainfall available. For this reason, Prowers County has been zoned by amount of rainfall (fig. 17). The boundaries of these zones are, of course, approximate, and any zone may contain small areas where effective precipitation is more or less than average for the zone.

A given kind of soil may occur in more than one climatic zone. If it does, it will require different management in the different zones, and therefore will be placed in more than one capability unit. The guide to mapping units at the back of this report shows whether or not a soil occurs in more than one capability unit for dryland cropping. If a soil is irrigated, climatic zones

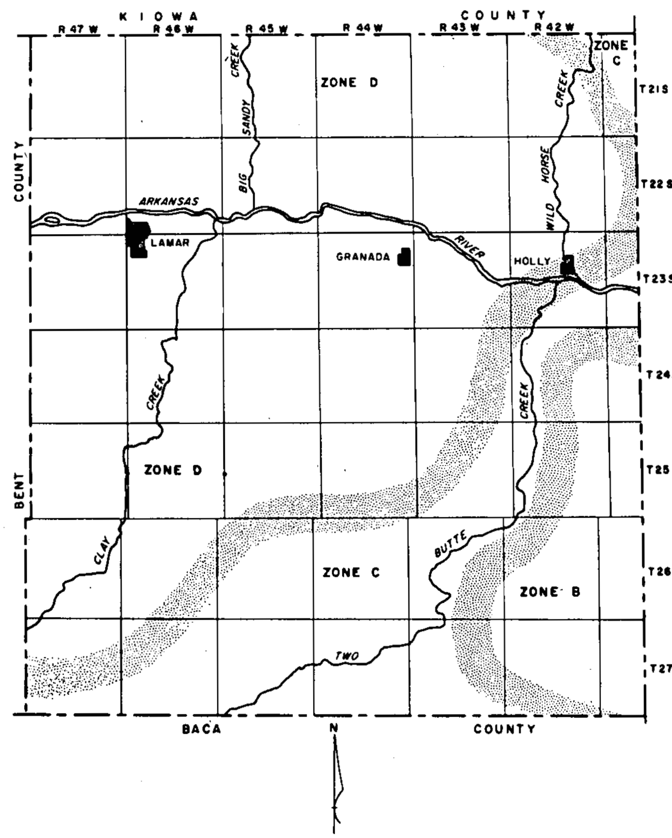

Figure 17.—**Sketch map of Prowers County showing approximate boundaries of climatic zones. Zone B receives the greatest amount of effective precipitation; zone C, less precipitation; and zone D, the least precipitation.**

do not apply, since the water supplied by irrigation removes limitations imposed by natural rainfall.

Dryland production of crops is hazardous in all parts of Prowers County, but less so in zone B than in zones C and D. It cannot be said that crop production is impossible in any zone, because other factors are involved. Among these factors are soil moisture at planting time; amount of rainfall during the growing season; temperature; and farming methods. When rainfall is above average, dryland crops can be produced in the zone of lowest rainfall if moisture is conserved by contour farming, stubble mulching, summer fallowing, terracing, and similar practices. Occasionally, there will be a year in which rainfall is so favorable that crops can be produced without the moisture-conserving practices. But on the basis of long-term experience and records, the risk of producing crops in climatic zone D is too great. The risk is somewhat less, but is also great, in zone C.

Reference to the guide to mapping units will indicate whether a soil is present in a given climatic zone, and the capability unit in which it is grouped for dryland farming. For example, Baca clay loam, 3 to 5 percent slopes, is in capability unit IVe–2 in climatic zone C, but in capability unit VIe–2 in climatic zone D. Remembering the definitions of capability classes given in the list immediately preceding this discussion, we know that class IV soils are suitable for limited cultivation, and that class VI soils are not suitable for cultivated crops but can be used for pasture or range. Thus, for this soil chosen as an example, difference in effective rainfall in the different climatic zones has made necessary different use of the soil.

Dryland capability units

The soils of Prowers County have been placed in dryland capability units so that suitable management may be suggested in an orderly way. The soils of one capability unit are similar in the uses for which they are suitable, in the management they need, and in their response to management. Following are the dryland capability units in Prowers County, listed by capability class and subclass.

Class I. Soils that have few limitations that restrict their use. (No class I soils in this county.)

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices. (No class II soils in this county.)

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIe. Soils highly susceptible to erosion when used for crops; limited also by climate.
  - Unit IIIe–1. Deep, gently sloping, moderately coarse textured upland soils.
  - Unit IIIe–2. Deep, nearly level to gently sloping upland soils with a moderately coarse textured, dark-colored surface layer.
- Subclass IIIc. Soils having moderate climatic limitations; limited also by moderate risk of wind erosion if they are not protected.
  - Unit IIIc–1. Deep, nearly level to gently sloping, medium-textured upland soils with a dark-colored surface layer.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected; limited also by climate.
  - Unit IVe–1. Deep, nearly level to gently sloping, medium-textured soils that have a light-colored surface layer, have unstable structure, and are highly erodible.
  - Unit IVe–2. Deep to moderately shallow upland soils that have a medium to moderately fine textured surface layer and are gently sloping or gently rolling.
  - Unit IVe–3. Nearly level to gently sloping, medium-textured soils of the uplands and terraces that have a moderately coarse textured surface layer.
  - Unit IVe–4. Moderately coarse textured, nearly level to gently sloping soils of the terraces and uplands.
  - Unit IVe–5. Deep, gently sloping soils of the uplands that have a light-colored, coarse-textured surface layer and are highly erodible and very droughty.
  - Unit IVe–6. Deep, gently sloping, medium-textured soils that have a moderately coarse textured surface layer.
- Subclass IVc. Soils that have very severe climatic limitations when used for dryland crops; limited also by a very severe risk of wind erosion if they are not protected.
  - Unit IVc–1. Nearly level to gently sloping soils of uplands and stream terraces; medium-textured to moderately fine textured surface layer.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, range, woodland, or wildlife food and cover. (No class V soils in this county.)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

- Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained; severely limited also by climate.
  - Unit VIe–1. Deep upland soils derived from shale.
  - Unit VIe–2. Hardland soils of the uplands and terraces; they have unstable structure, have high erodibility, or are in a dry climatic zone.
  - Unit VIe–3. Soils of the uplands that have a moderately coarse textured surface layer; they are highly erodible or are in a dry climatic zone.
  - Unit VIe–4. Sandy, well-drained soils on bottom lands and low stream terraces.
  - Unit VIe–5. Shallow to moderately deep, clayey soils.

Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation; limited also by salinity.

Unit VIw–1. Poorly or imperfectly drained soils of bottom lands and low stream terraces.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIIe–1. Very sandy soils on hilly or choppy slopes.

Unit VIIe–2. Very sandy, undulating or gently rolling soils.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs–1. Shallow or very shallow, gravelly, and steep soils of the uplands.

Unit VIIs–2. Sandy and loamy soils of the bottom lands that are subject to frequent flooding.

Unit VIIs–3. Shallow and very shallow upland soils on shale.

Unit VIIs–4. Shallow and very shallow soils on limestone.

Unit VIIs–5. Shallow and very shallow soils on sandstone.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIe. Soils limited by extremely coarse texture and droughtiness.

Unit VIIIe–1. Loose, unvegetated sand.

CAPABILITY UNIT IIIe-1 (DRYLAND)

Vona sandy loam, 1 to 3 percent slopes (in climatic zone B), is the only soil in this capability unit. This is a deep, gently sloping, moderately coarse textured soil of the uplands. It is well drained and has moderately rapid permeability in the subsoil. This soil occurs south of Holly in the zone of highest rainfall in the county.

This soil is easy to work. Its natural fertility is medium. Movement of water into this soil is moderately rapid. The water-holding capacity is moderately low to moderately high, and most of the water held in the soil is readily available to plants.

This soil is used for dryfarming and for range. It is well suited to cultivation, though care must be used to control wind erosion. Sorghum and wheat are most commonly grown, but broomcorn is occasionally grown. The cropping systems used are sorghum grown year after year; wheat-fallow; or wheat-sorghum-fallow. Sorghum is especially well suited to this sandy soil.

Good management that provides stubble-mulch tillage and wind stripcropping helps to conserve moisture and to control wind erosion. Listing a field in summer fallow or some other emergency tillage may be needed where there is not enough cover to protect this soil from wind erosion. A cover crop also protects against wind erosion. If stubble is grazed, enough of the stubble should be left on this soil to protect it.

CAPABILITY UNIT IIIe-2 (DRYLAND)

Only Ulysses sandy loam, 0 to 3 percent slopes (in climatic zone B), is in this capability unit. This is a nearly level or gently sloping soil of the uplands. It is deep, well drained, and moderately coarse textured. The surface layer is dark colored. The subsoil is moderately permeable.

This soil is easy to work and has high natural fertility. It takes in water at a moderately rapid rate. The water-holding capacity is high, and most of the water stored is readily available to plants. Surface drainage is medium. If this soil is dry farmed, it is moderately susceptible to wind erosion. Wind erosion is hard to control in the places where the ground cover is not adequate for protection, because clods cannot be brought to the surface.

This soil is dry farmed and used for range. It is well suited to sorghum, and good yields of sorghum are obtained. Wheat can also be grown successfully if crop residue is kept on the surface to control soil blowing. The cropping system should be flexible and ought to provide the best cover possible. Suitable cropping systems are sorghum grown year after year; wheat-fallow; sorghum-fallow; or wheat-sorghum-fallow. A cover crop, planted but not harvested, protects this soil in years of drought. The grazing of stubble should be restricted so that adequate ground cover is left.

Good management is needed to conserve soil moisture and to control wind erosion. Terracing and farming on the contour help to conserve moisture. Stubble mulching helps to control erosion, and stripcropping is also desirable in the places where the cropping system is suitable. In many areas where the ground cover is not adequate for protection, emergency tillage is necessary. Emergency tillage includes chiseling that conserves moisture in fields of wheat seedlings and listing that roughens the surface in summer-fallowed fields. This soil remains in good tilth, even though it is worked under a wide range of moisture content.

CAPABILITY UNIT IIIc-1 (DRYLAND)

This capability unit consists of deep, nearly level or gently sloping soils that have a dark, medium-textured surface layer and a slowly permeable to moderately permeable subsoil. These soils are well drained. They are—

Goshen silt loam (0 to 2 percent slopes) (in climatic zone B).
Richfield silt loam, 0 to 1 percent slopes (in climatic zones B and C).
Ulysses silt loam, 0 to 3 percent slopes (in climatic zone B).

These soils are easy to work. Their natural fertility is high. The water-holding capacity is high, and most of the water held in the soils is readily available to plants. Surface drainage is slow or medium, and most rainfall is absorbed. Under dryland farming, these soils are slightly to moderately susceptible to wind erosion. The Ulysses soil is more erodible than the Richfield.

These soils are well suited to dryfarming and usually produce good yields. Wheat and sorghum are the main crops (fig. 18), but a small amount of barley is also

Figure 18.—**Grain sorghum on Ulysses silt loam, 0 to 3 percent slopes.**

grown. The cropping system should be flexible. The cropping systems most used are wheat-sorghum-fallow and wheat-fallow.

Stubble-mulch tillage, stripcropping, and contour farming are among the practices that help to conserve moisture and to control erosion. Emergency tillage may be needed where there is not enough cover to control wind erosion. Such tillage includes chiseling or rotary hoeing of young wheat and listing or chiseling of land that is summer fallowed. Timely tillage helps to keep these soils in good tilth. Grazing of stubble should be limited so that enough of the stubble remains on these soils to protect them.

CAPABILITY UNIT IVe-1 (DRYLAND)

This capability unit consists of deep, nearly level or gently sloping soils that have unstable structure. These soils are well drained. They have a light-colored, medium-textured surface layer and a moderately permeable subsoil. The soils are—

Colby silt loam, 0 to 1 percent slopes (in climatic zone C).
Colby silt loam, 1 to 3 percent slopes (in climatic zone C).
Colby silt loam, 0 to 3 percent slopes (in climatic zones B and C).
Colby-Ulysses complex, 1 to 3 percent slopes (in climatic zones B and C).
Harvey loam, 0 to 1 percent slopes (in climatic zone C).
Harvey loam, 1 to 3 percent slopes (in climatic zone C).
Harvey loam, 0 to 3 percent slopes (in climatic zones B and C).
Havre loam (in climatic zone C).
Manvel loam, 0 to 1 percent slopes (in climatic zone C).
Tyrone loam, 0 to 3 percent slopes (in climatic zones C and D).
Wiley silt loam, 0 to 3 percent slopes (in climatic zones C and D).
Wiley and Baca soils, 0 to 3 percent slopes, eroded (in climatic zones C and D).

These soils are easy to work, but erosion is difficult to control. The water-holding capacity is high, and the water held in the soils is readily available to plants. Water penetrates these soils at a medium rate. Under dryland cultivation, these soils are highly susceptible to erosion. Wind erosion is more difficult to control on the soils of this unit than on the soils of capability unit IVc–1 because obtaining a cloddy surface is more difficult.

The soils in this unit are used for dryfarming and for range. They are well suited to permanent grass, and fair crop yields are produced under dryfarming if management and weather are good. A suitable cropping system is wheat-fallow or sorghum-fallow. Some farmers use wheat-sorghum-fallow when the content of soil moisture is favorable. Barley may be substituted for wheat. The cropping system should be flexible so that wheat is planted only when soil moisture is adequate. The nearly level areas generally produce higher yields than the gently sloping areas.

When plants are not growing, these soils should be managed so that as much cover as possible is kept on the surface. The best practices should be used to control erosion and to conserve soil moisture. Stubble-mulch tillage helps to maintain the organic-matter content and to control erosion. Stripcropping also helps to control erosion. Terracing and contour tillage help to conserve soil moisture and to control erosion. Wind stripcropping should be used in some places on Colby-Ulysses complex, 1 to 3 percent slopes, because the slopes are so complex that terracing or contour farming is not suitable.

If ground cover is not adequate, emergency tillage is needed to roughen the surface of these highly erodible soils. Where young wheat or barley does not provide enough cover to control erosion, the soils can be chiseled or listed. Land in summer fallow may be listed (fig. 19) or pitted. Timely tillage helps keep these soils in good tilth. In periods of drought, planting a cover crop is often necessary to protect these soils against erosion. Grazing stubble should be limited so that enough cover remains on the soil to control erosion.

If permanent pasture is seeded, wheatgrass, Russian wildrye, and other grasses suited to hardland should be used. Blue grama, western wheatgrass, and galleta are suitable. Stubble of small grain or sorghum generally should be left on these soils.

Stock water can be provided by drilling wells or building dams. In grazed areas diversions and structures to spread water and control erosion may be needed.

CAPABILITY UNIT IVe-2 (DRYLAND)

This capability unit consists of gently sloping and gently rolling, deep to moderately shallow soils of the uplands. The surface layer of these soils is brown and is medium textured or moderately fine textured. The sub-

Figure 19.—**A fallow Wiley soil that has been listed as an emergency practice to control soil blowing.**

soil is slowly permeable. These soils are well drained. They are—

Baca clay loam, 3 to 5 percent slopes (in climatic zone C).
Fort Collins loam, 3 to 5 percent slopes (in climatic zone C).
Renohill loam, 3 to 5 percent slopes (in climatic zone C).
Tyrone loam, 3 to 5 percent slopes (in climatic zone C).
Wiley silt loam, 3 to 5 percent slopes (in climatic zone C).

These soils are easy or moderately easy to work and have moderately high natural fertility. They take in water at a medium to slow rate, and their water-holding capacity is moderately low to high. Most of the water stored is readily available to plants. Surface drainage is moderately rapid.

If these soils are dry farmed, they are subject to moderate erosion by wind and water. Water erosion on these soils is more difficult to control than on less sloping soils. Wind erosion is fairly easy to control because clods can be brought to the surface. These soils are well suited to permanent grass, but fair yields of dry-farmed crops are obtained in a favorable climatic zone. The cropping system normally used is wheat-fallow or sorghum-fallow. It should be flexible so that wheat is planted only when the soil moisture is adequate. Barley may be planted instead of wheat.

Farming on the contour, terracing, and stripcropping on the contour help to control water erosion and to conserve moisture. Such practices are more important for these soils than for less sloping soils. Stubble-mulch tillage and stripcropping help to control wind erosion. In places where the ground cover is not adequate for protection, emergency tillage is needed to control wind erosion, or a cover crop may be planted in periods of drought. Emergency tillage includes chiseling or using a rotary hoe in fields where the wheat seedlings do not provide enough cover, and listing or pitting in fields where summer fallowing does not conserve enough moisture. Timely tillage helps to keep these soils in good tilth.

Mixtures for seeding range may include western wheatgrass, blue grama, galleta, and other grasses. Wheatgrass, Russian wildrye, or other kinds of grass that are suited to hardland should be seeded in cultivated areas. The recovery of areas that are depleted of grass can be helped by contour furrowing or pitting. Water for livestock can be provided from wells and ponds.

CAPABILITY UNIT IVe-3 (DRYLAND)

This capability unit consists of nearly level or gently sloping, deep to moderately shallow, brown to grayish-brown, medium-textured soils on uplands and stream terraces. The surface layer of these soils is moderately coarse textured. The subsoil is moderately permeable. These soils are well drained. They are—

Colby fine sandy loam, 0 to 1 percent slopes (in climatic zones C and D).
Colby fine sandy loam, 1 to 3 percent slopes (in climatic zones C and D).
Colby fine sandy loam, 0 to 3 percent slopes (in climatic zones C and D).
Renohill sandy loam, 1 to 3 percent slopes (in climatic zones C and D).
Renohill sandy loam, moderately shallow, 1 to 3 percent slopes (in climatic zone C).
Ulysses sandy loam, 0 to 3 percent slopes (in climatic zones C and D).

These soils are easy to work, and natural fertility is medium to high. In most of the soils, the water-holding capacity is high, but in the moderately shallow Renohill soil, it is moderately low. Water penetrates these soils at a moderately rapid rate, and most of the water stored is readily available to plants. If they are dry farmed, these soils are moderately to highly susceptible to wind erosion. In places where ground cover is not adequate for protection, wind erosion is hard to control because clods cannot be brought to the surface easily.

These soils are dry farmed and used for range. They are well suited to permanent grass but produce good yields of dryland crops if they are carefully managed and are in a favorable climatic zone. In dry-farmed areas they are best suited to sorghum, but wheat can be grown if enough crop residue is left on the surface to control soil blowing. The cropping system should be flexible so that the best cover possible is maintained. Suitable cropping systems are sorghum-fallow; wheat-fallow; or sorghum grown year after year. In years of drought it is necessary to protect these soils by growing cover crops that are planted but not harvested. Stubble should not be overgrazed.

Good management is needed to conserve moisture and to control erosion. Practices that help are stubble-mulch tillage, contour farming, terracing, and stripcropping. In many places where the ground cover is not adequate for protection, emergency tillage is necessary. It includes chiseling in fields of wheat seedlings, and listing that roughens the surface in summer-fallowed fields. These soils remain in good tilth, even though they are worked under a wide range of moisture content.

If soil blowing is controlled by first establishing a cover of stubble, grass can be reseeded in cultivated areas. Suitable pasture grasses are sand lovegrass, crested wheatgrass, and ryegrass. Sideoats grama, needle-and-thread, bluestem, and other grasses are suitable for seeding range. Good management of range and pasture is more necessary and more profitable on these soils than on finer textured soils. Generally, water spreading is hazardous on these soils, and pasture furrows are not effective. Water for livestock can be supplied from wells or from ponds made by constructing a dam across drainageways in areas of less permeable soils.

CAPABILITY UNIT IVe-4 (DRYLAND)

In this capability unit are deep, nearly level or gently sloping, well-drained soils of the uplands and stream terraces. The surface layer of these soils is moderately coarse textured and is brown or grayish brown. The subsoil has weak structure or is structureless and has moderately rapid permeability. These soils are—

Glendive fine sandy loam, 0 to 1 percent slopes (in climatic zone C).
Glendive fine sandy loam, 1 to 3 percent slopes (in climatic zone C).
Glendive fine sandy loam (0 to 3 percent slopes) (in climatic zone C).
Glendive fine sandy loam, clay substratum (in climatic zone C).
Glendive and Havre fine sandy loams, 0 to 1 percent slopes (in climatic zone C).
Glendive and Havre fine sandy loams, 1 to 3 percent slopes (in climatic zone C).

- Glendive and Havre fine sandy loams (0 to 3 percent slopes) (in climatic zone C).
- Glendive and Havre soils, sand substrata (0 to 3 percent slopes) (in climatic zone C).
- Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (in climatic zone C).
- Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (in climatic zone C).
- Otero sandy loam, 1 to 3 percent slopes (in climatic zones B and C).
- Vona sandy loam, 1 to 3 percent slopes (in climatic zone C).
- Vona sandy loam, 3 to 5 percent slopes (in climatic zone B).

These soils are easy to work but have low natural fertility. They take in water at a moderately rapid rate. The water-holding capacity is low to medium, and most of the water stored is readily available to plants. These soils are highly susceptible to wind erosion, and wind erosion is hard to control because clods cannot be brought to the surface.

These soils are dry farmed and used for range. They are well suited to permanent grass and produce fair yields if they are in a favorable climatic zone. Sorghum is the row crop best suited, but some broomcorn is grown. Wheat is not well suited. The cropping sequence most used is sorghum grown year after year or sorghum-fallow, but in some places the cropping sequence is wheat-fallow. The best cover possible should be maintained on these soils. These soils are protected from wind erosion in years of drought if cover crops are planted but not harvested. Crop residue should not be grazed.

The best management should be used on these soils. Stubble-mulch tillage, contour farming, and stripcropping help to conserve soil moisture and to reduce wind erosion. The kind of crops that can be grown in the strips should be determined by the cropping system and the slope of the soils. In places where the ground cover is not adequate for protection, chiseling, listing, or other emergency tilling may be necessary to control wind erosion. Because these soils are not cloddy, the chisel marks or lister furrows have to be closely spaced.

If a cover of sorghum stubble is first established in cultivated areas, grass can be reseeded on these soils. Grasses and seeding mixtures that are suited to sandy soils should be used. Sand lovegrass and Russian wildrye are suitable pasture grasses, and sideoats grama, bluestem, and needle-and-thread are suitable range grasses. Water for livestock can be supplied from wells. It can also be supplied from ponds made by constructing a dam across drainageways in areas of less permeable soils.

CAPABILITY UNIT IVe-5 (DRYLAND)

Vona loamy sand, 1 to 3 percent slopes (in climatic zone B), is the only soil in this capability unit. It is a deep, gently sloping soil of the uplands that is coarse textured and excessively drained. The surface layer is light colored and coarse textured. It is droughty and highly erodible.

This soil is easy to work and has medium natural fertility. Water penetrates the soil at a rapid rate. The water-holding capacity is low, but most of the water stored is readily available to plants. If it is dry farmed, this soil is highly susceptible to wind erosion. Wind erosion is hard to control because clods cannot be brought to the surface.

This sandy soil is dry farmed and used for range. It is well suited to range and is suited to sorghum, but it is not suited to wheat. Some broomcorn is grown, but in most areas the cropping system is sorghum grown year after year.

Because wind erosion is hard to control, this soil is difficult to manage. Stubble-mulch tillage of idle areas should be done to keep as much of the crop residue on the surface as possible. In some places where the ground cover is not adequate for protection, listing is necessary to control soil blowing, but the lister furrows must be spaced close together.

If a cover of sorghum is established first, soil blowing can be controlled by seeding grass in cultivated areas. Sand lovegrass for pasture, bluestem for range, and other grasses suited to sandy soils can be used. In areas that are grazed, it is important to manage these soils so that an adequate cover of plants is assured. Water for livestock needs to be supplied from wells, because these soils are too porous for storage of water in ponds.

CAPABILITY UNIT IVe-6 (DRYLAND)

The soils in this capability unit are on uplands and are deep, gently sloping, and medium textured. They are well drained, and their surface layer is moderately coarse textured. These soils are—

- Colby fine sandy loam, 3 to 5 percent slopes (in climatic zone C).
- Renohill sandy loam, 3 to 5 percent slopes (in climatic zone C).

These soils are easy to work and have medium natural fertility. Water penetrates easily, the water-holding capacity is medium to high, and most of the water stored is readily available to plants. If they are dry farmed, these soils are subject to wind erosion and water erosion.

These soils are dry farmed and used for range. The cropping system should be flexible so that wheat is planted only when the soil moisture is adequate. The cropping systems best suited are sorghum-fallow, wheat-fallow, or sorghum grown year after year. Barley may be grown instead of wheat. In places where the ground cover is not adequate for protection, planting a cover crop may be necessary to protect these soils in years of drought.

Good management is needed to conserve moisture and to protect these soils from erosion. Stubble-mulch tillage, contour farming, and contour stripcropping conserve soil moisture and help to control water erosion and wind erosion. Terracing helps to conserve moisture and to control water erosion. In many places where the ground cover is not adequate for protection, emergency tilling is necessary to control erosion. It includes chiseling and listing and should be done on the contour.

If a cover of grain or sorghum stubble is established first, any suitable grass can be seeded in cultivated areas. Wheatgrass, ryegrass, sand lovegrass, and other grasses are suitable for pasture. Suitable for range are blue grama, sideoats grama, bluestem, and other grasses. A supply of water for livestock can be obtained from wells or from a pond made by constructing a dam across a drainageway.

CAPABILITY UNIT IVc-1 (DRYLAND)

This capability unit consists of deep to moderately shallow, nearly level or gently sloping soils that are on uplands and stream terraces. These soils have a medium-textured to moderately fine textured, brown or grayish-brown surface layer and a slowly permeable subsoil. They are well drained. Most of them have a medium-textured substratum, but the substratum of the Fort Collins soil is gravelly, and that of the Renohill soils contains sandstone. These soils have more gentle slopes than those in capability unit IVe-2 (dryland). They are—

- Baca clay loam, 0 to 3 percent slopes (in climatic zones C and D).
- Campo clay loam, 0 to 3 percent slopes (in climatic zones C and D).
- Fort Collins loam, 0 to 3 percent slopes (in climatic zones C and D).
- Goshen silt loam (in climatic zones C and D).
- Renohill loam, 1 to 3 percent slopes (in climatic zones C and D).
- Renohill loam, moderately shallow, 1 to 3 percent slopes (in climatic zone C).
- Ulysses silt loam, 0 to 3 percent slopes (in climatic zones C and D).

The soils of this unit are easy to work and are fertile enough for dryfarming. Their water-holding capacity is moderately high or high, and most of the water they hold is readily available to plants. Water penetrates these soils at a medium to slow rate, and surface drainage is slow to medium. Surface drainage is slowest on the Campo soil. Under dryland cultivation the soils in this unit are moderately susceptible to wind erosion, but clods can be brought to the surface to control wind erosion.

Wheat and sorghum (fig. 20) are the main crops, but a small amount of barley is also grown. A good cropping sequence that is commonly followed is wheat-fallow or sorghum-fallow. Some farmers use the wheat-sorghum-fallow sequence when soil moisture is adequate, though usually it is better to precede a crop with summer fallow. Barley may be substituted for wheat. The cropping system should be flexible so that wheat is planted only when soil moisture is adequate.

Good management helps to conserve soil moisture and to control erosion. Stubble-mulch farming helps to maintain the organic-matter content and to conserve soil moisture. In the gently sloping areas, contour farming and terracing help to control water erosion and to conserve moisture. Stripcropping helps to control erosion.

***Figure 20.*—Grain sorghum on Baca clay loam, 0 to 3 percent slopes.**

Practices that control erosion are needed because these soils are erodible if ground cover is not adequate. These practices include listing or pitting of fields that are summer fallowed and chiseling or using a rotary hoe when the stand of young wheat does not sufficiently protect the soils. Timely tillage helps to keep these soils in good tilth. To prevent soil blowing, a cover crop is sometimes needed on fields not having enough crop residue. Stubble and young wheat should not be grazed so low that these soils start to blow.

CAPABILITY UNIT VIe-1 (DRYLAND)

In this capability unit, the only soil is Arvada clay loam (in climatic zone D). This soil is deep, saline, and gently sloping, and it has a moderately fine textured surface layer and a very slowly permeable subsoil. It is on uplands and developed in material weathered from shale. In most places the shale in the substratum is partly weathered. Throughout this soil is a large amount of gypsum.

This soil takes in water slowly. The water-holding capacity is high, but the water held is not readily available to plants, because the content of salts is high. Surface drainage is slow.

This soil is not suitable for farming, though in some small areas it is cultivated. Yields of crops are not good, and dry-farmed areas should be reseeded to grass. Alkali sacaton and galleta are among the grasses that grow on the range. Range should be managed well.

CAPABILITY UNIT VIe-2 (DRYLAND)

In this capability unit are moderately shallow to deep, nearly level to moderately sloping soils on uplands and stream terraces. These soils are in an area of low rainfall. They have a medium-textured surface layer and a moderately to slowly permeable subsoil. Because of their unstable structure and steep slopes, they cannot be cultivated without damage from erosion. These soils are—

- Baca clay loam, 3 to 5 percent slopes (in climatic zone D).
- Breaks-Alluvial land complex.
- Colby fine sandy loam, 3 to 5 percent slopes (in climatic zone D).
- Colby silt loam, 0 to 1 percent slopes (in climatic zone D).
- Colby silt loam, 1 to 3 percent slopes (in climatic zone D).
- Colby silt loam, 0 to 3 percent slopes (in climatic zone D).
- Colby silt loam, 3 to 5 percent slopes.
- Colby silt loam, clay substratum, 0 to 1 percent slopes (in climatic zones C and D).
- Colby silt loam, sand substratum, 0 to 1 percent slopes (in climatic zones C and D).
- Fort Collins loam, 3 to 5 percent slopes (in climatic zone D).
- Harvey loam, 0 to 1 percent slopes (in climatic zone D).
- Harvey loam, 1 to 3 percent slopes (in climatic zone D).
- Harvey loam, 0 to 3 percent slopes (in climatic zone D).
- Harvey loam, 3 to 5 percent slopes.
- Harvey loam, 5 to 9 percent slopes, eroded.
- Havre loam (in climatic zone D).
- Loamy alluvial land.
- Manvel loam, 0 to 1 percent slopes (in climatic zone D).
- Manvel and Minnequa loams, 1 to 5 percent slopes.
- Penrose loam, 1 to 5 percent slopes (in climatic zones C and D).
- Renohill loam, 3 to 5 percent slopes (in climatic zone D).
- Renohill loam, moderately shallow, 1 to 3 percent slopes (in climatic zone D).
- Renohill loam, moderately shallow, 3 to 5 percent slopes (in climatic zones C and D).
- Tyrone loam, 3 to 5 percent slopes (in climatic zone D).
- Tyrone soils, eroded (in climatic zones C and D).
- Wiley silt loam, 3 to 5 percent slopes (in climatic zone D).

Wiley and Baca soils, 3 to 5 percent slopes, eroded (in climatic zones C and D).

The water-holding capacity is medium to high, and most of the water stored is readily available to plants. Surface drainage is medium or rapid.

These soils are best suited to range, but much of the acreage is dry farmed. If they are dry farmed, the soils are likely to be moderately or severely eroded by wind and water. Because the cover of plants is generally not adequate for protection, these soils frequently blow in windy periods through the time they are in summer fallow. In some areas hummocks have formed (fig. 21) and should be smoothed.

Good management is needed in the areas used for grazing. Grass ought to be seeded in cultivated areas, but a cover crop should be planted first to stabilize the soils. The grass should not be grazed until it is established. Blue grama and buffalograss grow on the range.

CAPABILITY UNIT VIe-3 (DRYLAND)

This capability unit consists of soils of the uplands that have a moderately coarse textured surface layer and that have unstable soil structure or occur in a dry climatic zone. These soils range from nearly level to steep and are highly erodible under cultivation. They are—

- Fort Collins sandy loam, 3 to 5 percent slopes (in climatic zones C and D).
- Otero sandy loam, 1 to 3 percent slopes (in climatic zone D).
- Otero sandy loam, 3 to 5 percent slopes.
- Renohill sandy loam, 3 to 5 percent slopes (in climatic zone D).
- Renohill sandy loam, moderately shallow, 1 to 3 percent slopes (in climatic zone D).
- Renohill sandy loam, moderately shallow, 3 to 5 percent slopes (in climatic zones C and D).
- Renohill soils, eroded (in climatic zones C and D).
- Travessilla sandy loam (in climatic zones C and D).
- Vona loamy sand, 1 to 3 percent slopes (in climatic zones C and D).
- Vona loamy sand, 3 to 5 percent slopes.
- Vona sandy loam, 1 to 3 percent slopes (in climatic zone D).
- Vona sandy loam, 3 to 5 percent slopes (in climatic zones C and D).
- Vona soils, 1 to 3 percent slopes, eroded.
- Vona soils, 3 to 9 percent slopes, eroded.

***Figure 21.*—Hummocky soils of dryland capability unit VIe-2 in a field where protection from blowing has not been adequate. These soils will be difficult to smooth.**

These soils are best suited to permanent pasture, but a considerable acreage is dry farmed. Because these soils are in a dry climatic zone or are too steep, in many years they cannot produce enough vegetation to prevent soil blowing during windy periods or through periods of summer fallow. A cover crop ought first to be planted in the areas now dry farmed, to stabilize the soil before reseeding. Then good practices of grass management should be followed. Areas in range have a cover of sand sage, yucca, little bluestem, and blue grama.

CAPABILITY UNIT VIe-4 (DRYLAND)

In this capability unit are nearly level to gently sloping, well-drained soils that developed in alluvium on bottom lands and low stream terraces. The surface layer of these soils is moderately coarse textured. The subsoil has medium to moderately rapid permeability. These soils have unstable structure and occur in an area of low rainfall. If they are dry farmed, they are highly susceptible to wind erosion. They are—

- Glendive fine sandy loam, 0 to 1 percent slopes (in climatic zone D).
- Glendive fine sandy loam, 1 to 3 percent slopes (in climatic zone D).
- Glendive fine sandy loam (0 to 3 percent slopes) (in climatic zone D).
- Glendive fine sandy loam, clay substratum (in climatic zone D).
- Glendive and Havre fine sandy loams, 0 to 1 percent slopes (in climatic zone D).
- Glendive and Havre fine sandy loams, 1 to 3 percent slopes (in climatic zone D).
- Glendive and Havre fine sandy loams (0 to 3 percent slopes) (in climatic zone D).
- Glendive and Havre soils, sand substrata (0 to 3 percent slopes) (in climatic zone D).
- Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (in climatic zone D).
- Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (in climatic zone D).

The water-holding capacity is low to moderately high, and the water stored is readily available to plants. Surface drainage is slow, and these soils take in water at a moderately rapid rate. Some of these soils are subject to occasional flooding from streams or receive runoff from higher land. Natural fertility is medium.

In this climatic zone, these soils are best suited to grass. The areas in grass need good management. Grass ought to be seeded in dry-farmed areas, but a cover crop should be planted first to stabilize the soils. The vegetation on the range varies, largely because of differences in the amount of flooding. In some areas it is switchgrass, blue grama, and sand sage. In other areas cottonwood trees form an overstory.

CAPABILITY UNIT VIe-5 (DRYLAND)

This capability unit consists of shallow to moderately deep, clayey soils that absorb water slowly and that are slowly permeable. The water-holding capacity is low because these soils are shallow over shale or shaly material. These soils are—

- Lismas clay loam (in climatic zones C and D).
- Pultney loam, 1 to 5 percent slopes (in climatic zones C and D).

These soils are not suitable for farming and need a good cover of grass that will protect them from erosion. Grazing needs to be controlled. If the native grasses are once eliminated by overgrazing, they are difficult to reestablish on these soils; therefore, good management of the grass is particularly important. A cover of grass and crop residue left on these soils helps to control erosion. In addition to keeping a protective cover of stubble on the soils, contour furrowing or range pitting are necessary for conserving moisture and controlling erosion in reseeded areas. The grasses most suitable for reseeding are western wheatgrass and blue grama.

CAPABILITY UNIT VIw-1 (DRYLAND)

In this capability unit are nearly level, poorly drained or imperfectly drained, moderately deep to deep soils on bottom lands and low stream terraces. The surface layer of these soils ranges from coarse to moderately fine in texture. The subsoil has moderately rapid to very slow permeability. These soils are saline, and they have a high water table if they are not artificially drained. They are—

- Las loam (in climatic zones C and D).
- Las loam, clay substratum (in climatic zones C and D).
- Las clay loam (in climatic zones C and D).
- Las clay loam, clay substratum (in climatic zones C and D).
- Las clay loam, saline (in climatic zones C and D).
- Las clay loam, sand substratum (in climatic zones C and D).
- Las clay loam, sand substratum, saline (in climatic zones C and D).
- Las clay loam, wet, saline (in climatic zones C and D).
- Las sandy loam (in climatic zones C and D).
- Las Animas soils (in climatic zones C and D).
- Saline wet land (in climatic zones C and D).

These soils have medium to high natural fertility. They take in water at a slow to rapid rate and have slow or very slow surface drainage and internal drainage. The water-holding capacity ranges from low to high, but in most areas the water stored is adequate for native plants because the high water table makes ground water available. Where the water table has been lowered, however, as in the Las Animas and saline Las soils, the water stored may not be adequate for plants.

Areas of these soils that are not irrigated are best suited to range or pasture, but the grass needs good management for high yields of forage. The dominant plants are alkali sacaton, inland saltgrass, switchgrass, sedges, and rushes.

CAPABILITY UNIT VIIe-1 (DRYLAND)

This capability unit consists of deep, excessively drained, unstable soils of the sandhills. The surface layer is coarse textured, and the subsoil is very rapidly permeable. In some areas these soils have a complex pattern of slopes and dunes, and no surface drainage. In other areas they are gently sloping to moderately sloping or rolling. They are—

- Tivoli sand, hilly.
- Tivoli-Dune land complex (Tivoli soil only)

These soils are droughty and very low in natural fertility. They take in water rapidly. Although the water-holding capacity is very low, most of the water stored is readily available to plants. In places where the vegetation does not provide enough ground cover for protection, wind is likely to severely erode these soils.

These soils are not suitable for cultivation and are used mostly for range to which they are best suited. The areas in grass should be managed well. In areas of small blowouts, it is necessary to reseed these soils and to exclude grazing.

CAPABILITY UNIT VIIe-2 (DRYLAND)

Only Tivoli sand is in this capability unit. This soil is deep and very sandy and is undulating or gently rolling. It takes in water rapidly, but it has low water-holding capacity. The surface layer dries quickly. The soil blows easily and drifts in places where it is exposed to wind.

This soil is too loose and sandy for farming in such a dry climate. In a semiarid climate, however, it is well suited to grass. It is best suited to tall, deep-rooted grasses that grow well on sandhills, for the roots of tall grasses extend to a greater depth than those of short grasses. Because the surface layer of this soil holds so little water and dries rapidly, seeds germinate in only a few spots; they fail to germinate in many other places.

Areas of this soil in range need to be managed so that a good cover of grass and crop residue is kept on the soil. Bluestem, sideoats grama, and sand reedgrass are the best suited grasses for reseeding. In most areas drilling is the method used for seeding the grass. Seedbed preparation is not feasible, because any cultivation destroys the cover of plants or crop residue and allows soil blowing.

CAPABILITY UNIT VIIs-1 (DRYLAND)

In this capability unit are gravelly soils of the uplands. The soils are shallow or very shallow in some areas and steep and rough in other areas. Their surface layer is medium textured to moderately coarse textured and is gravelly. In the deeper areas of these soils, the subsoil is rapidly permeable. The substratum is very gravelly. These soils have slopes that range from gentle to steep. They are—

- Cascajo sandy loam, 3 to 25 percent slopes.
- Potter and Nihill gravelly soils, 1 to 5 percent slopes (in climatic zones C and D).
- Potter and Stoneham gravelly loams, 5 to 35 percent slopes (in climatic zones C and D).
- Terrace escarpments.

Generally, these soils have low or very low natural fertility. They are difficult to work because they are gravelly. They take in water at a moderately rapid rate. The water-holding capacity is low or very low, but most of the water stored is readily available to plants. Surface drainage is medium to very rapid.

These soils are used mostly for range, to which they are best suited. They are not suitable for cultivation, and only small areas are included in cultivated fields. The areas in range should be managed well. Except in some small areas, the soils are too steep and too rough for the use of machinery for reseeding. In many areas eroding gullies need to be stabilized.

CAPABILITY UNIT VIIs-2 (DRYLAND)

The soils in this capability unit are nearly level and excessively drained. They are on bottom lands and in many areas are subject to frequent flooding and deposition of new material. The surface layer is medium textured to coarse textured, and the subsoil is rapidly permeable. Many gravel bars are within areas of these soils, and many areas are without vegetation. These soils are—

Lincoln loam.
Lincoln sand.

These soils are droughty and low in natural fertility. They take in water at a medium to rapid rate. The water-holding capacity is very low, but most of the water stored is readily available to plants.

Management of grass should be good on these soils. The frequency of flooding determines the kinds of vegetation that can grow on the range. In some areas that are flooded frequently, various grasses grow and there is a thick stand of tamarisk and cottonwood trees. In other areas that are flooded less frequently, sand sage is the main vegetation.

CAPABILITY UNIT VIIs-3 (DRYLAND)

Only Lismas-Shale outcrop complex (in climatic zones C and D) is in this capability unit. It is in the uplands, and it consists of soils that are shallow and very shallow over shale. Shale crops out in most areas, but it is at a depth of 18 inches or less in some places. Some areas are gently sloping, and others are steep and broken.

These soils have low or very low natural fertility. They take in water slowly and have low or very low water-holding capacity. The water stored in the Lismas soil is not readily available to plants. The shale is impermeable, and water runs off rapidly.

This complex is used mostly for range to which the soils are best suited. Good management should improve the range. These soils are not suitable for cultivation, but small areas are cultivated where these soils are included in cultivated fields with other soils. Grass should be reseeded in dry-farmed areas if seeding is feasible. Seeded areas should not be grazed until a cover of grass is established.

CAPABILITY UNIT VIIs-4 (DRYLAND)

Only Penrose-Rock outcrop complex (in climatic zones C and D) is in this capability unit. The soils are stony, moderately sloping, and shallow or very shallow over bedrock. The rate of infiltration is medium, but the depth of penetration is restricted to the shallow layer over limestone.

These soils are not suitable for farming, but they are suited to grass and other forage plants. The range needs protection from overgrazing, and from other uses that would damage the vegetation, because restoring the native plants by reseeding is extremely difficult.

CAPABILITY UNIT VIIs-5 (DRYLAND)

The only soils in this capability unit are those of Travessilla-Rock outcrop complex (in climatic zones C and D). Some areas are sloping and some are rough and broken. The less sloping areas lie between the bluffs and escarpments. Livestock cannot travel in some areas of bluffs and escarpments. These soils are loamy, shallow or very shallow over bedrock, and in many places stony. They take in water at a moderately rapid rate, but they have low water-holding capacity because they are shallow.

These soils are not suitable for cultivation, but are suited to grasses and other forage plants. Grass grows abundantly. If the desirable forage plants are to be preserved as ground cover, particularly in the more accessible areas, careful management of these soils is needed.

CAPABILITY UNIT VIIIe-1 (DRYLAND)

Only Dune land is in this capability unit. In most places this land type blows, even when it is not used for grazing, because there is not enough vegetation to provide adequate ground cover for protection. Much of the acreage was formerly Tivoli soils, but because of the destruction of vegetation and the severe erosion, a soil profile can no longer be distinguished in most areas.

In most places revegetation of this land type is not feasible, but in some places it is necessary to keep the sand from blowing onto other soils, buildings, or structures. In areas where revegetation is desired, the movement of sand commonly is reduced by spreading native grass or sorghum hay. In most of the areas where hay consisting of native grass has been spread, enough seed falls so that other seeding is not necessary. Broadcasting the seeds of native grasses by hand helps to reseed the areas where sorghum has been spread.

Yield predictions for the principal dry-farmed crops

Table 2 gives the predicted average yields per acre for barley, wheat, and grain sorghum, the three main dry-farmed crops grown in this county. Because some of the soils are considered suitable for cultivated crops only in climatic zones B and C, the table shows the climatic zones for those soils. Yield predictions apply only to arable soils in capability classes III and IV.

The yields given are for two levels of management. Those in columns A were obtained under the level of management followed by most of the farmers in the county. Those in columns B were obtained under a high level of management. The yields on some farms may be even higher than those shown in columns B if a high level of management is used. For wheat, the yields shown may be obtained when a system of summer fallow is used, that is, the land is left fallow for one season and wheat is grown the second season.

Yield predictions are based on records of the Agricultural Research Service and the Farmers Home Administration; on statistics of the Colorado Crop and Livestock Reporting Service on observations made by the field party throughout the survey; and on discussions with farmers, with members of the staff of the Colorado State University, and with other agricultural specialists in the county.

Under the prevailing management, dryfarming operations are done either around and around the field or parallel to boundary lines; a one-way disk plow is used primarily for tillage, and as a result, only a small amount of stubble is left to protect the soils during the summer fallow period; the soils are not fully protected from wind erosion; and the full benefit from the seasonal moisture is not obtained, because contour farming is not practiced.

Under the high level of management for which yields are shown in columns B, the following practices are used:

1. Erosion is controlled and moisture is conserved by practicing stripcropping, and terracing where needed; maintaining as good a cover of stubble as feasible during the period of summer fallow;

and farming on the contour where the slopes are more than 1 percent and in some places where the slopes are less than 1 percent.

2. Such practices as growing a cover crop, tilling at the proper time, and practicing emergency tillage are used to minimize wind erosion.

TABLE 2.—*Predicted average yields per acre of dry-farmed crops grown under two levels of management*

[Absence of a yield figure indicates the soil is not suited to the crop specified; wheat yields reflect the general use of summer fallow]

Soil	Barley		Wheat		Grain sorghum	
	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Baca clay loam, 0 to 3 percent slopes	8	10	9	11	10	12
Baca clay loam, 3 to 5 percent slopes (in climatic zone C)	6	8	7	9	7	10
Campo clay loam, 0 to 3 percent slopes	9	11	9	11	10	12
Colby fine sandy loam, 0 to 1 percent slopes	9	10	9	10	12	13
Colby fine sandy loam, 0 to 3 percent slopes	9	10	9	10	12	13
Colby fine sandy loam, 1 to 3 percent slopes	9	10	9	10	12	13
Colby fine sandy loam, 3 to 5 percent slopes (in climatic zone C)	7	9	7	9	9	11
Colby silt loam, 0 to 1 percent slopes (in climatic zone C)	6	8	6	8	7	9
Colby silt loam, 0 to 3 percent slopes (in climatic zones B and C)	6	8	7	10	8	10
Colby silt loam, 1 to 3 percent slopes (in climatic zone C)	5	7	5	7	6	8
Fort Collins loam, 0 to 3 percent slopes	6	8	7	9	8	10
Fort Collins loam, 3 to 5 percent slopes (in climatic zone C)	5	7	5	8	7	9
Glendive fine sandy loam (in climatic zone C)	7	8	7	8	9	10
Glendive fine sandy loam, 0 to 1 percent slopes (in climatic zone C)	7	8	7	8	9	10
Glendive fine sandy loam, 1 to 3 percent slopes (in climatic zone C)	7	8	7	8	9	10
Glendive fine sandy loam, clay substratum (in climatic zone C)	7	8	8	9	9	10
Glendive and Havre fine sandy loams, 0 to 1 percent slopes (in climatic zone C)	6	7	6	8	7	9
Glendive and Havre fine sandy loams, 1 to 3 percent slopes (in climatic zone C)	6	7	6	8	7	9
Glendive and Havre fine sandy loams (in climatic zone C)	6	7	6	8	7	9
Glendive and Havre soils, sand substrata (in climatic zone C)	5	7	5	7	7	9
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (in climatic zone C)	5	7	5	7	7	9
Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (in climatic zone C)	5	7	5	7	7	9
Goshen silt loam	15	17	16	19	16	18
Harvey loam, 0 to 3 percent slopes (in climatic zones B and C)	5	7	5	7	6	8
Harvey loam, 0 to 1 percent slopes (in climatic zone C)	6	8	6	8	7	9
Harvey loam, 1 to 3 percent slopes (in climatic zone C)	5	7	5	7	6	8
Havre loam (in climatic zone C)	5	7	5	7	6	8
Manvel loam, 0 to 1 percent slopes (in climatic zone C)	5	8	6	8	6	8
Otero sandy loam, 1 to 3 percent slopes (in climatic zones B and C)	7	9	7	9	10	12
Renohill loam, 1 to 3 percent slopes	7	10	8	11	8	11
Renohill loam, 3 to 5 percent slopes (in climatic zone C)	6	8	6	9	6	9
Renohill loam, moderately shallow, 1 to 3 percent slopes (in climatic zone C)	6	8	6	8	6	9
Renohill sandy loam, 1 to 3 percent slopes	7	9	7	9	10	12
Renohill sandy loam, 3 to 5 percent slopes (in climatic zone C)	6	8	6	8	8	10
Renohill sandy loam, moderately shallow, 1 to 3 percent slopes (in climatic zone C)	6	8	7	8	9	11
Richfield silt loam, 0 to 1 percent slopes	14	16	15	18	15	17
Tyrone loam, 0 to 3 percent slopes	6	8	6	8	6	8
Tyrone loam, 3 to 5 percent slopes (in climatic zone C)	5	6	5	6	5	6
Ulysses sandy loam, 0 to 3 percent slopes	11	13	12	14	16	18
Ulysses silt loam, 0 to 3 percent slopes	13	15	14	17	14	16
Vona loamy sand, 1 to 3 percent slopes (in climatic zone B)	----	----	----	----	9	10
Vona sandy loam, 1 to 3 percent slopes (in climatic zones B and C)	8	10	8	10	13	15
Vona sandy loam, 3 to 5 percent slopes (in climatic zone B)	6	8	6	8	9	11
Wiley silt loam, 0 to 3 percent slopes	7	8	8	10	8	10
Wiley silt loam, 3 to 5 percent slopes (in climatic zone C)	6	7	6	7	7	9
Wiley and Baca soils, 0 to 3 percent slopes, eroded	6	8	7	10	7	11

3. A cropping system is used that best fits the climate and kinds of soils.
4. Insects are controlled.

Many factors besides management affect crop yields, and an accurate prediction of yields is difficult to make, particularly for dry-farmed crops. Therefore, the yield predictions given in table 2 should be used only as a guide in planning farming operations. Among the other factors that influence yields of dry-farmed crops are the amount and timeliness of rainfall; the amount and severity of windstorms and hailstorms; the amount of moisture in the soils at planting time; and the variety of seed planted. As an example of the way yields are affected by these other factors, dry-farmed wheat may produce 40 bushels per acre on some soils of this county in years of favorable rainfall, but it may produce nothing in years when there is only a small amount of rainfall. Also, even though the amount and timeliness of rainfall are favorable, the crop may be damaged by a severe windstorm or hailstorm. Furthermore, if the soil does not contain enough moisture at planting time, the seed may not germinate, or only a sparse stand may be obtained, and a good stand may not be obtained unless a suitable variety of seed is planted.

Management of Irrigated Soils

The first part of this section gives general information about irrigation in Prowers County, the second discusses the irrigated capability units in the county, and the third gives predicted average acre yields for the principal irrigated crops under two levels of management.

Prowers County had slightly more than 100,000 acres under irrigation in 1959. The irrigated areas are mainly in the valley of the Arkansas River and on uplands to the north. In those areas the irrigation water is obtained from wells or is diverted from the river, but a few other areas are irrigated by pumping water from wells.

Under good management the crops grown in the county respond well to irrigation, but in irrigated areas practices are needed that protect the soils, conserve water, and help to maintain good tilth and the content of organic matter. Other good practices consist of fertilizing the soils and of using good methods for irrigating. Technical help in constructing an irrigation system and in managing irrigated soils can be obtained from a local representative of the Soil Conservation Service or the county agent.

Sources of irrigation water.—Water for irrigation is taken from three main sources in this county. These are the Arkansas River; storage reservoirs, which, in turn, receive water from the Arkansas River; and wells. A fourth source is drainage ditches, but water from that source is not generally used.

The largest amount of water used for irrigation is supplied through the Amity and Fort Lyon Canals. Water is also supplied through the Keesey, Lamar, Buffalo, Fort Bent, Hyde, X–Y, Comanche, and Sisson Stubbs Canals and through the Graham and Manvel Ditches. The amount of water available in any of these canals depends upon the amount of flow in the Arkansas River and upon the amount of water stored in the John Martin Reservoir and other reservoirs. The John Martin Reservoir, in Bent County to the west, has a storage capacity of 402,110 acre-feet. In it is stored water from flooding and from normal streamflow not currently needed for irrigation. The reservoirs that supply the Amity Canal system north of Lamar have a storage capacity of 265,500 acre-feet. Also, water for irrigating a small acreage is stored in the Two Buttes Reservoir.

Many wells that supply water for irrigation have been installed in recent years. At the time the soil survey was made, about 200 to 250 wells were in the county, mainly in the valley of the Arkansas River and in the irrigated areas north of the river. Several wells have also been established in the northeastern corner of the county, and about 50 wells have recently been established south of Holly. Most of the wells produce between 1,000 and 1,800 gallons per minute.

Quality of the irrigation water.—The quality of the water used for irrigation varies, largely as the result of differences in the source. Water from the Arkansas River and from reservoirs normally contains only a small amount of salts. Most of the seepage water that accumulates in drainage ditches, on the other hand, contains a large amount of salts and is not suitable for irrigation.

The amount and kind of salts in the water from the river and from reservoirs depend on how much rainfall has occurred and on the source of the runoff. Runoff from melting snow in the mountains contains a comparatively small amount of salts, but runoff from some of the shaly areas carries a large amount.

The water pumped from wells is generally of good quality for irrigation, and the water from deep wells in the upland normally contains less salts than that from the shallow wells in the valley. The amount of salts varies, however, as the result of differences in the kind of material from which the water is drawn. Additional information about the wells in the county and about the chemical analysis of the water is given in the publication "Colorado Ground Water Basic Data Report, Denver" (*8*),[2] prepared by the U.S. Geological Survey in cooperation with the Colorado Water Conservation Board.

Irrigation water taken from the canals generally carries a large amount of silt and clay, especially after a hard rain if runoff has been rapid. When muddy water is used for irrigation, part of the sediment settles in the canals and reservoirs. Also part of the silt and clay is deposited on the surface of the soil. The silt and clay are then worked into the soil when tillage takes place, or they penetrate deeper into the soil through cracks and root holes. Each time the soil is irrigated, a small amount of silt and clay is added and accumulates. This process is called siltation, and the soils that receive the silt and clay are called silted.

Where muddy irrigation water has been used for many years, the surface layer is finer textured than it was originally and the soils are less permeable and are hard when they are dry. In some places the texture of the surface layer has been changed from sandy loam to clay loam. In other small areas enough fine-textured material has been added that the texture of the present surface layer is clay. In the areas where the surface layer is clay, the whole profile is normally fine textured.

[2] Italic numbers in parentheses refer to Literature Cited, p. 147.

The depth to which the soils are silted varies as the result of differences in the slope, in the amount of irrigation water applied, and in the length of time the water has been applied. It also varies as the result of differences in the amount of runoff and erosion. As a rule, the nearly level areas and slightly concave areas have been silted to a greater depth than more sloping areas. In the nearly level areas, the depth to which the soils have been silted is generally between the depth to which a plowshare penetrates and about 15 inches, but in some small areas at the end of fields or in slight depressions, the soils are silted to a depth as great as 30 inches. Sloping soils are not silted to so great a depth, because the silt and clay are carried away by runoff. Even in sloping areas, however, there is some evidence of siltation in the surface layer.

Some silted soils are easily identified by the sharp boundary, marked in both texture and color, between the silted upper part of the profile and the lower part. This boundary is obvious in the Rocky Ford and Kornman soils. Siltation is also easy to identify in soils that are normally sand, but it is hard to recognize in soils such as the Las, because the silted material is similar to that in the lower part of the profile.

Silted soils are more difficult to work and manage than soils that are not silted, and they are likely to contain more soluble salts than before they were irrigated. Also, the range of moisture content within which they can be worked is narrower than that of similar soils that have not been irrigated with muddy water.

A large part of the watershed that supplies surface water to Prowers County lies in counties to the west where there is a large acreage of slowly permeable soils derived from shale. Runoff from such areas is more rapid than it is in areas of more permeable soils, and more silt is carried in the water used for irrigation. These shaly areas may also be the source of some of the soluble salts in the irrigation water used in Prowers County.

Soil moisture as related to irrigation.—The purpose of irrigation is to supply enough readily available moisture for crops. By readily available moisture is meant the moisture a plant can draw from the soil and maintain good growth. If the soil is not saline, this is about half of the field capacity, that is, it is about half the amount of moisture a soil can hold against the force of gravity. Field capacity is usually reached 2 or 3 days after irrigation is begun. The amount of moisture readily available is decreased when the soil contains salts, for drawing moisture from a saline soil is more difficult for plants than drawing moisture from soil that is not saline. After the readily available moisture has been drawn out of the soil, plants begin to wilt.

The amount of readily available moisture any soil can hold at field capacity depends largely on the texture and thickness of the soil and on the content of salts. Silt loams and silty clay loams hold about 2.3 inches of readily available moisture per foot of soil; loams and clay loams about 2 inches; sandy loams about 1.2 inches; and loamy sands and fine sands about 0.8 inch.

The speed at which water enters the soil, and the permeability of the subsoil, affect the supply of readily available moisture. Both depend largely on the texture of the soil (*18*), though the tilth of the surface layer and the structure of the subsoil have their effect. The speed at which water enters the soil and the permeability of the soil are slowest in the clays and silty clays. They are progressively more rapid in the clay loams, silty clay loams, loams, silt loams, sandy loams, loamy sands, and sands.

Methods of applying water.—The three principal methods of irrigating the soils in this county are furrow irrigation, border irrigation, and flood irrigation, but a fourth method, sprinkler irrigation, is used to some extent.

Furrow irrigation (fig. 22) is used where row crops are grown. When this method is used, the water is taken from ditches and is applied in the furrows between the rows of plants. Furrow irrigation is an efficient way of irrigating crops, for the amount and speed of the flow can be well regulated.

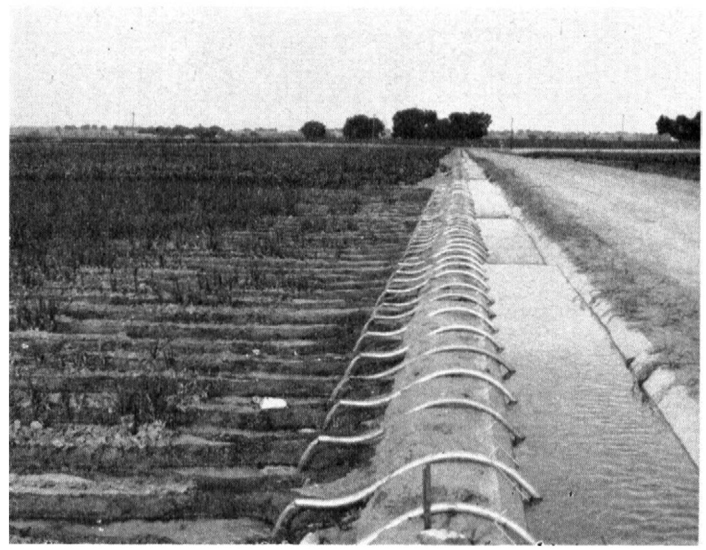

***Figure 22.*—Furrow irrigation on a soil near Big Sandy Creek.**

Border irrigation is used primarily in nearly level fields of close-growing crops. It consists of flooding the surface of a field, but controlling the speed of the flow and the amount of water. When this method is used, a sheet of water flows down a narrow strip between low ridges or borders, and the water soaks into the soil as it advances. The areas between the small dikes or ridges must be well leveled, and the grade down the strip must be fairly uniform so that ponding will be avoided. If low spots remain in the field, water will stand in them, and if high spots remain, it may be impossible to get water over them. The small dikes or ridges between the strips should be low and rounded so that they can be planted along with the strips and no areas taken out of production.

Suitable Management Practices for Irrigated Soils

If plants are to receive the amount of moisture they need, water must be applied efficiently. Irrigation is inefficient when water is allowed to penetrate below the root zone and is lost, when runoff occurs at the end of the field, or when water escapes through seepage and in ditches. Water seeps down below the root zone if the irrigation runs are too long or if the water is allowed to run too long on the same set. Also if the runs are too long or if the amount of water used is too small for the length of the run, the soils at the upper end of the run likely will be wet below the root zone before the soils at the lower end have received enough water. This is especially likely in sandy soils or in soils that have a root zone that is shallow over sand. Wetting the soil below the root zone has little value and is likely to create drainage problems.

If the size of the head of water is known, the amount of water being applied can be calculated. One second-foot of water (450 gallons per minute) covers an acre to a depth of 1 inch in an hour, that is, 1 inch of water is applied to 1 acre of soil. Therefore, after all the readily available moisture has been used, a crop that has a 2-foot root zone needs a 4-inch irrigation to refill the root zone if the soil is a clay loam or loam, for clay loams and loams hold about 2 inches of readily available moisture per foot of soil.

It is not always feasible to irrigate at the time crops need irrigation, because the water in ditches cannot be turned on and off at will as can the pump from a well. The best way to keep plants growing at a favorable rate is to irrigate when the readily available moisture in the uppermost 6 to 12 inches of the soil is about one-fourth of field capacity. This has been determined through experiments with irrigation. These experiments show that plants draw about 40 percent of the moisture they use from the upper quarter of the root zone, about 30 percent from the second quarter, about 20 percent from the third quarter, and about 10 percent from the lowest quarter. Because plants absorb the greatest part of the moisture they use from the upper part of the root zone, the uppermost 6 to 12 inches of soil material in soils of uniform texture can be examined to see whether irrigation water is needed. In soils that do not have uniform texture, it may be necessary to examine the soil material to a greater depth.

Many methods are available for making irrigation more efficient and for saving water and labor. For example, losses of water through seepage from ditches may be stopped by lining the ditches with concrete (fig. 23) or by using a pipeline for transporting the water. Lining the ditches with concrete or using a pipeline also saves labor because little maintenance is required, and less time is required for the water to flow from the headgate or pump to the area to be irrigated.

Storing water overnight in a reservoir (fig. 23) also saves labor. A storage reservoir is most useful where the pump does not produce a large enough head for irrigation. Water can be pumped into the reservoir at night or at other times when it is not needed for irrigation. Then it can be pumped from the reservoir as needed, and a larger head used for irrigation.

Structures like the one shown at the bottom of figure 23 provide an easy way of dividing a head of water or of

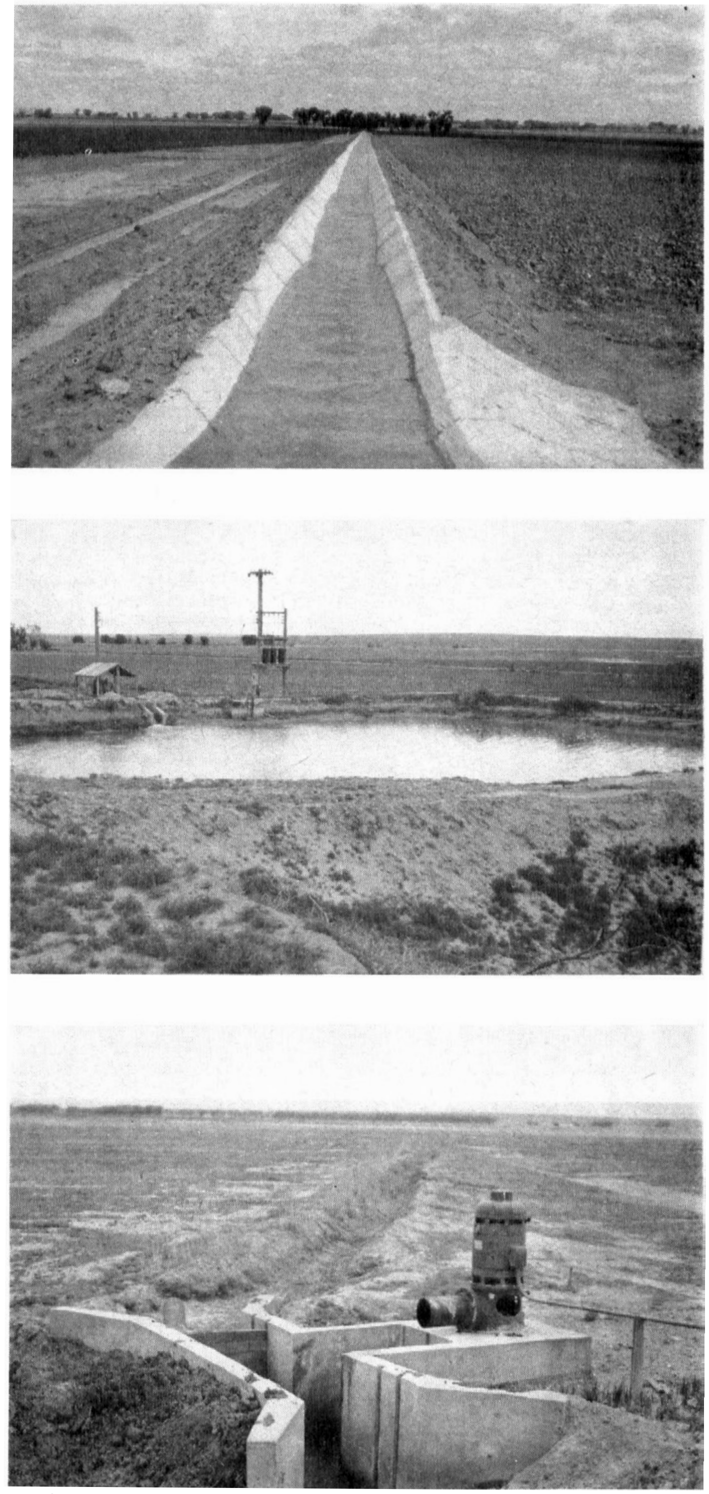

Figure 23.—**Structures used to make irrigation more efficient. At the top is a picture of an irrigation ditch that will require little maintenance because it is lined with concrete; in the center is a reservoir used for overnight storage of irrigation water; and at the bottom is a structure used for dividing a head of water or for directing the water from one ditch to another.**

directing the water from one ditch to another. Siphon tubes or a gated pipe will help to regulate the flow of water to the furrows or borders, and land leveling or smoothing allows more even distribution of the water. A Parshall flume or other measuring device will indicate how much water is being used.

Timely tillage.—Tillage of irrigated soils is done mainly to prepare a suitable seedbed, to kill weeds, to incorporate fertilizer and plant residue into the soils, and to improve tilth. Timely tillage means that the soils are tilled when they contain the right amount of moisture for tillage; that is, they are not tilled when too wet or too dry. If the soils are tilled when they are too wet, they are likely to become compacted or puddled, and if they are tilled when too dry, clods are likely to form. Tilling the soils when they are neither too wet nor too dry helps to maintain or improve tilth. When the soils are in good tilth, moisture, air, and roots can penetrate readily.

Land leveling.—The farmer who irrigates his soils needs to be able to apply water uniformly and to conserve water and labor. Land leveling helps to do these things, and it is necessary if border irrigation is used. Most land leveling is done in areas that are already nearly level, for in such areas less soil material must be moved for good results. Where land leveling is to be done, the kinds of soils, the relief, and the general topography must all be considered. Sloping areas may be bench leveled.

Drainage.—Many of the soils of the county need drainage or need to have the present drainage system maintained if they are to be irrigated successfully. Some of the soils are naturally wet because they have a high water table, and others have been made wet as the result of seepage. In this county many miles of open drainage ditches have been dug (fig. 24). Tile drains have also been established in some places.

Maintaining fertility.—The fertility of irrigated soils must be kept at a high level if high yields are to be obtained. This can be done by applying commercial fertilizer and by plowing under green-manure crops and crop residue. Barnyard manure can also be added, but it is not used extensively, because there is only a limited supply. Before commercial fertilizer or barnyard manure is applied, the soils should be tested. The county agent can give assistance in testing the soils.

The amount of available plant nutrients in the soils varies as the result of differences in the past use of the soils, in the amount of fertilizer applied in the past, and in the kind of crops grown just before the soils are tested. In general, a commercial fertilizer high in nitrogen and phosphorus is needed for the best yields of corn, sorghum, and sugar beets, but phosphate also increases the yields of alfalfa. The soils are adequately supplied with potassium and minor elements needed for good yields.

Control of weeds.—In all irrigated areas, weeds are a problem. The most common annual weeds in the county are Russian-thistle, kochia, sunflower, cocklebur, sandbur, wild lettuce, common ragweed, devilsclaw, rough pigweed, and down bromegrass. These weeds can be controlled easily by cultivation or by spraying with chemicals. Fence rows and the banks of ditches may be sprayed with chemicals or the weeds burned off to prevent them from making seed.

***Figure 24.*—A drainage ditch dug into the bedrock. This ditch will intercept the flow of ground water and will eliminate seepage.**

Noxious weeds grow in many irrigated areas. The most common noxious weeds are Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), johnsongrass (*sorghum halepense*), povertyweed (*Iva axillaris*), and Russian knapweed (*centaurea repens*). These weeds are hard to eradicate once they have become established. They may be controlled by cultivation or by spraying with chemicals. The areas in fence rows or along ditches can be sterilized so that noxious weeds will not grow.

Reclaiming saline and alkali soils.—Some saline and alkali soils occur in Prowers County where drainage is poor and seepage has occurred. In a large part of the acreage along the Arkansas River, the soils are affected by salinity to some degree. If the saline and alkali soils are to be reclaimed, drainage must be provided. After drainage is established, the salts can be leached out, although it may be necessary to apply chemical amendments to some soils before some salts can be leached out.

Using good tillage practices and growing green-manure crops and legumes improve the tilth of saline-alkali soils, and they thus help to reclaim the soils and to restore high productivity. Until the salts are leached out, it may be necessary to grow crops that tolerate salt. Barley and sugar beets are among the crops that tolerate a large amount of salt; cantaloups, tomatoes, onions, alfalfa, rye, wheat, oats, sorghum, and corn tolerate a moderate amount; and beans tolerate only a small amount (*13*).

Irrigated capability units

In this section each irrigated capability unit is described and the soils in each unit are listed. Suggestions are also given for using and managing the soils, and some of the risks involved in using the soils for cultivated crops are described. The capability classes, subclasses, and units used for irrigation farming are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.
- (No subclasses)
  - Unit I–1. Deep, nearly level soils that have a medium-textured surface layer.

Class II. Soils that have some limitations that reduce the choice of plants, or require moderate conservation practices, or both.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, gently sloping soils of the uplands and stream terraces; the surface layer is moderately fine textured.
  - Unit IIe–2. Deep, nearly level or gently sloping soils that have a medium-textured surface layer and are on uplands and stream terraces.
  - Unit IIe–3. Deep, nearly level or gently sloping soils that have a moderately coarse textured surface layer and are on stream terraces and bottom lands.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Unit IIw–1. Nearly level, seeped soils of the uplands.
  - Unit IIw–2. Nearly level, imperfectly drained soils of the bottom lands.
  - Unit IIw–3. Gently sloping, seeped soils of the uplands.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs–1. Deep, nearly level soils that have a moderately fine textured surface layer and are on uplands and stream terraces.
  - Unit IIs–2. Sandy, nearly level soils of the stream terraces and bottom lands.
  - Unit IIs–3. Nearly level soils that have a sandy subsoil.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1. Deep, moderately sloping soils that have a medium-textured surface layer and are on uplands.
  - Unit IIIe–2. Deep, moderately sloping soils that have a moderately fine textured surface layer and are on uplands.
  - Unit IIIe–3. Gently sloping soils of the stream terraces; they have a moderately fine textured surface layer and a moderately coarse textured subsoil or a sandy substratum.
  - Unit IIIe–4. Nearly level or gently sloping, moderately coarse textured soils.
- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw–1. Imperfectly drained, nearly level soils that have a clayey substratum and are on bottom lands and low stream terraces.
  - Unit IIIw–2. Imperfectly drained, nearly level soils that have a sandy substratum and are on bottom lands.
  - Unit IIIw–3. Nearly level, saline soils that have a moderately permeable to slowly permeable subsoil and are on uplands.
  - Unit IIIw–4. Deep, gently sloping, saline soils that have a moderately permeable to slowly permeable subsoil and are on uplands.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
  - Unit IIIs–1. Nearly level soils that formed in alluvium and have a clayey substratum.
  - Unit IIIs–2. Nearly level soils that formed in alluvium and have a sandy substratum.
  - Unit IIIs–3. Sandy, nearly level soils that formed in alluvium and have a clayey substratum and a water table deep in the profile.
  - Unit IIIs–4. Sandy, nearly level or gently sloping soils that formed in alluvium, have a sandy substratum, and are droughty.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1. Moderately sloping soils, moderately shallow over limestone and shale and on uplands.
  - Unit IVe–2. Moderately shallow, moderately sloping soils that have a sandy or gravelly substratum.
- Subclass IVw. Soils that have very severe limitations for cultivation, because of excess water.
  - Unit IVw–1. Imperfectly drained or poorly drained, nearly level, moderately fine textured soils of the bottom lands.

Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.

Unit IVs-1. Nearly level, droughty soils that have a sandy or gravelly subsoil and formed in alluvium.

Unit IVs-2. Gently sloping upland soils that are moderately shallow over limestone.

CAPABILITY UNIT I-1 (IRRIGATED)

This capability unit consists of deep, well-drained, nearly level soils of the uplands and stream terraces. The surface layer of these soils is medium textured, and the subsoil is moderately to slowly permeable. In contrast to many other irrigated soils that are lower than the canal system, these soils are not silted, because in most places the irrigation water has been pumped from wells. These soils are—

Colby silt loam, 0 to 1 percent slopes.
Harvey loam, 0 to 1 percent slopes.
Richfield silt loam, 0 to 1 percent slopes.

These soils are well suited to irrigation, and high yields of suitable crops are obtained. The soils are easy to work and manage and can be worked within a wider range of moisture content than finer textured soils. The water-holding capacity is high, and most of the water stored is readily available to plants.

All the crops normally grown in the area can be grown on these soils, and a flexible cropping system that includes at least 3 or 4 years of alfalfa is suitable. The soils respond well to fertilization and to good management of irrigation water. In some places land leveling is necessary to spread the water uniformly. Barnyard manure, green-manure crops, and crop residue that is returned to the soils help to maintain fertility and to keep the soils in good tilth. On the Richfield soil, chiseling or subsoiling may be necessary.

CAPABILITY UNIT IIe-1 (IRRIGATED)

In this capability unit are deep, gently sloping soils that developed in loess or alluvium on uplands and stream terraces. The surface layer is moderately fine textured, and the subsoil is slowly to moderately permeable. These soils are silted because they have been irrigated with muddy water. They are normally well drained, but in some small areas they are wet as the result of seepage. These soils are—

Nepesta clay loam, 1 to 3 percent slopes.
Numa clay loam, 1 to 3 percent slopes.
Rocky Ford clay loam, 1 to 3 percent slopes.

These soils are well suited to irrigation, but they are moderately difficult to moderately easy to work. Because they are silted, the soils can be worked only within a narrow range of moisture content. If they are worked when wet, they tend to compact, and if they are worked when dry, large hard clods are formed. Natural fertility is high. The soils take in water at a moderately slow rate but have high water-holding capacity. Most of the water stored is readily available to plants.

These soils are well suited to all of the crops grown in the area. The cropping system should be one that controls erosion, maintains good tilth, and maintains the content of organic matter. A cropping system that includes 3 or 4 years of alfalfa and not more than 3 consecutive years of row crops is the most satisfactory for these soils.

These soils respond well to fertilization and good management of irrigation water. Because they are gently sloping, they need more careful management of irrigation water than soils that are nearly level. In some places land leveling is necessary to spread the water uniformly. If row crops are planted across the slope or on the contour, the grade of the irrigation furrows is reduced. Ditches for irrigating close-growing crops are normally on the contour. It may be necessary to drain some wet spots. Barnyard manure, green-manure crops that are plowed under, and crop residue that is returned to the soils help to maintain the content of organic matter and to improve tilth. Timely tillage is important because it prevents compacting and excessive cloddiness. Chiseling and subsoiling help to loosen and to aerate the subsoil.

CAPABILITY UNIT IIe-2 (IRRIGATED)

In this capability unit are deep, nearly level or gently sloping soils of uplands and stream terraces. These soils have a medium-textured surface layer and a moderately permeable subsoil. They are not silted, because most of the irrigation water used on them was pumped from wells. These soils are—

Baca clay loam, 0 to 3 percent slopes.
Colby silt loam, 0 to 3 percent slopes.
Colby silt loam, 1 to 3 percent slopes.
Goshen silt loam.
Harvey loam, 1 to 3 percent slopes.
Harvey loam, 0 to 3 percent slopes.
Ulysses silt loam, 0 to 3 percent slopes.
Wiley silt loam, 0 to 3 percent slopes.

The soils that have a slope phase of 0 to 3 percent are above the canal system and are irrigated by pumping water from wells. Those that have a slope phase of 1 to 3 percent slopes are below the canal system and are irrigated by taking water from the canals or pumping from wells. Where large areas of these soils have slopes of less than 1 percent, they can be managed like the soils in irrigated unit I-1.

The soils of this unit are well suited to irrigation, are easy to work and to manage, and can be worked within a wide range of moisture content without becoming compacted or excessively cloddy. They have medium to high natural fertility and take in water at a medium rate. The water-holding capacity is high, and most of the water stored is readily available to plants.

All crops normally grown in the area can be grown on these soils, and good yields are obtained. The large areas that have slopes of less than 1 percent should be managed like the soils in capability unit I-1. For the other areas, the cropping system should be a flexible one that helps to control erosion and to maintain the content of organic matter. A flexible cropping system in which alfalfa is grown for 3 or 4 years and row crops not more than 3 consecutive years is more suitable than one that does not include alfalfa or other legumes. Some areas of these soils have been irrigated only a few years, but each year water for irrigation is pumped to many new areas.

Generally, these soils respond well to fertilization and to good management of the irrigation water. If erosion is to be controlled, the irrigation water should be more carefully managed than on soils that are more nearly level. In some places land leveling is necessary to spread the water uniformly. If row crops are planted across the slope, the grade of the irrigation furrows is reduced. Irrigation ditches in fields where close-growing crops are grown should be nearly on the contour. Barnyard manure, green-manure crops, and crop residue returned to the soils help to maintain fertility and the content of organic matter. Subsoiling and chiseling help to aerate the Baca soil.

CAPABILITY UNIT IIe-3 (IRRIGATED)

This capability unit consists of deep, well-drained, nearly level to gently sloping soils of the stream terraces and bottom lands. The surface layer is moderately coarse textured, and the subsoil is moderately permeable. These soils have not been silted so much as some other irrigated soils, because they have been irrigated with water pumped from wells. These soils are—

Colby fine sandy loam, 0 to 3 percent slopes.
Colby fine sandy loam, 1 to 3 percent slopes.
Ulysses sandy loam, 0 to 3 percent slopes.

These soils are well suited to irrigation. They are easy to work and remain in good tilth, even though they are worked under a wide range of moisture content. Natural fertility is medium to high, and the soils take in water at a moderately rapid rate. The water-holding capacity is high, and most of the water stored is readily available to plants.

The crops most commonly grown on these soils are alfalfa, small grains, and sorghum. The many areas that have slopes of less than 1 percent need management like that used for the soils in capability unit IIs–1. For the other soils, the cropping system should be a flexible one in which alfalfa is grown for 3 or 4 years and row crops are grown not more than 3 consecutive years. Such a cropping system is suitable for maintaining the content of organic matter and controlling erosion. A close-growing crop grown part of the time also helps to control erosion and to maintain the content of organic matter. As much of the time as feasible, keep a cover of plants on these soils to help control wind erosion.

These soils respond well to fertilization and to good management of irrigation water. Careful management of the irrigation water is necessary because the soils are sloping and moderately coarse textured. The irrigation runs should not be so long that too much water is absorbed into the soil. In some places land leveling is necessary to spread the water uniformly, but leveling should not be done during a windy period. In areas where the ground cover is not adequate for protection, chiseling, listing, or other emergency tillage is necessary. In other areas where the soil is bare, planting a cover crop will be necessary to control erosion. Barnyard manure and green-manure crops plowed under help to maintain the content of organic matter.

CAPABILITY UNIT IIw-1 (IRRIGATED)

In this capability unit are deep, nearly level soils of the uplands. These soils have a moderately fine textured surface layer and a moderately to slowly permeable subsoil. They are silted because they have been irrigated with muddy water. These soils are seeped during the season when crops are irrigated; the water table is high enough that it retards the growth of deep-rooted crops. The seepage causes slight salinity in these soils. These soils are—

Kornman clay loam, wet, 0 to 2 percent slopes.
Nepesta clay loam, wet, 0 to 1 percent slopes.
Rocky Ford clay loam, wet, 0 to 1 percent slopes.

Under good management these soils are well suited to irrigation, and all of the acreage is irrigated. The soils are moderately difficult to work and can be worked only within a rather narrow range of moisture content without compacting or becoming excessively cloddy. Natural fertility is moderately high. The water-holding capacity is high, and most of the water stored is readily available to plants.

Most crops normally grown in the area can be grown on these soils, but onions and other truck crops are grown on only a small acreage. In some areas seepage occurs and the soils are slightly saline. In those areas, yields of some crops, such as alfalfa, are reduced unless drainage is established. A cropping system in which alfalfa is grown for 3 or 4 years is satisfactory for keeping the soils in good tilth and maintaining the content of organic matter.

Good management of irrigation water is important because of the seepage and a high water table. In some places land levelling is necessary to spread the irrigation water uniformly. Timely tillage is important. In some places subsoiling is necessary to improve the penetration of water. Barnyard manure and green-manure crops improve the soil tilth and help to maintain fertility. Crop residue should be plowed under to improve tilth and to help maintain the content of organic matter. If drainage is provided or the existing drainage is maintained, these soils can easily be leached of soluble salts.

CAPABILITY UNIT IIw-2 (IRRIGATED)

Deep, nearly level, imperfectly drained soils of the bottom lands make up this capability unit. The soils have a medium-textured to moderately fine textured surface layer and a moderately to slowly permeable subsoil. They are slightly to moderately saline. In irrigated areas these soils are silted because they have been irrigated with muddy water. In most of the areas, drainage ditches have been established because these soils are naturally wet and have a high water table. The soils are—

Las loam.
Las clay loam.

Las clay loam is moderately difficult to work, but Las loam is easy to work. The soils can be worked only within a rather narrow range of moisture content but have high natural fertility. They take in water at a medium to slow rate and have high water-holding capacity. Most of the water stored is readily available to plants. Surface drainage and internal drainage are slow.

After these soils have been drained and reclaimed, all crops normally grown in the area can be grown. Sugar beets and sorghum are especially well suited (fig. 25), and onions, canteloups, and other truck crops are grown on a large acreage. A flexible cropping system in which

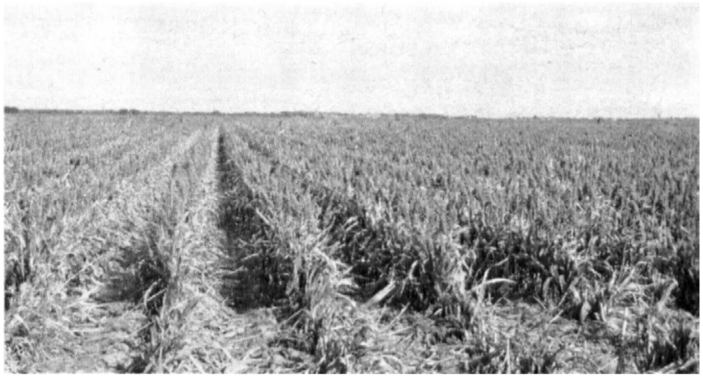

Figure 25.—**Grain sorghum in a field of Las clay loam.**

alfalfa is grown for 3 or 4 years is suitable for maintaining tilth, fertility, and the content of organic matter. Many different cropping systems may be used, however, depending on the kind of crops that are grown.

Good management of the irrigation water is important, and land leveling helps to spread the water uniformly. Providing drainage or maintaining the existing drainage is necessary to keep the water table low enough for farming. In some places there may not be enough slope for drainage outlets. After drainage has been established, these soils can be leached of salts if the water is managed carefully. Timely tillage is important because it prevents excessive cloddiness and compacting. Subsoiling is necessary in some places because it improves the penetration of water. Crop residue that is returned to the soils helps to improve tilth. Barnyard manure and green-manure crops also improve tilth and help to maintain fertility. Commercial fertilizer will increase yields if the soils have been drained and leached of salts.

CAPABILITY UNIT IIw-3 (IRRIGATED)

In this capability unit are deep, gently sloping soils that have a moderately fine textured surface layer and a moderately to slowly permeable subsoil. These soils are on the uplands. They are silted because they have been irrigated with muddy water. These soils are seeped, at least during the season when crops are irrigated, and the water table is high enough or seepage is great enough that ground water may retard the growth of deep-rooted crops. These soils have slight salinity that is associated with seepage. They are—

Numa clay loam, wet, 0 to 3 percent slopes.
Rocky Ford clay loam, wet, 1 to 3 percent slopes.

These soils are moderately difficult to work. They can be worked only within a rather narrow range of moisture content but have moderately high natural fertility. The soils take in water slowly. They have high water-holding capacity, and most of the water stored is readily available to plants.

Most crops normally grown in the area can be grown on these soils, but onions and other truck crops are grown on only a small acreage. Cropping systems that include alfalfa and small grains are most commonly used. A flexible cropping system in which alfalfa is grown for 3 or 4 years, but in which row crops are grown not more than 3 consecutive years, is suitable for these soils.

Good management of irrigation water is important, so that additional water will not accumulate in these seeped soils. In some places land leveling is necessary to spread the water uniformly. Planting row crops on the contour or across the slope is desirable so that the grade of the irrigation furrows will be reduced. Generally, field ditches for irrigating close-growing crops are nearly on the contour. Timely tillage is important because it prevents excessive cloddiness or compacting. In some places subsoiling is necessary to improve the penetration of water. Drainage should be established, or existing drainage should be maintained. Drainage outlets are easily obtained. After drainage has been established, these soils can easily be leached of salts. Barnyard manure and green-manure crops improve tilth and maintain the fertility of the soils. Commercial fertilizer increases the yields of crops.

CAPABILITY UNIT IIs-1 (IRRIGATED)

In this capability unit are deep, well-drained, nearly level soils of uplands and stream terraces. The soils have a moderately fine textured surface layer and a slowly permeable subsoil. The soils have been irrigated with muddy irrigation water, and most of the areas are silted, but the Campo soil is generally not silted, because most of the acreage is higher than the canal system. In the few areas that are lower than the canal system, the Campo soil is silted and has a surface layer of silty clay loam. The Campo soil is irrigated only where the slopes are less than 1 percent. These soils are—

Campo clay loam, 0 to 3 percent slopes.
Nepesta clay loam, 0 to 1 percent slopes.
Numa clay loam, 0 to 1 percent slopes.
Rocky Ford clay loam, 0 to 1 percent slopes.

Areas of these soils that are irrigated are well suited to irrigation. The soils are moderately difficult to work, however, because of their fine texture, and they can be worked only within a rather narrow range of moisture content. If the soils are tilled when too dry, hard clods are formed, and if tilled when too wet, the subsoil may be compacted. Natural fertility is high. The soils have high water-holding capacity, and most of the water stored is readily available to plants.

All crops normally grown in the area can be grown on these soils. A flexible cropping system in which alfalfa is grown 3 or 4 years is suitable, or the alfalfa can be grown longer if the stand remains good. Alfalfa helps to improve the aeration of these soils.

In some places on these soils, land leveling is necessary to spread the irrigation water uniformly. Timely tillage is important because it prevents excessive cloddiness or compacting. Subsoiling and chiseling improve the penetration of water and are necessary in many areas. Crop residue should be plowed under to help maintain fertility, tilth, and the content of organic matter. Barnyard manure and green-manure crops help to maintain fertility and tilth if they are plowed under.

CAPABILITY UNIT IIs-2 (IRRIGATED)

This capability unit consists of deep, sandy, well-drained, nearly level soils that developed in alluvium on bottom lands and stream terraces. The surface layer of these soils is moderately coarse textured. The subsoil or substratum has moderate or moderately rapid permeability. These soils are—

Colby fine sandy loam, 0 to 1 percent slopes.
Glendive fine sandy loam, 0 to 1 percent slopes.
Glendive fine sandy loam, wet.
Glendive and Havre fine sandy loams, 0 to 1 percent slopes.

These soils are well suited to irrigation if they are managed well and if wind erosion is controlled. They are easy to work and can be worked within a wider range of moisture content than can finer textured soils. Natural fertility is medium to low. The soils take in water at a moderately rapid rate and have moderately low to high water-holding capacity. Most of the water stored is readily available to plants. Wind erosion is a hazard when these soils are in row crops or when the ground cover is not adequate for protection.

These soils are suited to most of the crops commonly grown in the area, but sugar beets, onions, and other truck crops are grown only on a small acreage. A suitable cropping system is one in which the content of organic matter is maintained and erosion is controlled. A flexible cropping system in which alfalfa is grown 3 or 4 years can be used, but generally alfalfa is left for a longer time. Close-growing crops should be grown part of the time, and a carefully maintained cover should be kept on the soils at all times. Plowing under the stubble of close-growing crops helps to maintain the content of organic matter.

In some places land leveling is necessary to spread irrigation water uniformly on these soils, but it should not be done during windy periods. The irrigation runs should not be too long. Emergency tillage is necessary in places where the ground cover is not adequate to control soil blowing. It includes listing or chiseling that roughens the surface. Wind erosion ought to be controlled because it makes the surface uneven and makes irrigation more difficult. If the soils are not protected by a growing crop, planting a cover crop is necessary to control erosion. Barnyard manure and green-manure crops plowed under help to maintain fertility and the content of organic matter. Crop residue should be returned to the soils.

CAPABILITY UNIT IIs-3 (IRRIGATED)

In this capability unit are deep, nearly level, well-drained soils that have a sandy subsoil. The soils developed in alluvium on bottom lands and stream terraces. Their surface layer is moderately fine textured, and their subsoil has moderately rapid permeability. In the areas where they are irrigated, these soils are silted. They are—

Havre loam.
Kornman clay loam, 0 to 1 percent slopes.

These soils are well suited to irrigation, and in most areas they are irrigated. They are easy to moderately difficult to work and have medium natural fertility. The soils take in water at a medium or moderately slow rate. The water-holding capacity is medium, and most of the water stored is readily available to plants.

All crops grown in the area grow well on these soils. The Kornman soil is less well suited to alfalfa than the Havre loam, however, because it has a somewhat droughty subsoil and substratum.

These soils respond well to fertilization and to good management of irrigation water. They need more frequent irrigation than soils that have a less sandy subsoil. In some places land leveling is necessary to spread water uniformly. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure and green-manure crops plowed under help to maintain the content of organic matter and to improve tilth. Crop residue should be plowed under.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

This capability unit consists of deep, well-drained, moderately sloping soils of the uplands. These soils have a medium-textured surface layer and a moderately to slowly permeable subsoil. Unlike many other irrigated soils in Prowers County, they are not silted, because they are at elevations higher than the canal system and have been irrigated with water pumped to them from wells. These soils are—

Baca clay loam, 3 to 5 percent slopes.
Colby silt loam, 3 to 5 percent slopes.
Wiley silt loam, 3 to 5 percent slopes.

If they are managed well and water erosion is controlled, the areas of these soils that are irrigated are fairly well suited to irrigation. The soils are easy to work, have high natural fertility, and take in water at a medium rate. The water-holding capacity is high, and most of the water stored is readily available to plants.

The crops most commonly grown on these soils are sorghum, small grains, and alfalfa. Many different cropping systems may be used, but a cropping system should be chosen that controls erosion, improves tilth, and maintains the content of organic matter. A suitable cropping system is one in which row crops are grown no more than 3 consecutive years and close-growing crops are grown at least 1 year in 4. This kind of cropping system helps to control erosion.

These soils respond well to fertilization and to good management of irrigation water. Good management of irrigation water is especially important so that erosion will be controlled and excessive losses of water will be prevented. In some areas land leveling is necessary to spread the irrigation water uniformly. Planting row crops on the contour will reduce the grade of the irrigation furrows. Field ditches for irrigating close-growing crops should be nearly on the contour. Barnyard manure, crop residue, and green-manure crops help to maintain the content of organic matter and fertility.

CAPABILITY UNIT IIIe-2 (IRRIGATED)

In this capability unit are deep, moderately sloping soils that have a moderately fine textured surface layer and a moderately permeable subsoil. These soils are on the uplands. They are silted because they have been irrigated with muddy water. Generally, they are well drained, but in some areas they are seeped and saline. Some areas are underlain by sand and gravel, and other small areas have limestone deep in the substratum. These soils are—

Numa clay loam, 3 to 5 percent slopes.
Rocky Ford clay loam, 3 to 5 percent slopes.

If these soils are well managed, they are well suited to irrigation. All of the acreage is irrigated. The soils are easy to moderately difficult to work and have medium to high natural fertility. The water-holding capacity is medium to high, and most of the water stored is readily available to plants.

Most crops grown in the area can be grown on these soils. Sugar beets and truck crops, however, are suited only to the less sloping areas and are grown only on a small acreage. The crops most commonly grown are alfalfa, sorghum, and small grains. Generally, a cropping system should be used in which row crops are grown 3 years or less and close-growing crops are grown at least 1 year in 4. A cropping system that is even better for controlling erosion and maintaining the content of organic matter is one in which alfalfa is grown for 3 or 4 years and row crops no more than 2 years.

Good management of the irrigation water is important for the control of runoff and erosion. Because of the moderate slopes and slowly permeable surface layer, irrigation is more difficult than on less sloping, more rapidly permeable soils. In some places land leveling is necessary to spread the water uniformly. Planting row crops across the slope or on the contour will reduce the grade of the irrigation furrows. Field ditches for irrigating close-growing crops should be nearly on the contour. Chiseling and subsoiling help to improve the penetration of water. Barnyard manure, green-manure crops, and stubble or other crop residue that is returned to the soils help to maintain the content of organic matter and good tilth.

CAPABILITY UNIT IIIe-3 (IRRIGATED)

This capability unit consists of well-drained, gently sloping soils of the stream terraces. The soils have a moderately fine textured surface layer and a moderately coarse textured subsoil or a sandy substratum. Their subsoil has moderate or moderately rapid permeability. These soils are silted because they have been irrigated with muddy water. They are moderately shallow over sand and gravel. These soils are—

Kornman clay loam, 1 to 3 percent slopes.
Rocky Ford clay loam, sand substratum, 1 to 3 percent slopes.

These soils are well suited to irrigation, and all of the acreage is irrigated. The soils are easy to moderately difficult to work and have medium or moderately high natural fertility. They take in water at a medium to slow rate. The water-holding capacity is medium, and most of the water stored is readily available to plants. Surface drainage is medium, and internal drainage is rapid.

These soils are suited to most of the crops grown in the area. The crops most frequently grown are alfalfa, small grains, sorghum, and sugar beets. If the alfalfa is to make as high yields as that grown on deeper soils, however, it must be irrigated more frequently than is necessary on the deeper soils. The cropping system generally used varies from place to place, but it should be flexible and include crops that control soil erosion and that maintain good tilth and the content of organic matter. The cropping system may include 3 or 4 years of alfalfa, but not more than 3 years of row crops.

Irrigation water on these soils should be managed well so that erosion will be controlled and excessive losses of water will be prevented. If irrigation is light and frequent, water is used most efficiently and the rapid growth of plants is maintained. In some areas land leveling is necessary to spread water uniformly, but deep cuts should not be made until the depth of the soils is determined. If row crops are planted across the slope or on the contour, the grade of the irrigation furrows is reduced. Field ditches for irrigating close-growing crops should be nearly on the contour. In some places chiseling is necessary to improve the penetration of water.

CAPABILITY UNIT IIIe-4 (IRRIGATED)

In this capability unit are deep, nearly level or gently sloping soils of uplands and stream terraces. The surface layer of these soils is moderately coarse textured, and the subsoil is rapidly permeable. These soils are droughty because they are somewhat excessively drained. In some areas they are underlain by sand and gravel at a depth below 3 feet. These soils are—

Glendive fine sandy loam (0 to 3 percent slopes).
Glendive fine sandy loam, 1 to 3 percent slopes.
Glendive and Havre fine sandy loams (0 to 3 percent slopes).
Glendive and Havre fine sandy loams, 1 to 3 percent slopes.
Vona sandy loam, 1 to 3 percent slopes.

Under good management the soils of this unit are fairly well suited to irrigation, and part of the acreage is irrigated. The soils are easy to work and remain in good tilth, even though they are worked under a wide range of moisture content. Natural fertility is low. The soils take in water at a moderately rapid rate and have low to medium water-holding capacity. Most of the water stored is readily available to plants. If the ground cover is not adequate for protection, these soils are subject to severe wind erosion.

If these soils are well managed, they are fairly well suited to sorghum and small grains. Alfalfa makes lower yields, however, than on finer textured soils. Only a small acreage of sugar beets and truck crops is grown on these sandy soils. The cropping system used should be one that controls wind erosion and water erosion and that helps to maintain the content of organic matter. A cropping system in which alfalfa is grown 3 or 4 years and row crops are grown not more than 3 consecutive years is more suitable for controlling erosion and maintaining the content of organic matter than one in which row crops are grown year after year. The best cover feasible should be kept on these soils for protection against erosion. Where these soils are bare, it may be necessary to plant a cover crop.

These sandy soils may be improved by irrigating with silty water. Good management of the water is important because it helps to prevent excessive losses of water. In some places land leveling is necessary to spread the water uniformly, but it should not be done in windy periods. The irrigation runs should be short. Planting row crops across the slope or on the contour will reduce the grade of the irrigation furrow. Ditches in irrigated fields where close-growing crops are grown should be nearly on the contour.

Barnyard manure and green-manure crops help to maintain the content of organic matter. All stubble and crop residue should be returned to the soils.

CAPABILITY UNIT IIIw-1 (IRRIGATED)

This capability unit consists of deep, imperfectly drained, nearly level soils of the bottom lands and low stream terraces. The surface layer of these soils is medium textured or moderately fine textured. The subsoil is moderately to slowly permeable, and the clayey substratum is very slowly permeable. In irrigated areas these soils are silted because they have been irrigated with muddy water. They have a high water table and are normally wet unless they have been drained. In most of the areas, however, drainage ditches have been established. These soils are—

Las clay loam, clay substratum.
Las loam, clay substratum.

Under good management these soils are well suited to irrigation, and part of the acreage is irrigated. The soils are easy to moderately difficult to work. They have high natural fertility but can be worked only within a rather narrow range of moisture content. The soils take in water at a medium to slow rate and have high water-holding capacity. Most of the water stored is readily available to plants. Surface drainage is slow, and internal drainage is very slow. These soils are slightly to moderately saline because of the imperfect drainage.

After drainage is established, these soils are suited to all of the crops grown in the area. They are especially well suited to sugar beets and sorghum, and truck crops are grown on a large acreage. A cropping system that will help to keep the soils in good tilth is one in which row crops are grown not more than 3 consecutive years and close-growing crops are grown at least 1 year in 4. A flexible cropping system in which alfalfa is grown for 3 or 4 years helps to improve the aeration of the soils.

Good management of irrigation water is important because of the high water table. Drainage must be provided, or the present drainage maintained, if the water table is to be kept low enough that the soil will be suitable for farming. Drainage is more difficult, however, than for soils that do not have a clayey substratum. Drainage outlets are difficult to establish in some flat areas. After drainage has been provided, the salts can be leached from these soils, but this too is more difficult than in less clayey soils.

Land leveling helps to spread the water uniformly. Timely tillage is important because it prevents the soils from becoming excessively cloddy and compacted. In some places subsoiling is necessary to improve the penetration of water. Barnyard manure and green-manure crops help to maintain the content of organic matter and to improve tilth. Crop residue plowed under also improves tilth. After the soils have been drained and reclaimed, high yields of crops are obtained if commercial fertilizer is added.

CAPABILITY UNIT IIIw-2 (IRRIGATED)

The only soil in this capability unit is Las clay loam, sand substratum. This is a moderately shallow, imperfectly drained, nearly level soil of the bottom lands. The surface is medium textured or moderately fine textured, and the subsoil is moderately to slowly permeable. In areas under irrigation, this soil is silted because it has been irrigated with muddy water. It has a high water table and is naturally wet if it has not been drained. In most of the areas under irrigation, drainage ditches have been established.

Where drainage is adequate, this soil is well suited to irrigation. It is easy to moderately difficult to work. Natural fertility is high. This soil can be worked only within a rather narrow range of moisture content. It takes in water at a medium to slow rate and has medium water-holding capacity. Most of the water stored is readily available to plants. Surface drainage and internal drainage are slow. This soil is slightly to moderately saline because of its imperfect drainage.

After drainage is established, this soil is suited to most of the crops grown in the area. Yields of alfalfa are lower, however, than on deeper soils. Sugar beets, sorghum, and truck crops do well and are grown on a large acreage. The cropping system used should be one that helps to maintain fertility and good tilth. Shallow-rooted legumes, such as sweetclover, may be grown, or alfalfa may be included in the cropping system if the areas can be irrigated frequently.

Good management of irrigation water is important because it prevents losses of water by deep penetration. The irrigation runs should be fairly short. In some areas land leveling is necessary to spread the water uniformly, but deep cuts should not be made until the depth of the soil is determined. Water penetrates the soil better if chiseling or subsoiling is done. Drainage should be established or the existing drainage maintained. Where drainage outlets can be established, this soil is easily drained because of the rapid permeability of its substratum. After drainage has been provided, the salts can easily be leached out. Timely tillage is important because it prevents excessive cloddiness and compacting. Barnyard manure, crop residue, and green-manure crops plowed under improve tilth and help to maintain the content of organic matter.

CAPABILITY UNIT IIIw-3 (IRRIGATED)

This capability unit consists of deep, nearly level, saline soils of the uplands. The surface layer is moderately fine textured, and the subsoil is moderately permeable to slowly permeable. The soils are silted because they have been irrigated with muddy water. Because these soils are seeped or have a high water table, the growth of crops may be severely retarded. The soils are moderately to severely saline as a result of the seepage. They are—

Nepesta clay loam, saline, 0 to 1 percent slopes.
Rocky Ford clay loam, saline, 0 to 1 percent slopes.

These soils are moderately difficult to work and have moderately high natural fertility. They take in water slowly. The water-holding capacity is high, but because the soils are saline, the water stored is not readily available to plants.

Crops do not do well unless these soils are drained and reclaimed. The soils are often too wet to work. After drainage has been established, a flexible cropping system that includes alfalfa for 3 or 4 years helps to improve aeration and tilth and to maintain the content of organic matter.

Drainage should be provided or the existing drainage maintained, and drainage outlets are easy to obtain. In areas where drainage has been established, these soils can be leached of salts, although leaching is slow. The management of irrigation water is especially important, so that seepage and salinity will not get worse or recur after the soils have been drained and leached of salts. Water penetrates some areas better if subsoiling is done. In areas that have been drained, land leveling will help to spread the irrigation water uniformly. Also, barnyard manure, all crop residue, and green-manure crops should be plowed under.

CAPABILITY UNIT IIIw-4 (IRRIGATED)

In this capability unit are deep, gently sloping, saline soils of the uplands. These soils have a moderately fine textured surface layer and a moderately permeable to slowly permeable subsoil. Their management is similar to that of the soils in capability unit IIe–1 after they are drained and leached of salts. These soils are silted because they have been irrigated with muddy water. Because the soils have a high water table in some areas and seepage has occurred in other areas, the growth of crops may be severely retarded because of the excessive moisture. These soils are moderately to severely saline as the result of seepage. These soils are—

Nepesta clay loam, saline, 1 to 3 percent slopes.
Numa clay loam, saline, 0 to 3 percent slopes.
Rocky Ford clay loam, saline, 1 to 3 percent slopes.

These soils are moderately difficult to work. Natural fertility is moderately high.

These soils are irrigated, but they are not well suited to crops unless they are drained. Many times they are too wet for tillage. After drainage has been established, a suitable cropping system is a flexible one in which alfalfa is grown for 3 or 4 years and row crops not more than 3 years. This kind of cropping system helps to improve the aeration and tilth of the soils and to maintain the content of organic matter.

If crops are to be grown, drainage and reclamation of these soils are necessary. Drainage should be established or existing drainage maintained. Drainage outlets are easy to establish. The salts should be leached out, but they leach out slowly from these soils. Good management of irrigation water is important. After drainage has been established, land leveling may be needed to spread the water uniformly. Planting row crops on the contour or across the slope will reduce the grade of the irrigation furrows. Generally, ditches for irrigating close-growing crops are nearly on the contour. In some places subsoiling is necessary to improve the penetration of water. After drainage is established, barnyard manure and green-manure crops can be plowed under to improve the soils. All crop residue should be returned to the soils.

CAPABILITY UNIT IIIs-1 (IRRIGATED)

This capability unit consists of deep, well-drained, nearly level soils that developed in alluvium on stream terraces and bottom lands. These soils have a surface layer that is medium textured or moderately fine textured and a subsoil that has moderate to moderately rapid permeability. Their substratum is clay. In areas that are irrigated, these soils are silted. These soils are—

Colby silt loam, clay substratum, 0 to 1 percent slopes.
Kornman clay loam, clay substratum, 0 to 1 percent slopes.
Rocky Ford clay loam, clay substratum, 0 to 1 percent slopes.

These soils are well suited to irrigation if they are managed well. Most of the acreage is irrigated, but some areas of the Colby soil are in range. The soils are easy to moderately difficult to work and have medium to moderately high natural fertility. They can be worked only within a rather narrow range of moisture content. If the Kornman and Rocky Ford soils are plowed when too dry, they are extremely cloddy. The soils take in water at a medium to slow rate. The water-holding capacity is high, and most of the water stored is readily available to plants. Surface drainage is medium and internal drainage is very slow.

These soils are suited to all of the crops grown in the area. Close-growing crops should be grown at least 1 year in 4, however, and row crops should be grown not more than 3 consecutive years. A suitable cropping system is a flexible one in which alfalfa is grown for 3 or 4 years. Such a cropping system helps to maintain tilth, fertility, and content of organic matter, and it helps to keep the soils well aerated.

Good management of irrigation water is important because of the clayey substratum. Overirrigation should be avoided because it may cause seepage and salinity. Land leveling helps to spread the irrigation water uniformly. Excessive cloddiness or compacting can be prevented by timely tillage. Chiseling and subsoiling help to improve the penetration of water. Barnyard manure, green-manure crops, and crop residue improve tilth and maintain the content of organic matter.

CAPABILITY UNIT IIIs-2 (IRRIGATED)

In this capability unit are well-drained, nearly level soils that developed in alluvium on stream terraces and bottom lands. These soils have a medium-textured to moderately fine textured surface layer and a moderately permeable subsoil. They are moderately shallow over a substratum of sand that lies at a depth between 20 and 36 inches. They tend to be droughty. These soils are—

Colby silt loam, sand substratum, 0 to 1 percent slopes.
Rocky Ford clay loam, sand substratum, 0 to 1 percent slopes.

These soils are easy to moderately difficult to work and have medium to moderately high natural fertility. They can be worked only within a rather narrow range of moisture content. The Rocky Ford soil especially must be tilled at the proper moisture content so that it will not become excessively cloddy or compacted. These soils take in water at a medium to slow rate. The water-holding capacity is low to medium, but most of the water stored is readily available to plants.

These soils are suited to most of the crops grown in the area. Alfalfa needs to be irrigated more frequently, however, than on deeper soils, and it does not grow so well. Many different cropping systems are used, but the cropping system chosen should maintain tilth, fertility, and the content of organic matter. A cropping system in which alfalfa is grown for 3 or 4 years may be used, but generally, the yields of alfalfa are much lower than those on deeper soils. Sweetclover and other shallow-rooted legumes grow well and make good yields on these soils.

The water is used most efficiently on these soils and plants make the best growth if irrigation is light and frequent. Water is lost by deep penetration if the irri-

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gation runs are too long. Land leveling helps to spread the irrigation water uniformly, but deep cuts should not be made until the depth of the soils is determined. In most areas chiseling is not needed, but in some places it is necessary. Barnyard manure and green-manure crops improve tilth and help to maintain the content of organic matter. If these soils are well managed, yields of crops are increased if commercial fertilizer is added.

CAPABILITY UNIT IIIs-3 (IRRIGATED)

This capability unit consists of deep, imperfectly drained to well-drained, nearly level, sandy soils that developed in alluvium on stream terraces and bottom lands. These soils have a surface layer that is moderately coarse textured or coarse textured. Their subsoil has slow to moderately rapid permeability, and their substratum is clayey. These soils have a water table deep in the profile. They are—

Glendive fine sandy loam, clay substratum.
Las sandy loam.

These soils are used partly for irrigated crops and partly for native pasture. They are fairly well suited to irrigation if they are managed well. The soils are easy to work and can be worked within a wide range of moisture content. Natural fertility is low to medium. The soils take in water at a moderately rapid or rapid rate and have medium to high water-holding capacity. Most of the water stored is readily available to plants. Surface drainage is slow, and internal drainage is slow or very slow. Wind erosion is a hazard when the soils are not protected.

All of the irrigated acreage of these soils is in row crops. Most of the crops grown in the area are suitable, but sugar beets and truck crops are not grown extensively. The best cover possible should be kept on these soils at all times. In periods when a growing crop or crop residue does not provide protection, a cover crop should be planted. Many different cropping systems are used, but the cropping system chosen should be one that controls erosion. A cropping system in which alfalfa is grown for 3 or 4 years is suitable, for it helps to maintain tilth and fertility and protects the soils from wind erosion.

Good management of the irrigation water is necessary so that these soils will not be overirrigated. Because the intake of water is moderately rapid, the irrigation runs should not be long. Keeping the runs short protects against overirrigating the soils at the beginning of the run and also conserves water. Land leveling is desirable to get a more uniform distribution of water, but it should not be done during a windy period. Barnyard manure and green-manure crops help to maintain the content of organic matter.

CAPABILITY UNIT IIIs-4 (IRRIGATED)

In this capability unit are moderately shallow, sandy soils that developed in alluvium on stream terraces and bottom lands. The surface layer of these soils is coarse textured, and the subsoil is rapidly permeable. These soils have a sandy substratum. Most of the areas are nearly level, but the small areas that are higher than the canal system are gently sloping. These soils are somewhat excessively drained and droughty. They are—

Glendive and Havre soils, sand substrata (0 to 3 percent slopes).
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes.

These soils are fairly well suited to irrigation if they are well managed. Part of their acreage is irrigated. The soils are easy to work and can be tilled within a wide range of moisture content, but they have low natural fertility. They take in water at a moderately rapid rate. The water-holding capacity is low, but most of the water that is stored is readily available to plants. Surface drainage is slow. If the ground cover is not adequate for protection, these soils are subject to severe wind erosion.

When these soils are managed well, they are fairly well suited to sorghum and small grains. Only a small acreage of sugar beets and truck crops is grown. Some alfalfa is grown, but yields are lower than on deeper and finer textured soils. Sweetclover and other shallow-rooted legumes grow well. The best cover feasible should be maintained on these soils to control wind erosion. If the ground cover is not adequate, a cover crop should be planted to control wind erosion.

The soils of this unit can be improved by using silty water for irrigation. Good management of the irrigation water is important so that losses of water will be prevented. The irrigation runs ought to be short, and light, frequent irrigations will make the most efficient use of the water. Land leveling may be necessary in some places so that water can be spread uniformly, but it should not be done during a windy period. Also, land leveling should not be done until the depth of the soils is determined. Barnyard manure and green-manure crops help to maintain the content of organic matter. Crop residue returned to the soils will help maintain fertility and the content of organic matter.

CAPABILITY UNIT IVe-1 (IRRIGATED)

The only soil in this capability unit is Rocky Ford clay loam, over limestone, 3 to 5 percent slopes. This soil is on uplands and is moderately shallow over limestone or shale. The surface layer is medium textured or moderately fine textured, and the subsoil is moderately permeable to slowly permeable. Limestone or shale is within 3 feet of the surface. This soil is silted because it has been irrigated with muddy water. In most places it has not been silted to so great a depth, however, as the less sloping soils, and its surface layer is not so fine textured.

This soil is only fairly well suited to irrigation. It is easy to moderately difficult to work and has low natural fertility. The soil can be tilled within a wider range of moisture content than the less sloping soils, but it should not be tilled when too dry or too wet, for excessive cloddiness or compacting will result. The water-holding capacity is low to medium, but most of the water stored is readily available to plants.

This soil is fairly well suited to small grains and other close-growing crops, but sugar beets and truck crops are not grown. Sorghum does fairly well under good management, but the yields of alfalfa are limited by the bedrock near the surface. A cropping system should be used in which sweetclover or other close-growing crops are grown at least half the time. Row crops should be grown no more than 2 years in succession.

Good management of the irrigation water is important on this soil, for applying too much water causes erosion, makes the soil excessively wet, and causes seepage and salinity in adjacent soils. The water should be applied more frequently and in lighter applications than on deeper soils. Row crops can be planted nearly on the contour or across the slope, so that the grade of the irrigation furrows will be reduced. Generally the field ditches used for irrigating close-growing crops are nearly on the contour. In some places land leveling may be necessary to spread the irrigation water uniformly, but deep cuts should be avoided. Barnyard manure and crops grown as green manure improve tilth and help to maintain fertility. The use of crop residue helps to maintain the content of organic matter.

CAPABILITY UNIT IVe-2 (IRRIGATED)

In this capability unit, the only soil is Rocky Ford clay loam, sand substratum, 3 to 5 percent slopes. This soil is moderately sloping and is on the uplands. The surface layer is medium textured or moderately fine textured, and the subsoil is moderately permeable. The soil is moderately shallow over a sandy or gravelly substratum, and it is silted because it has been irrigated with muddy water.

If this soil is managed well, it is fairly well suited to irrigation. It is easy to moderately difficult to work and has medium to moderately high natural fertility. The water-holding capacity is medium, and most of the water stored is readily available to plants.

This soil is fairly well suited to small grains and other shallow-rooted crops, but sugar beets and truck crops are not grown, because of the strong slopes. The yields of alfalfa are generally not good, but if alfalfa is irrigated frequently, it grows well and may be included in the cropping system. Sweetclover or other close-growing crops should be grown at least one-fourth of the time in the cropping system, and row crops should not be grown longer than 3 years in succession.

Good management of the irrigation water is important on this soil, for applying too much water causes erosion and losses of water through deep penetration. The water should be applied more frequently than on deeper soils. In some places land leveling is needed to spread the water uniformly, but deep cuts should not be made until the depth of the soil is determined. Planting row crops nearly on the contour or across the slope reduces the grade of the irrigation furrows. Field ditches used for irrigating close-growing crops should be nearly on the contour. Barnyard manure and crops grown as green manure improve tilth and help to maintain fertility and the content of organic matter.

CAPABILITY UNIT IVw-1 (IRRIGATED)

This capability unit consists of moderately deep to deep, imperfectly drained or poorly drained, nearly level soils of the bottom lands. The surface layer of these soils is moderately fine textured, and the subsoil is very slowly permeable. If these soils are not drained, their use is limited by the high water table. Under irrigation these soils are moderately to severely saline and are silted because they have been irrigated with muddy water. They are—

Las clay loam, saline.
Las clay loam, sand substratum, saline.

In areas where drainage has been provided, these soils are fairly well suited to irrigation. They are difficult to work, however, and can be worked only within a narrow range of moisture content without becoming excessively cloddy or compacted. Natural fertility is medium to high. The soils take in water slowly but have high water-holding capacity. However, much of the water stored is not readily available to plants, because the soils are saline. Surface drainage is slow, and internal drainage is very slow.

In areas where drainage is adequate, these soils are suited to most of the crops grown in the area. Sugar beets, sorghum, and truck crops are grown on a large acreage, and fairly good yields are obtained under good management. The yields of some crops, especially of alfalfa and corn, are lower than those on soils that are medium textured and better drained. A cropping system in which alfalfa is grown for 3 or 4 years, however, helps to maintain good tilth and to provide aeration. Close-growing crops should be grown at least 3 years out of 4 in the cropping system, and row crops no longer than 1 year. This kind of cropping system best maintains the tilth and content of organic matter in these soils.

Drainage of these soils should be established and maintained, but in many places establishing enough grade for drainage outlets is difficult. As much of the salts as is feasible to leach out should be leached from these soils. The soils are difficult to drain and to leach of salts, however, because they are nearly level and very slowly permeable. The Las soil that has a sand substratum is easier to drain than the other soil. These soils respond well to fertilization and to good management of water. Extreme care is needed in irrigating, to prevent seepage and to keep the soils from becoming more saline. Land leveling helps to spread the water uniformly. Chiseling and subsoiling help to improve the penetration of water.

CAPABILITY UNIT IVs-1 (IRRIGATED)

In this capability unit are excessively drained, nearly level, droughty soils in alluvium on bottom lands. The surface layer is medium textured, and the subsoil is very rapidly permeable. The soils are underlain by sandy or gravelly material. They are—

Kornman clay loam, sand substratum, 0 to 1 percent slopes.
Lincoln loam.

Because they are droughty, these soils are only fairly well suited to irrigation. They are easy to work and can be worked within a fairly wide range of moisture content, but they have very low natural fertility. They take in water at a medium rate. The water-holding capacity is very low, but most of the water stored is readily available to plants. Surface drainage is slow, and internal drainage is very rapid.

If the irrigation water is well managed, these soils are fairly well suited to shallow-rooted crops and sorghum and small grains make fair yields. Alfalfa does not do well, but sweetclover may be included in the cropping system. Sugar beets and truck crops are grown on only a small acreage. Close-growing crops should be grown in the cropping system at least half of the time, but row crops should be grown not more than 2 consecutive years.

Good management of the irrigation water is important because it prevents losses of water through deep penetration. It is necessary to irrigate these soils frequently, and the irrigation runs ought to be short. Land leveling helps to spread the water uniformly, but deep cuts should not be made until the depth of the soil is determined. It is best done in a season that is not windy. Using muddy water for irrigation improves these soils because it deposits fine-textured material. Barnyard manure and green-manure crops help to maintain the content of organic matter. All crop residue should be returned to the soil.

CAPABILITY UNIT IVs-2 (IRRIGATED)

The only soil in this capability unit is Rocky Ford clay loam, over limestone, 1 to 3 percent slopes. This soil is moderately shallow over limestone. It is gently sloping and developed on uplands in material weathered from limestone and shale. The surface layer is moderately fine textured and is silted because it has been irrigated with muddy water. The subsoil is moderately permeable. Depth to limestone ranges from 20 to 36 inches.

Because it is shallow over bedrock, this soil is only fairly well suited to irrigation. It is easy to moderately difficult to work, but it is important to till when this soil contains the right amount of moisture, so that excessive cloddiness or compacting will be prevented. Natural fertility is low. The soil takes in water at a medium to slow rate. The water-holding capacity is low to medium, but most of the water stored is readily available to plants.

This soil is fairly well suited to shallow-rooted crops. Yields of small grains and sorghum are fairly good, but yields of alfalfa are low. Close-growing crops should be grown at least half the time in the cropping system, and row crops not more than 2 years in succession.

Good management of the irrigation water helps to control erosion and to prevent losses of water through runoff. It also prevents the soil from becoming wet and saline. Irrigation should be lighter and more frequent on these soils than on deeper soils. In some places leveling the areas slightly is necessary to spread water more uniformly, but deep cuts should be avoided. Planting row crops nearly on the contour will reduce the grade of the irrigation furrows. Field ditches for irrigating close-growing crops are nearly on the contour. Barnyard manure, crop residue, and green-manure crops plowed under help to maintain the content of organic matter and to improve tilth.

Yield predictions for the principal irrigated crops

Table 3 gives the predicted average yields per acre for the main crops grown on the arable soils under irrigation in this county. The main crops are alfalfa, wheat, grain sorghum, corn, barley, sugar beets, corn or sorghum silage, and onions, but other crops are grown less extensively.

The yields given are for two levels of management. Those in columns A were obtained under the level of management used by most of the farmers in the county. Those shown in columns B were obtained under a high level of management. The yields on some farms may be even higher than those shown in columns B if a high level of management is used.

As in the predictions for dry-farmed crops, the yield predictions for irrigated crops are based on records of the Agricultural Research Service and the Farmers Home Administration; on statistics of the Colorado Crop and Livestock Reporting Service; on observations of the field party made during the survey; on discussions with farmers, with agricultural specialists from various government agencies, and with members of the staff of the Colorado State University; and on records of yields kept by a sugar company in the area.

Under the prevailing management (columns A), only a limited amount of commercial fertilizer and barnyard manure is added, except that phosphate is normally applied to sugar beets. Legumes are rarely plowed under as a green-manure crop. In sloping areas row crops are not planted on the contour, but parallel to field boundaries. In many fields the irrigation runs are too long and the irrigation system needs to be improved.

Under the high level of management for which yields are shown in columns B, the following practices are used:

1. The supply of plant nutrients and the content of organic matter are maintained by adding barnyard manure, plowing under green-manure crops, and applying commercial fertilizer after the need has been determined by soil analysis.
2. Irrigation water is managed better than under the prevailing management.
3. Crops, including legumes, are grown in a rotation that best fits the climate and soils.
4. Weeds and insects are controlled.
5. Erosion is controlled by using the best practices for the particular soil.

Many factors besides management affect crop yields, and an accurate prediction of yields is difficult to make. Therefore, the yield predictions given in table 3 should be used only as a guide in planning farming operations. Among the other factors that influence yields of irrigated crops are the amount and timeliness of rainfall, the amount and severity of windstorms and hailstorms, the amount of moisture in the soils at planting time, and the variety of seed planted. Crop yields in irrigated areas are less erratic than those in dry-farmed areas, because instead of rainfall the source of water is mainly the fairly stable streamflow stored in reservoirs.

Use and Management of Range[3]

About 40 percent of the total land area in Prowers County is range. On this range the potential plant community consists of native grasses, forbs, and shrubs that are valuable for forage. The range plants grow in large enough amounts so that they can be used for grazing.

The native vegetation in this county consists mainly of short prairie grasses, but mid grasses grow on the fine-textured saline and wet saline soils, and tall grasses grow on the sandy soils. Blue grama, buffalograss, alkali sacaton, galleta, saltgrass, sand dropseed, and three-awn

[3] By E. C. DENNIS, range conservationist, Soil Conservation Service, Lamar, Colo.

TABLE 3.—*Predicted average crop yields per acre of irrigated crops under two levels of management*

[Absence of a yield figure indicates that the crop specified is not normally grown on the soil]

Soil	Alfalfa		Wheat		Grain sorghum		Corn		Barley		Sugar beets		Corn or sorghum silage		Onions	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*50 lb. bags*	*50 lb. bags*
Baca clay loam, 0 to 3 percent slopes	3	4.5	45	65	50	75	55	80	45	65	----	----	14	20	----	----
Baca clay loam, 3 to 5 percent slopes	2.5	3	35	45	40	55	45	60	35	45	----	----	10	15	----	----
Campo clay loam, 0 to 3 percent slopes	3	4.5	40	55	50	70	50	70	40	55	13	16	15	22	350	525
Colby fine sandy loam, 0 to 1 percent slopes	3	4	40	50	45	60	45	65	35	50	13	15	12	18	350	450
Colby fine sandy loam, 0 to 3 percent slopes	2.5	3.5	35	45	40	55	40	60	35	45	11	13	12	18	300	400
Colby fine sandy loam, 1 to 3 percent slopes	2.5	3.5	40	50	45	60	40	60	35	50	11	13	12	18	300	400
Colby silt loam, 0 to 1 percent slopes	3.5	5	45	60	55	75	55	80	40	60	15	18	15	22	400	600
Colby silt loam, 0 to 3 percent slopes	3.5	4.5	40	60	50	75	50	75	40	60	14	17	14	20	----	----
Colby silt loam, 1 to 3 percent slopes	3	5	40	60	50	75	55	80	40	60	13	16	15	22	400	600
Colby silt loam, 3 to 5 percent slopes	2.5	3	30	40	40	50	40	55	30	40	----	----	10	15	----	----
Colby silt loam, clay substratum, 0 to 1 percent slopes	3	4	40	50	45	60	45	65	35	50	13	16	12	18	400	600
Colby silt loam, sand substratum, 0 to 1 percent slopes	2	2.5	35	45	40	50	40	55	35	45	10	13	10	15	350	450
Glendive fine sandy loam	1.5	2.5	20	30	35	50	30	50	20	30	10	12	10	14	250	350
Glendive fine sandy loam, 0 to 1 percent slopes	2	3	20	30	35	50	30	50	20	30	10	12	10	14	250	350
Glendive fine sandy loam, 1 to 3 percent slopes	1.5	2.5	20	30	35	50	30	50	20	30	10	12	10	14	250	350
Glendive fine sandy loam, clay substratum	2	3	25	35	30	50	30	50	25	35	10	12	10	15	250	350
Glendive fine sandy loam, wet	3	4	25	35	35	55	35	55	25	35	10	12	10	15	250	350
Glendive and Havre fine sandy loams, 0 to 1 percent slopes	2.5	3.5	35	45	40	55	40	55	30	40	10	12	12	16	250	350
Glendive and Havre fine sandy loams, 1 to 3 percent slopes	2	3	30	40	45	50	40	55	25	35	10	12	10	14	250	350
Glendive and Havre fine sandy loams	2	3	30	40	45	50	40	55	25	35	10	12	10	14	250	350
Glendive and Havre soils, sand substrata	1.5	2	15	20	25	35	25	35	15	20	7	9	8	10	----	----
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes	1.5	2	15	20	25	35	25	35	15	20	7	9	8	10	----	----
Goshen silt loam	3.5	5	45	60	55	75	55	80	40	60	15	18	15	22	----	----
Harvey loam, 0 to 3 percent slopes	3.5	4.5	35	55	45	65	45	65	35	55	12	15	12	18	----	----
Harvey loam, 0 to 1 percent slopes	3.5	5	45	60	55	75	55	75	40	60	14	17	14	20	----	----
Harvey loam, 1 to 3 percent slopes	3.5	4.5	35	55	45	60	45	65	35	55	12	15	12	18	----	----
Havre loam	2.5	3.5	25	30	40	55	40	55	25	30	11	14	11	15	300	400
Kornman clay loam, 0 to 1 percent slopes	2.5	3.5	30	40	40	65	40	65	30	40	11	14	12	18	350	500
Kornman clay loam, 1 to 3 percent slopes	2	3	25	35	35	55	35	55	25	35	9	11	10	15	300	450
Kornman clay loam, clay substratum, 0 to 1 percent slopes	2	3	30	40	35	55	35	55	30	40	11	14	12	18	350	500
Kornman clay loam, sand substratum, 0 to 1 percent slopes	2	2.5	20	25	30	45	30	45	20	25	9	12	10	15	350	500
Kornman clay loam, wet, 0 to 2 percent slopes	3	4	30	40	40	60	40	60	30	40	13	16	12	18	300	450
Las loam	2.5	4.5	30	40	45	65	40	60	35	50	15	18	14	20	350	500
Las loam, clay substratum	2	3.5	30	40	45	65	35	55	35	50	15	18	12	18	350	500
Las clay loam	2.5	4.5	30	40	45	65	40	60	35	50	15	18	14	20	350	500
Las clay loam, clay substratum	2	3.5	30	40	45	60	35	55	35	50	13	16	12	18	350	500
Las clay loam, saline	2	3	25	35	35	55	30	50	30	40	10	14	8	12	350	425
Las clay loam, sand substratum	2	2.5	25	35	35	50	30	55	30	45	12	15	12	16	300	400
Las clay loam, sand substratum, saline	2	3	20	30	35	55	30	50	25	40	10	14	8	12	300	375
Las sandy loam	2	3	25	35	35	55	30	50	30	45	11	14	10	14	250	350
Lincoln loam	.5	1	15	20	15	20	15	20	15	20	----	----	7	10	----	----
Nepesta clay loam, 0 to 1 percent slopes	3	4.5	40	55	50	70	50	75	40	55	15	18	15	22	----	----
Nepesta clay loam, 1 to 3 percent slopes	2.5	4	35	50	45	65	45	70	40	55	13	16	15	22	----	----
Nepesta clay loam, saline, 0 to 1 percent slopes	2	3	20	30	35	50	30	45	25	40	11	14	8	12	----	----
Nepesta clay loam, saline, 1 to 3 percent slopes	2	3	20	30	35	50	30	45	25	40	10	13	8	12	----	----
Nepesta clay loam, wet, 0 to 1 percent slopes	2.5	3.5	35	50	50	70	45	70	35	50	13	16	13	18	----	----
Numa clay loam, 0 to 1 percent slopes	3	4.5	45	60	55	75	55	80	40	60	15	18	15	22	400	600
Numa clay loam, 1 to 3 percent slopes	2.5	3.5	40	55	50	70	50	75	35	55	13	16	14	20	----	----
Numa clay loam, 3 to 5 percent slopes	2	3	35	45	45	60	45	65	35	45	----	----	10	14	----	----
Numa clay loam, saline, 0 to 3 percent slopes	1.5	2	15	20	25	40	20	35	20	30	8	10	8	11	----	----
Numa clay loam, wet, 0 to 3 percent slopes	2	3.5	20	30	40	60	30	45	25	40	11	14	12	16	300	450
Richfield silt loam, 0 to 1 percent slopes	3	5	45	60	55	75	55	80	40	60	15	18	15	22	----	----
Rocky Ford clay loam, 0 to 1 percent slopes	3.5	5	45	60	55	75	55	80	40	60	15	18	15	22	400	600
Rocky Ford clay loam, 1 to 3 percent slopes	3	5	45	60	50	70	50	75	40	55	13	16	14	22	375	500
Rocky Ford clay loam, 3 to 5 percent slopes	2.5	3	35	50	45	60	45	65	35	50	----	----	10	15	----	----
Rocky Ford clay loam, clay substratum, 0 to 1 percent slopes	3	4	40	50	45	60	45	65	35	50	13	16	12	18	350	450
Rocky Ford clay loam, sand substratum, 0 to 1 percent slopes	2	2.5	40	50	45	60	45	65	35	50	11	14	10	15	350	450

TABLE 3.—*Predicted average crop yields per acre of irrigated crops under two levels of management*—Continued

Soil	Alfalfa		Wheat		Grain sorghum		Corn		Barley		Sugar beets		Corn or sorghum silage		Onions	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*50 lb. bags*	*50 lb. bags*
Rocky Ford clay loam, sand substratum, 1 to 3 percent slopes	2	2.5	35	50	40	55	40	55	30	45	11	14	10	15	350	450
Rocky Ford clay loam, sand substratum, 3 to 5 percent slopes	1.5	2	25	35	35	50	35	50	25	35	----	----	8	12	----	----
Rocky Ford clay loam, over limestone, 1 to 3 percent slopes	2	2.5	20	30	25	35	25	35	20	30	----	----	8	10	----	----
Rocky Ford clay loam, over limestone, 3 to 5 percent slopes	1.5	2	20	30	25	35	25	35	20	30	----	----	7	9	----	----
Rocky Ford clay loam, saline, 0 to 1 percent slopes	2.5	3.5	30	40	40	50	30	40	35	45	12	15	8	12	----	----
Rocky Ford clay loam, saline, 1 to 3 percent slopes	2	3	25	35	40	50	30	40	30	40	9	12	8	12	----	----
Rocky Ford clay loam, wet, 0 to 1 percent slopes	3	4.5	40	55	55	75	45	65	40	60	14	17	15	22	350	450
Rocky Ford clay loam, wet, 1 to 3 percent slopes	3	4.5	35	55	50	70	40	65	40	55	12	15	14	22	325	425
Ulysses sandy loam, 0 to 3 percent slopes	2.5	3.5	45	60	50	65	50	65	40	55	11	13	13	20	----	----
Ulysses silt loam, 0 to 3 percent slopes	3.5	5	45	60	55	75	55	80	40	60	15	18	15	22	----	----
Vona sandy loam, 1 to 3 percent slopes	1.5	2.5	25	35	40	55	40	60	25	35	8	10	10	16	----	----
Wiley silt loam, 0 to 3 percent slopes	3.5	4.5	40	60	50	75	50	75	40	60	14	17	14	20	----	----
Wiley silt loam, 3 to 5 percent slopes	2.5	3	35	45	40	55	45	60	35	45	----	----	10	15	----	----

are the principal grasses. Western wheatgrass, vine-mesquite, sideoats grama, sand bluestem, needle-and-thread, little bluestem, sandreed, and blowoutgrass are less extensive. Numerous forbs grow in mixture with the grasses. The shrubs are mainly sand sage, rabbitbrush, tamarisk, and winterfat, but there is a small amount of fourwing saltbush and greasewood.

The condition of about 70 percent of the range is fair or poor. Because the range has been overgrazed in past years, the areas of hardland are now covered mostly with buffalograss and sod-bound blue grama, and the sandy areas have been invaded by sand sage. Tamarisk covers a large acreage of the bottom lands along the Arkansas River and its tributaries.

Cows and calves are the main kinds of livestock in this county, but there are some winter stockers or carryover calves. On almost all of the ranches, some areas are planted to crops used for supplemental grazing. The principal crops used for that purpose are wheat, sudangrass, and sorghum.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that have a different potential for producing range plants. Within a given climate, the sites differ only in the kind and amount of native plants they will produce. The productive capacity depends to a great extent on the characteristics of the soils and climate. In Prowers County the amount of available soil moisture is one of the more important factors that determines the kind of plants on each range site and the productivity of the site.

Native plants grow under a variable climate on the range sites in this county, and the differences in the amount of rainfall cause differences in the amount of available soil moisture. Snowfall is light, and storms of high intensity distribute most of the rainfall erratically. In some years the amount of rainfall in one 24-hour period exceeds that recorded in another whole year of low rainfall. Hot dry winds in spring and the generally erratic distribution of rainfall commonly result in short periods of drought. These periods of drought retard or prevent the growth of native range plants. In spring the amount of moisture lost by evaporation and transpiration is excessive, but in June, July, and August the amount of moisture is more likely to be favorable for plants.

The range operator needs to know not only the kind of range sites on his holdings, but also the condition of each site. By range condition is meant the present state of the soils and vegetation in terms of what productivity could or should be under the normal amount of rainfall and the best practical management. If the range operator knows the condition of each of his range sites, he can determine the kind of management needed to improve the site.

Range condition is determined by computing the proportions of decreasers, increasers, and invaders in the present vegetation on a given site. Livestock tend to graze the most palatable and nutritious plants first; consequently, those plants are destroyed or damaged first. Plants that generally decrease under close grazing are called *decreasers.* The stand is thinned as the decreasers are eliminated. Then, less palatable plants, known as increasers and invaders, move in. *Increasers* tend to increase at first under heavy grazing but are the next plants to be reduced or eliminated. As the decreasers and increasers are eliminated, the condition of the range continues to decline and successively less desirable plants dominate the site. Finally, plants from other sites or

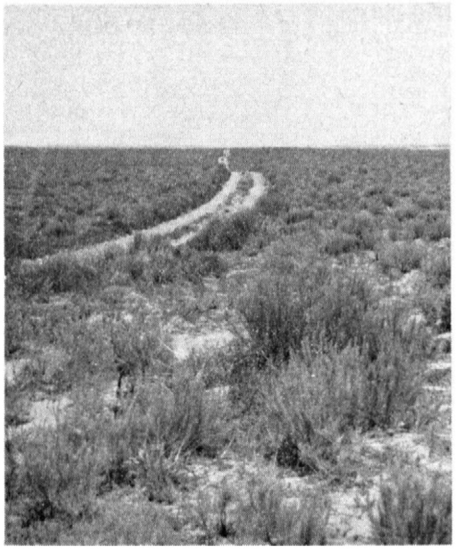
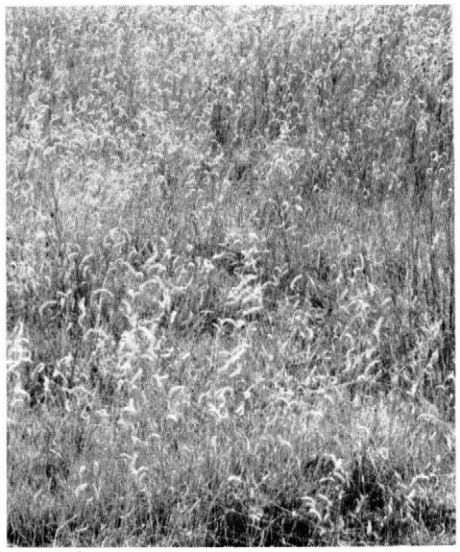


***Figure 26.*—Three range sites in Prowers County. The one on the left shows an area of the Deep Sand range site in poor condition; the one in the center shows an area of the Loamy Plains range site in good or excellent condition; and the one on the right shows an area of the Choppy Sands range site in fair or poor condition. Sand sage is dominant on the Deep Sand and Choppy Sands range sites in fair or poor condition.**

distant areas invade the plant community. These plants are known as *invaders*.

The condition classes generally recognized are *excellent*, *good*, *fair*, and *poor*. A range is in excellent condition if the present vegetation consists mostly of decreasers and important increasers and includes only a small proportion of invaders. It is in good condition if more increasers are growing to take the place of the diminishing or absent decreasers, and if the stand includes only a small amount of invaders. The range is in fair condition if most of the plants are decreasers, if a smaller part of the stand consists of invaders, and if decreasers make up a minor part of the stand or none. The range is in poor condition if a large part of the stand consists of unpalatable increasers and if there is a large proportion of invaders. Figure 26 shows three range sites in Prowers County. One is in good or excellent condition, and two are in poor or fair condition.

From year to year, the production of forage on any given range site may vary as much as 100 percent, mainly because the total amount of seasonal precipitation and the kinds and vigor of the vegetation vary widely. The yields on a site in excellent or good condition are less likely to fluctuate from year to year than yields on a site in fair or poor condition. Either in wet or dry years, however, all four condition classes may be seen on the same site. The condition of the range reflects how past grazing has affected a particular range site. Continued heavy grazing during a prolonged drought causes a rapid decline in the condition of the range.

Descriptions of range sites

The range sites of Prowers County are described in the following pages. For each range site is given in pounds per acre the total annual yield of air-dry herbage, excluding woody plants. The yield figures were based upon field estimates and upon the results obtained by weighing vegetation that had been clipped from experimental plots. For each range site, the soils in the site are listed. Not all soils have been placed in a range site.

The common names of plants growing on each range site are mentioned in describing the site. In order that these plants be properly identified, common names and equivalent scientific names are listed as follows (*3*, *16*).

Common names	*Scientific names*
TALL GRASSES	
Big bluestem	*Andropogon gerardi.*
Indiangrass	*Sorghastrum nutans.*
Sand bluestem	*Andropogon hallii.*
Sandreed	*Calamovilfa longifolia.*
MID GRASSES	
Alkali sacaton	*Sporobolus airoides.*
Blowoutgrass	*Redfieldia flexuosa.*
Indian ricegrass	*Oryzopsis hymenoides.*
Little bluestem	*Andropogon scoparius.*
Needle-and-thread	*Stipa comata.*
Sideoats grama	*Bouteloua curtipendula.*
Silver beardgrass	*Andropogon saccharoides.*
Switchgrass	*Panicum virgatum.*
Western wheatgrass	*Agropyron smithii.*
SHORT GRASSES	
Alkali grass	*Puccinellia airoides.*
Alkali muhly	*Muhlenbergia asperifolia.*
Black grama	*Bouteloua eriopoda.*
Blue grama	*Bouteloua gracilis.*
Buffalograss	*Buchloe dactyloides.*
False buffalograss	*Munroa squarrosa.*
Galleta	*Hilaria jamesii.*
Hairy grama	*Bouteloua hirsuta.*
Pullup muhly	*Muhlenbergia filiformis.*
Ring muhly	*Muhlenbergia torreyi.*
Saltgrass	*Distichlis stricta.*
Sand dropseed	*Sporobolus cryptandrus.*
Three-awn	*Aristida longiseta.*
Tumblegrass	*Schedonnardus paniculatus.*
Vine-mesquite	*Panicum obtusum.*

WOODY PLANTS

Common names	*Scientific names*
Greasewood	*Sarcobatus vermiculatus.*
Rabbitbrush	*Chrysothamnus nauseosus.*
Saltbush	*Atriplex canescens.*
Sand sage	*Artemisia filifolia.*
Skunkbush	*Rhus trilobata.*
Snakeweed	*Gutierrezia sarothrae.*
Winterfat	*Eurotia lanata.*
Yucca	*Yucca glauca.*
Bigelow sage	*Artemisia bigelovii.*
Shadscale	*Atriplex confertifolia.*
Wolfberry	*Lycium pallidum.*

FORBS

Beggars lice	*Bidens frondosa.*
Pricklypear	*Opuntia polyacantha.*
Cocklebur	*Xanthium commune.*
Crotonweed	*Croton texensis.*
Fireweed	*Kochia scoparia.*
Gumweed	*Grindelia squarrosa.*
Lambsquarters	*Chenopodium album.*
Prostrate knotweed	*Polygonum aviculare.*
Puncturevine	*Tribulus terrestris.*
Pursley	*Portulaca oleracea.*
Skeletonweed	*Lygodesmia rostrata.*
Snow-on-the-mountain	*Euphorbia marginata.*
Stickleaf mentzelia	*Mentzelia oligosperma.*
Sunflower	*Helianthus annuus.*
Russian-thistle	*Salsola kali.*
Devilsclaw	*Proboscidia louisianica.*

TREES

Cedar	*Juniperus monosperma.*
Cottonwood	*Populus sargentii.*
Tamarisk	*Tamarix pentandra.*

LOAMY PLAINS RANGE SITE

This is the largest range site in the county; it amounts to 25 percent of the total rangeland. It is on uplands and stream terraces in nearly level to gently rolling areas that generally have slopes of less than 5 percent. The soils have a medium to moderately fine textured surface layer and a slowly to moderately permeable subsoil. They are generally deep but are shallow over bedrock or other impermeable material in some places. Their water-holding capacity is good, and there is ample depth for plant roots. During heavy rains, runoff is excessive on the steeper slopes. These soils absorb water at a moderate rate. They are—

Baca clay loam, 0 to 3 percent slopes.
Baca clay loam, 3 to 5 percent slopes.
Breaks-Alluvial land complex.
Campo clay loam, 0 to 3 percent slopes.
Colby fine sandy loam, 0 to 1 percent slopes.
Colby fine sandy loam, 1 to 3 percent slopes.
Colby fine sandy loam, 0 to 3 percent slopes.
Colby fine sandy loam, 3 to 5 percent slopes.
Colby silt loam, 0 to 1 percent slopes.
Colby silt loam, 1 to 3 percent slopes.
Colby silt loam, 0 to 3 percent slopes.
Colby silt loam, 3 to 5 percent slopes.
Colby silt loam, clay substratum, 0 to 1 percent slopes.
Colby silt loam, sand substratum, 0 to 1 percent slopes.
Colby-Ulysses complex, 1 to 3 percent slopes.
Fort Collins loam, 0 to 3 percent slopes.
Fort Collins loam, 3 to 5 percent slopes.
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (Havre soil only).
Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (Havre soil only).
Glendive and Havre soils, sand substrata (Havre soil only).
Harvey loam, 0 to 1 percent slopes.
Harvey loam, 1 to 3 percent slopes.
Harvey loam, 0 to 3 percent slopes.
Harvey loam, 3 to 5 percent slopes.
Harvey loam, 5 to 9 percent slopes, eroded.
Havre loam.
Manvel loam, 0 to 1 percent slopes.
Manvel and Minnequa loams, 1 to 5 percent slopes.
Penrose loam, 1 to 5 percent slopes.
Renohill loam, 1 to 3 percent slopes.
Renohill loam, 3 to 5 percent slopes.
Renohill loam, moderately shallow, 1 to 3 percent slopes.
Renohill loam, moderately shallow, 3 to 5 percent slopes.
Richfield silt loam, 0 to 1 percent slopes.
Tyrone loam, 0 to 3 percent slopes.
Tyrone loam, 3 to 5 percent slopes.
Tyrone soils, eroded.
Ulysses silt loam, 0 to 3 percent slopes.
Wiley silt loam, 0 to 3 percent slopes.
Wiley silt loam, 3 to 5 percent slopes.
Wiley and Baca soils, 0 to 3 percent slopes, eroded.
Wiley and Baca soils, 3 to 5 percent slopes, eroded.

On this range site blue grama is the dominant grass in the potential plant community, and galleta grows with it in the western part of the county. The plant community is made up of these two increasers and western wheatgrass, sideoats grama, needle-and-thread, indian ricegrass, and winterfat. Other plants that grow in small amounts are fourwing saltbush, three-awn, sand dropseed, wild alfalfa, pricklypear, snakeweed, ring muhly, and rabbitbrush. In areas where moisture is favorable, buffalograss makes up a small part of the plant community and is an important grass for forage.

Ground cover is optimum where approximately 35 percent of the surface is in growing plants. If the plants are at a higher density, production is reduced in years of low rainfall. Most of the Loamy Plains range site is in fair condition, and a large part of the stand is buffalograss and blue grama, along with cactus and ring muhly. Snakeweed, a short-lived perennial, grows better on the Penrose and Minnequa soils than it does on deeper loams.

The total annual yield of air-dry forage, excluding woody plants, is about 500 to 1,000 pounds per acre, but in reseeded areas an additional 500 pounds may be obtained.

SALT FLAT RANGE SITE

The only soil in this range site is Arvada clay loam. The range site makes up only a minor part of the rangeland and is in the extreme western part of the county. The soil is nearly level to gently sloping and has slopes of less than 3 percent. Generally, it is moderately fine textured, but in many places it has a patchy, medium-textured surface layer. The permeability of the subsoil is slow or very slow. The soil is moderately deep to deep over shale. It takes in water slowly and has rapid runoff. The water-holding capacity is good, and there is ample depth for plant roots. Because of the content of salts and the moderately fine texture in most areas, this soil does not readily give up moisture to plants.

The potential plant community is mostly alkali sacaton, but about one-tenth is saltgrass. Western wheatgrass is limited in abundance, but it is an important forage plant. A smaller amount of blue grama, galleta, alkaligrass, and fourwing saltbush grows on this range site, and there is a small amount of curlycup gumweed, povertyweed, rabbitbrush, alkali muhly, and snakeweed. Plants are difficult to establish in the bare places.

The total annual yield of air-dry forage, excluding woody plants, is 800 to 2,000 pounds per acre.

SANDY PLAINS RANGE SITE

This range site is extensive and occurs in fairly large areas in all parts of the county. It is mostly adjacent to the sandhills and occupies about 10 percent of the total rangeland. Generally, the soils in this range site are nearly level or gently sloping, but they also occupy more sloping areas on some toe slopes within the area of sandstone breaks. The slopes are less than 5 percent in most places, but they are as steep as 9 percent in some areas. The surface layer of these soils is moderately coarse textured, and the subsoil is medium textured or moderately coarse textured.

The permeability of the subsoil is moderate or moderately rapid. Generally these soils are deep, but in some places they are shallow over sandstone. They take in water readily, and runoff is not excessive. The water-holding capacity is good, and there is ample depth for plant roots, except in the shallowest soils. These soils are—

Fort Collins sandy loam, 3 to 5 percent slopes.
Otero sandy loam, 1 to 3 percent slopes.
Otero sandy loam, 3 to 5 percent slopes.
Renohill sandy loam, 1 to 3 percent slopes.
Renohill sandy loam, 3 to 5 percent slopes.
Renohill sandy loam, moderately shallow, 1 to 3 percent slopes.
Renohill sandy loam, moderately shallow, 3 to 5 percent slopes.
Renohill soils, eroded.
Travessilla sandy loam.
Ulysses sandy loam, 0 to 3 percent slopes.
Vona loamy sand, 1 to 3 percent slopes.
Vona loamy sand, 3 to 5 percent slopes.
Vona sandy loam, 1 to 3 percent slopes.
Vona sandy loam, 3 to 5 percent slopes.
Vona soils, 1 to 3 percent slopes, eroded.
Vona soils, 3 to 9 percent slopes, eroded.

Blue grama and sand dropseed make up about 50 percent of the potential plant cover. Important decreasers—sideoats grama, needle-and-thread, sandreed, sand bluestem, and little bluestem—make up about 30 percent of the stand, and indian ricegrass, sedge, yucca, buckwheat, galleta, and other plants make up a smaller amount. Except in overgrazed areas, sand sage is less abundant on this site than on the Deep Sand range site. In most areas of this range site, the condition of the range is fair to poor. From 15 to 20 percent of the vegetation is sand sage, three-awn, sand dropseed, cactus, and blue grama.

The total annual yield of air-dry forage, excluding woody plants, is 800 to 1,000 pounds per acre.

DEEP SAND RANGE SITE

Tivoli sand is the only soil in this range site. It has slopes of 0 to 5 percent and occurs on uplands and high stream terraces that have been covered with wind-deposited sand. This range site is extensive in Prowers County; it occupies about 15 percent of the total rangeland.

Because the soil in this range site is coarse textured, it takes in water rapidly and has a rapidly permeable subsoil. It has low water-holding capacity, except in the areas where it is underlain by finer textured material.

Sandreed, sand bluestem, and big bluestem make up about 50 percent of the potential plant cover. Needle-and-thread, sideoats grama, little bluestem, and switchgrass are less important decreasers. The present vegetation on this site is mostly blue grama, sand sage, annuals, and three-awn.

The total annual yield of air-dry forage, excluding woody plants, is 1,200 to 2,000 pounds per acre.

CHOPPY SANDS RANGE SITE

This range site is made up of large dunelike upland areas that have no external drainage. Slopes are short and are more than 30 percent in some places. The range site amounts to about 10 percent of the total rangeland in the county and occurs mostly south and east of the Arkansas River, Two Butte Creek, Big Sandy Creek, and Wild Horse Creek. The soils of this range site are deep, coarse textured, and rapidly permeable. Water is taken in rapidly, and little runs off. The water-holding capacity is low. These soils are—

Tivoli sand, hilly.
Tivoli-Dune land complex (Tivoli soil only).

Sandhill muhly, indian ricegrass, blowout grass, three-awn, and yucca account for much of the potential vegetation on this site. The major forage plants, when the site is in good or excellent condition, are sandreed, sand bluestem, and switchgrass. Lemon scurfpea is a good indicator of this site. Sand sage is dominant when this site is in poor condition. Little vegetation grows on Dune land. Plants are hard to establish because the sand drifts and covers the plants that do get started.

The total annual yield of air-dry forage, excluding woody plants, is 1,000 to 1,200 pounds per acre.

SALT MEADOW RANGE SITE

This range site occupies the bottom lands and low stream terraces in areas where the uplands and high stream terraces are in the Sandy Bottom Land range site. It amounts to about 5 percent of the total rangeland in Prowers County. The soils are nearly level; the slopes are less than 1 percent.

Salinity and a high water table are characteristic of this range site; some areas are severely saline and swampy. The soils are highly productive and are subirrigated, but they vary widely in texture, permeability, and depth. These soils are—

Las loam.
Las loam, clay substratum.
Las clay loam.
Las clay loam, clay substratum.
Las clay loam, saline.
Las clay loam, sand substratum.
Las clay loam, sand substratum, saline.
Las clay loam, wet, saline.
Las sandy loam.
Las Animas soils.
Saline wet land.

Most of the vegetation on this range site is that of the potential plant community. This potential plant community consists of switchgrass, alkali sacaton, western wheatgrass, alkali bluegrass, sedges, and rushes. The present cover includes only a minor amount of saltgrass, foxtail barley, and wild licorice.

The total annual yield of air-dry forage, excluding woody plants, is 1,800 to 2,500 pounds per acre.

SHALY PLAINS RANGE SITE

This range site is scattered throughout the county in small, isolated, gently sloping or gently rolling upland areas where the slopes are less than 5 percent. It amounts to about 5 percent of the total rangeland in the county. The soils are moderately fine textured, and in most places they are shallow to moderately deep over shale. The depth to shale is generally less than 36 inches, and in many places it is less than 10 inches. Water is taken in very slowly, and runoff is rapid. The water-holding capacity is low to medium. The Lismas soil is droughty, and its root zone is so shallow that plants cannot take in enough water. These soils are—

Lismas clay loam.
Pultney loam, 1 to 5 percent slopes.

About 40 percent of the potential plant community on this site consists of blue grama and galleta. Alkali sacaton is the most abundant plant, but other important decreasers are western wheatgrass, indian ricegrass, and fourwing saltbush. Other plants on this site are winterfat, pricklypear, and snakeweed.

The total annual yield of air-dry forage, excluding woody plants, is 400 to 700 pounds per acre.

GRAVEL BREAKS RANGE SITE

This range site consists of gently sloping to steep soils, and it makes up about 10 percent of the rangeland in Prowers County. These soils have a gravelly surface layer and are shallow over gravel and other coarse-textured material.

The soils on this site take in water rapidly. They have low water-holding capacity, but the water is readily available to plants. Therefore, vegetation grows well on this range site. These soils are—

Cascajo sandy loam, 3 to 25 percent slopes.
Potter and Nihill gravelly soils, 1 to 5 percent slopes.
Potter and Stoneham gravelly loams, 5 to 35 percent slopes.
Terrace escarpments.

The potential plant community for this range site is dominantly sideoats grama and little bluestem, but it includes a smaller amount of big bluestem, needle-and-thread, blue grama, hairy grama, and indian ricegrass. Less important common forbs and other plants interspersed with grasses are hairy goldaster, dotted gayfeather, buckwheat, bigelow sage, and prairie clover. Yucca, snakeweed, sagewort, and sand sage are scarce. Blue grama, pricklypear, yucca, and snakeweed are dominant in large areas of this range site. In these areas the condition of the range is fair but not so good as in most other areas of this range site.

The total annual yield of air-dry forage, excluding woody plants, is 750 to 1,200 pounds per acre.

OVERFLOW RANGE SITE

The soils of this range site are deep, medium textured, and well drained. They are subject to periodic beneficial flooding and are highly susceptible to water erosion. Livestock contribute to the erosion of these soils by lingering for long periods in these rather small areas. Bare places erode rapidly and are severely gullied. In many places water has eroded stream channels into the soils. This range site makes up only an extremely limited acreage in Prowers County.

The infiltration and water-holding capacity of these soils are high. The periodic flooding contributes to the soil moisture and makes more moisture available to the plants. These soils are—

Goshen silt loam.
Loamy alluvial land.

The potential plant community is mainly western wheatgrass, vine mesquite, switchgrass, and fourwing saltbush, but blue grama will dominate in most areas. There is some alkali sacaton. Rabbitbrush, an increaser, is dominant in areas where this range site is under pressure of heavy grazing, and sand sage appears in a few areas. Buffalograss and blue grama are dominant in areas where the condition of this range site is fair.

The total annual yield of air-dry forage, excluding woody plants, is 900 to 1,500 pounds per acre.

SHALE BREAKS RANGE SITE

Only the Lismas-Shale outcrop complex is in this range site. The range site occupies only an extremely small acreage in Prowers County. The Lismas soil is moderately fine textured and steep, and it has a poorly developed profile. It is eroded and is very shallow over heavy clay shale.

No one grass is dominant on this site, because there are so many different grasses. As forage, western wheatgrass is most important. Western wheatgrass, sideoats grama, indian ricegrass, needlegrass, and little bluestem make up about one-third of the plant cover. Fourwing saltbush and winterfat are the main increasers. In most areas where this site is in poor condition, the areas are eroded and bare. In those areas the main plants are snakeweed, wolfberry, and muhly.

The total annual yield of air-dry forage, excluding woody plants, ranges from 600 to 800 pounds per acre.

SANDSTONE BREAKS RANGE SITE

Only Travessilla-Rock outcrop complex is in this range site. The range site makes up nearly 5 percent of the rangeland in Prowers County. The Travessilla soil is stony or rocky and is medium textured or moderately coarse textured. In many places it is steep. Rock crops out in many places, and there are many vertical cliffs.

The Travessilla soil takes in water rapidly, but it has very low water-holding capacity (fig. 27). The stones in this soil help to make moisture available to plants.

***Figure 27.*—An area where sandstone crops out on part of the Sandstone Breaks range site.**

Because this soil is stony and has favorable texture for the growth of plants, this range site has good potential for growing the taller, deeper rooted grasses. Many kinds of plants grow on the site. The thick cover of plants between the rocks and in the sloping areas consists of sand bluestem, little bluestem, indiangrass, sideoats grama, junegrass, and other tall and mid grasses. Skunkbush and yucca are common shrubs, and juniper forms an open canopy. Forbs growing on this range site are prairie clover, globemallow, buckwheat, and loco.

The total annual yield of air-dry forage is 600 to 900 pounds per acre.

LIMESTONE BREAKS RANGE SITE

Only the Penrose-Rock outcrop complex is in this range site. It consists partly of Penrose channery loam that is less than 10 inches deep over limestone bedrock and partly of areas where limestone crops out.

The permeability is medium, though water does not penetrate to a great depth. The water-holding capacity is very low. Erosion is excessive in places where the vegetation has been destroyed. This range site makes up only an extremely small amount of the rangeland in Prowers County.

The potential vegetation on this range site consists of sideoats grama, little bluestem, needle-and-thread, indian ricegrass, and other decreasers. Increasers are blue grama, hairy grama, galleta, three-awn, squirreltail, and dropseed. Increaser forbs are buckwheat, sandwort, nailwort, and phlox, and increaser shrubs are skunkbush, shadscale, bigelow sage, greasebush, and yucca. Snakeweed is the dominant increaser shrub. The present plant cover is sparse and consists principally of nailwort and bigelow sage together with a small amount of sideoats grama and blue grama.

The total annual yield of air-dry forage, excluding woody plants, is 300 to 600 pounds per acre.

SANDY BOTTOM LAND RANGE SITE

The soils in this range site are generally deep, but they are shallow over clean sand or gravel in some places. The range site makes up about 5 percent of the total rangeland in this county. The texture of the soils is fine sandy loam to loose sand. These sandy soils take in water more rapidly than finer textured soils, they release moisture to plants more readily, and the water penetrates to a greater depth. These are the principal soil characteristics that affect the growth of plants on this range site. However, the extra moisture received because of the location of the soils on bottom lands offsets, to some extent, the medium to low water-holding capacity. As a result, the vegetation is mainly a mixture of tall and mid grasses.

In most areas the concentration of salts is not strong enough to seriously affect the composition of the potential vegetation, but where the range has been misused, there is an abundance of saltgrass or of other plants that tolerate salt. The effect of the salts is more pronounced on this site than on the adjacent range site made up of wet meadows because the soils contain moisture in the upper 1 or 2 feet.

Generally, these soils are not highly erodible. In areas where they are bare, however, they are subject to severe wind erosion. These soils are—

Glendive fine sandy loam, 0 to 1 percent slopes.
Glendive fine sandy loam, 1 to 3 percent slopes.
Glendive fine sandy loam.
Glendive fine sandy loam, clay substratum.
Glendive and Havre fine sandy loams, 0 to 1 percent slopes.
Glendive and Havre fine sandy loams, 1 to 3 percent slopes.
Glendive and Havre fine sandy loams.
Glendive and Havre soils, sand substrata, 0 to 1 percent slopes (Glendive soil only).
Glendive and Havre soils, sand substrata, 1 to 3 percent slopes (Glendive soil only).
Glendive and Havre soils, sand substrata (Glendive soil only).

The potential vegetation is dominantly switchgrass, alkali sacaton, indiangrass, and tall bluestem, but it includes a small amount of needle-and-thread, Canada wildrye, and other mid grasses. Where this range site is in poor condition, the stand of sand dropseed, wild licorice, sand sage, and saltgrass is nearly solid and the dominant overstory along the streams is cottonwood trees, tamarisk, and willow (fig. 28).

The total annual yield of air-dry forage, excluding woody plants, is 1,800 to 2,000 pounds per acre.

General range management

Many different practices make up good range management. Among these are proper degree of range use, deferred grazing, and rotation-deferred grazing. Other practices that improve the range and that help to control the movement of livestock are seeding of the native grasses on the range, pitting and using contour furrowing in areas of range, controlling brush and weeds, and distributing grazing by building cross fences, making water widely available, locating salt in various places, and dispersing cattle that have concentrated in one area.

Proper degree of range use.—This refers to the rate of grazing that will maintain or improve the quantity and quality of the desirable vegetation, that will build up a reserve of forage, and that will provide enough residue to protect the soils and to conserve moisture. For most grasses, this consists of allowing not more than about 50

***Figure 28.*—Typical area of the Sandy Bottom Land range site along a major stream where the soils are not saline.**

percent, by weight, of the current growth to be grazed. The plant residue that remains after such grazing does the following:

1. Permits the plant to manufacture food for the vigorous growth of tops and roots.
2. Makes a mulch that helps the soil to take in more water and decreases the amount of soil moisture lost through evaporation.
3. Protects the soil from erosion by wind and water.
4. Permits the growth and reproduction of the taller and more productive grasses.
5. Enables plant roots to store the food needed for quick and vigorous growth in the next growing season.
6. Helps to hold snow where it falls.
7. Provides a reserve of feed that can be used during periods of drought.

Deferred grazing.—This practice consists of resting a pasture or range for a definite period during the growing season. It increases the vigor of the plants, permits the desirable plants to reproduce naturally by seed, and builds up a reserve of forage. When this practice is used along with other good practices, the maximum amount of forage is produced and livestock make the greatest gains. The growing season for the cool-season grasses is the latter part of April and the first part of May, and the growing season for the warm-season grasses extends through May and June. Using a moderate stocking rate gives a better return on the investment than overstocking the range.

Many ranchers feed protein supplements late in winter and early in spring, or until past calving time. During the period when supplements are fed, the cattle are kept off the range. Some of the supplements are in cake form, and some are in the form of mineral blocks. Sometimes alfalfa hay or alfalfa pellets are fed. During extended periods of drought, the pastures outside of the drought-stricken area are often leased.

Rotation-deferred grazing.—This is a practice in which one or more pastures are rested at planned intervals throughout the growing season. Each successive year each pasture is given a different rest period that permits the desirable forage plants to develop and produce seed. When this practice is used along with other good practices, the maximum amount of forage is produced and livestock make the greatest gains. The growing season is the most critical grazing period, for that is the time when the grass is the most palatable and is the most likely to be overgrazed. The growing season for the cool-season grasses is the latter part of April and the first part of May, and the growing season for the warm-season grasses extends through May and June. A local technician of the Soil Conservation Service or the county agent can give advice about rotating areas of range and can give help in selecting the key grasses that should be encouraged on each range site.

The following are practices that also improve the range and help to control the movement of livestock:

1. *Proper distribution of grazing.*—This is a problem on most pastures, because of the need for uniformly distributing the grazing load. Livestock can be distributed throughout an area by building cross fences, making water widely available, and locating salt in various places. In places where it is feasible, the fences should be built along a boundary between range sites or should reinforce natural barriers.

2. *Seeding of native grasses.*—This is a suitable practice on all deep soils that have slopes of less than 10 percent. The best results are obtained if the seeding mixture is made up of seeds of native range plants of the potential plant community for that particular range site. The county agent or a local representative of the Soil Conservation Service can help select the mixture best suited to the range site.

3. *Pitting and contour furrowing.*—These are short-term practices that mechanically reduce the density of blue grama and buffalograss in sod on medium-textured and fine-textured soils. These practices break up the soil temporarily so that the infiltration of water is improved, but they have no permanent effect on the soil.

4. *Control of brush and weeds.*—This practice is best suited to range sites where the soils are sandy and the competition from stands of sand sage needs to be reduced. If the sand sage is controlled, grasses increase on range that is properly managed.

Woodland Management

In Prowers County the only woodland is adjacent to the Arkansas River and Two Butte Creek, mostly in areas of the Lincoln, Glendive, Havre, and Las soils. Because these areas are flooded by the streams or have a high water table, or both, the extra water is available that is needed for the growth of trees in this semiarid climate. The stands are mostly cottonwood, but willow and tamarisk also grow in the area. These trees have no commercial value, but they do furnish protection for livestock during stormy periods.

In the southwestern part of the county, thin stands of juniper trees grow in a few areas of the Travessilla-Rock outcrop complex. These trees are remnants of an earlier stand that was cut for fence posts or destroyed by grazing practices that prevented the reproduction and establishment of seedlings.

Generally, the planting of trees for windbreaks has not been successful in this county, except in areas where irrigation or additional water is available. Most of the windbreaks that are started die out because of blowing soil, competition from weeds, activity of rabbits and rodents, and cycles of inadequate yearly rainfall. In nearly all irrigated areas, however, trees and shrubs do well, and if the soil is suited to alfalfa, it generally is as well suited to trees. Trees grow best in areas where the yields of alfalfa are high.

In areas of irrigated soils where windbreaks are needed to shelter buildings and livestock feeding areas from cold winter winds, the following trees and shrubs are well suited: Eastern redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, American plum, chokecherry, golden or white willow, cottonwood, honeylocust, Siberian (Chinese) elm, Russian-olive, squaw-bush, honeysuckle, and cotoneaster. These windbreaks should consist of at least three rows of trees and shrubs. If low-growing shrubs are planted on the windward side, the wind cannot sweep under the belt. Generally, evergreens provide better shelter throughout the year and live longer than other trees. All windbreaks should contain one or more rows of evergreens. The county agent or a local representative of the Soil Conservation Service can help in obtaining planting stock and designing and laying out the windbreak.

Wildlife

Use of the land has greatly affected the number and kinds of wildlife in the county. Dryfarming, for example, has favored Canada geese and other waterfowl, which feed on waste grain and the sprouts of winter wheat, especially in areas of the Richfield-Ulysses-Colby and Baca-Campo-Wiley soil associations. Many thousands of Canada geese, as well as many kinds of duck, winter near Two Buttes, John Martin, and Queens Reservoirs and fly each day to feeding areas in this county. Goose hunting is good to excellent; hunters come from more than 200 miles away.

After irrigation farming was begun in this county, the ring-necked pheasant was introduced. Irrigation farming produces crops that are essential as food for pheasants, but it also destroys much of the vegetation that these birds use for nesting and cover; the practice of burning areas along fence rows and irrigation ditches is especially detrimental to nesting sites and cover. Although the ring-necked pheasant is now common throughout the soil associations where irrigated crops are grown, irrigation farming is too intensive to support a large population of pheasant. The largest numbers of these birds in dryland areas are where water is nearby and available.

Pastures and areas of range support many kinds of wildlife, but the kinds of wildlife that frequent pastures and areas of range are not extensive or important to hunting. A few deer inhabit areas of the Travessilla-Cascajo and the Las-Glendive soil associations, and a few antelope live mostly in areas of range on the Wiley-Colby and Renohill-Wiley-Travessilla associations in the western part of the county.

Periodically, jackrabbits and cottontails are plentiful and are hunted locally. The jackrabbits are mainly on the open range and in dry-farmed areas, but most of the cottontails live in areas that provide brushy cover.

Generally, scaled quail live on range where plants provide some cover. Many of them live near abandoned buildings that provide some shelter. Practices that help these birds are making water available in many parts of the range and leaving piles of brush that will provide cover.

Manmade reservoirs and lakes that have been stocked with catfish, bullhead, pike, perch, trout, and other fish provide most of the fishing. Carp live in most of the drainage ditches and in the river, but they are not good game fish.

Engineering Uses of Soils [4]

This section describes the outstanding engineering properties of the soils, particularly in relation to highway construction and agricultural engineering. A brief description of the engineering soil classification systems and definitions of engineering terms used in the tables are also given.

The underlying material and the soil properties are likely to influence design, construction, and maintenance of engineering structures. Prowers County is underlain by a number of different geologic materials including gravel, sand, shale, limestone, and sandstone that are important to engineering. Many of these materials are important from an engineering standpoint, such as for the construction of roads or dams or for estimating runoff potential. The general characteristics of this geologic material and the part of the county where the various geologic formations occur is described in the section "Geology."

The soil properties most important to the engineer are permeability to water, water-holding capacity, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, dispersion characteristics, grain size, plasticity, depth of the soil material, and reaction. Depth to water table, depth to bedrock, and the topography are also important.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of the layers here reported. Even in those situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

The information in this report can be used to—

1. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and small structures for the control of erosion.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, topsoil, or rock for construction use.
4. Aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
5. Correlate performance of engineering structures with soil mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and aerial photographs so that maps and reports can be made that can be used readily by engineers.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some terms, such as soil, topsoil, soil separates, gravel, sand, silt, and clay, may have special meanings in soil science. These terms, as well as other special terms that are used in the soil sur-

[4] THOMAS E. COLLARD, area engineer, Soil Conservation Service, Lamar, Colo., assisted in the preparation of this section.

vey report, are defined in the Glossary at the back of this report.

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. The percentage of the soil material smaller than 2 millimeters in diameter, classified in soil science terminology as clay, silt, and sand, determine the textural classification of the soil material. This system is useful only as the initial step in making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the initial classifications have been made. Three systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO), the Unified system, and the system of hydrologic grouping. These systems are explained briefly in the following paragraphs. The explanations of the Unified and AASHO systems are taken mainly from the "PCA Soil Primer" (*11*).

Unified Classification System.—The Unified system is based on the identification of soils according to their texture, plasticity, and liquid limit. In this system soil material is divided into 15 classes (*20*). Eight classes are for coarse-grained material (GW, GP, GM, GC, SW, SP, SM, and SC); six are for fine-grained material (ML, CL, OL, MH, CH, and OH); and one (Pt) is for highly organic material. In this system SW and SP are clean sands, SM and SC are primarily sands that contain nonplastic fines, and GM, GC, GP and GW are soils in which the major coarse fraction is gravel. ML and CL are primarily nonplastic or plastic, fine-grained material that has a low liquid limit, and MH and CH are primarily nonplastic or plastic, fine-grained material that has a high liquid limit. Some soils are on the borderline between two classifications, and for those soils a joint classification symbol is used, for example, ML-CL.

AASHO Classification System.—The AASHO system is based on the actual performance of material used as a base for roads and highways (*1*). In this system soil material is classified in seven principal groups. The groups range from A–1, in which are gravelly soils of high bearing capacity, to A–7, which consists of clay soils having low strength when wet. Within each group the relative load-carrying capacity of the soil material is indicated by a group index number. These numbers range from 0 for the best material to 20 for the poorest. The group index numbers are determined by the gradation, liquid limit, and plasticity index.

Soil groups cannot be classified by group index without laboratory analysis that will give the percentage passing the 200 sieve and the liquid limit and plasticity index of the soils. For the soils tested in Prowers County, the group index number is shown in parentheses in table 6, p. 110, following the soil group symbol.

Some of the principal groups are subdivided into subgroups. For example, the A–1 group is subdivided into A–1–a and A–1–b subgroups. In the A–1–a subgroup, at least 50 percent of the soil material must be larger than the openings in a No. 10 sieve, and the material must contain no more than 15 percent particles smaller than the openings in a No. 200 sieve. In the A–1–b subgroup, the soil material may contain as much as 25 percent fines. The soils in the A–2 group can be made up of as much as 35 percent fines, but the soils in the A–3 group can have no more than 10 percent fines. The soils in the A–4 to A–7 groups are those in which 36 percent or more of the soil material passes a No. 200 sieve.

Hydrologic Grouping.—This consists of grouping soils that have similar rates of infiltration by water, even when thoroughly wet, that also have similar rates of water transmission within the soil profile, and that have similar runoff potential. The four groups currently recognized are groups A, B, C, and D.

In group A are soils that have the highest rate of infiltration, even when thoroughly wet, and the lowest runoff potential. These soils are deep sands or gravelly soils. In group B are soils less deep than those in group A. The soils in group B have a moderate rate of infiltration and moderate runoff potential. In group C are soils that are shallow over an impermeable layer or that contain considerable clay and colloids. These soils have a slow rate of infiltration and high runoff potential. In group D are mainly clayey soils that have high swelling potential or soils that are shallow over nearly impervious material or that contain a claypan or a clayey layer. The soils in group D have a very slow rate of infiltration and very high runoff potential.

Soil engineering interpretations

Three tables are given in this section. In the first (table 4, p. 78), the soils are briefly described and their physical properties important to engineering are estimated. In the second (table 5, p. 96) the suitability of the soils for various engineering uses is indicated. In the third (table 6, p. 110) engineering test data are given for various soils that were sampled.

The properties described in table 4 are for a typical profile, generally of each soil series. Therefore, some variation from these values should be anticipated. In the column that gives a description of the soil and site, the significant layers in each kind of soil are described. A more complete description of a profile that is typical for each series is given in the section "Genesis, Classification, and Morphology of Soils." Table 4 also gives classifications for each significant layer, according to the textural classes of the U.S. Department of Agriculture, as well as estimates of the Unified and AASHO classifications. In addition, the hydrologic grouping is indicated.

In the columns that show percentages of material passing sieves of various sizes, the separation between the coarse-textured and fine-textured soils is shown, as well as the percentage of soil material that is smaller in diameter than the openings in a given screen.

Soil permeability is the ability of the soil to transmit water and air. It is measured in terms of the rate at which water passes through the soil profile. The column that shows permeability gives the estimated probable rate of water percolation, expressed in inches per hour, through a soil in place. The estimates were based on a study of the soil structure, texture, and porosity. The following relative terms were used to rate permeability:

	Inches per hour
Very slow	Less than 0.05
Slow	0.05 to 0.20
Moderately slow	0.20 to 0.80
Moderate	0.80 to 2.50
Moderately rapid	2.50 to 5.00
Rapid	5.00 to 10.00
Very rapid	More than 10.00

In the column that shows available water holding capacity are estimates, in inches per inch of soil material, of the capillary water in the soil when that soil is wet to field capacity. When the soil is air dry, that is, when the wilting point of most common crops has been reached, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values. In this county many of the soils are moderately alkaline.

The salinity of the soils is estimated according to the electrical conductivity of the soil saturation extract, expressed in millimhos per centimeter at 25° C. The following defines the relative terms used to rate salinity: *None*—less than 2 millimhos per centimeter; *slight*—2 to 4 millimhos per centimeter; *moderate*—4 to 8 millimhos per centimeter; *severe*—8 to 16 millimhos per centimeter; and *very severe*—more than 16 millimhos per centimeter.

Dispersion, as used in this report, refers to the degree that particles smaller than 0.005 millimeter are separated or dispersed. This is to be distinguished from the single-grain, or unaggregated, condition common to clean sands. Dispersed soils are often slick when wet, and they have a crust on the surface when they are dry. Soils high in sodium, especially those that contain more than 15 percent exchangeable sodium, are likely to be dispersed. Acid silty soils that developed under poor drainage are also likely to be dispersed.

The column that shows shrink-swell potential indicates the volume change to be expected in a soil when the content of moisture changes. In general, soils classed as CH and A–7 have high shrink-swell potential, and clean, structureless sands and other nonplastic soil materials have low shrink-swell potential.

The suitability of the soils of this county for various engineering uses is indicated in table 5, p. 96. In that table are also given soil features that affect the use of the soils for highway construction and for agricultural engineering. The ratings given the soils have been evaluated from the estimated data in table 4, p. 78, from actual test data in table 6, p. 110, from other available test data, and from field experience.

Features that affect the suitability of the soils for irrigation are given in table 5. Additional facts about the suitability of the soils is given in the section "Management of Irrigated Soils."

Table 6 gives the engineering test data for some of the soils of the county. The modal profiles are the most nearly typical of the soil series. The other profiles give samples of significant variations within the concept of the soil series.

Genesis, Classification, and Morphology of Soils

The section presents the outstanding morphologic characteristics of soils in Prowers County and relates these characteristics to the factors of soil formation. Physical and chemical data are limited for these soils, and the discussion of soil genesis and morphology is correspondingly limited. The first part of the section defines the factors of soil formation, the second part discusses the classification of soils, and the third part gives facts about the morphology of soils. The last part gives the results of mechanical and chemical analyses of some of the soils.

Factors of Soil Formation

Five different factors are readily apparent in the formation of soils. These are parent material, climate, plants and animals, relief, and time. Thus, soil is produced by the action of soil-forming agencies on parent material deposited or accumulated through geologic processes (*4*). The characteristics of a soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since it accumulated; (3) the plant and animal life on and in the soil; (4) the topography, or lay of the land, which influences drainage; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors that affect soil genesis. They act on the parent material that has accumulated through the weathering of rocks or that has been deposited by wind and water and slowly change it to a soil that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed, and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. The amount of time needed may be much or little, but some time is always required for horizon differentiation. Usually, hundreds of years are required for the development of distinct horizons.

The factors of soil genesis are closely interrelated in their effects on soils. Therefore, few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. The factors of soil formation do not influence soil development equally, nor does any one factor always exert the same influence. For example, relief has had only a slight effect on the development of soils of the sandhills in this semiarid climate, but parent material has had a great effect. Many of the processes that affect soil development are unknown.

Parent Material

In this county parent material to a large extent determines the texture of the different soil horizons, as well as their structure, consistence, color, and arrangement.

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ac	Arvada clay loam.	Deep, well-drained, clayey soil developed in clayey material weathered from shale. This soil is highly gypsiferous below a depth of about 14 inches, and shale is below a depth of 42 inches in some places. Some areas are slightly concave; others have slopes of 1 to 3 percent.	0–42	Clay or clay loam.	CL or CH	A–6 or A–7
			42+	Gypsiferous shale.	(1)	(1)
BaB	Baca clay loam, 0 to 3 percent slopes.	Deep, well-drained, moderately fine textured soils developed in calcareous loess on the uplands. In most places the soils consist of about 24 inches of clay loam or silty clay loam over silt loam that extends to a depth of more than 60 inches. In other places the surface layer is about 6 inches of loam. The slopes range from 0 to 5 percent.	0–24	Silty clay loam.	ML–CL or CL.	A–6 or A–4
BaC	Baca clay loam, 3 to 5 percent slopes.		24–60+	Silt loam	ML–CL or CL.	A–4 or A–6
Bk	Breaks-Alluvial land complex.	Breaks: Consists mainly of deep, medium-textured, steep soils and of adjacent soils along upland stream channels, but some areas of sandy and gravelly soils are mapped with these soils. Alluvial land: Consists of stream channels within the uplands and is so variable that no estimates have been made.	0–60	Loam or silty clay loam.	ML or CL	A–4 or A–6
CaA	Campo clay loam, 0 to 3 percent slopes.	A deep, well-drained, fine textured or moderately fine textured soil developed in calcareous loess on the uplands. This soil consists of about 4 inches of silt loam or clay loam over silty clay that extends to a depth of about 36 inches. Below is silt loam that extends to a depth of more than 60 inches. This soil is nearly level, and in some areas it is in depressions.	0–36	Silt loam to silty clay.	CL or CH	A–6 or A–7
			36–60+	Silt loam	ML or CL	A–4 or A–6
CdE	Cascajo sandy loam, 3 to 25 percent slopes.	Moderately shallow soil of uplands. Developed in mixed sandy and gravelly material of the Ogallala formation. Consists of about 12 inches of coarse sandy loam over about 18 inches of gravelly coarse loamy sand that is underlain by gravelly material. The topography is rough and broken, and the slopes range from 3 to 25 percent.	0–12	Sandy loam	SM	A–2
			12–30	Gravelly loamy sand.	SM	A–2 or A–1
			30–60+	Gravel	GW–GM	A–1
CfA	Colby fine sandy loam, 0 to 1 percent slopes.	Deep, medium-textured, calcareous, well-drained soils that have a surface layer consisting of about 12 inches of fine sandy loam. Mostly on uplands, but on some stream terraces. The areas on stream terraces are underlain in some places by gravel or sand below a depth of 36 inches.	0–12	Fine sandy loam.	SM	A–2 or A–4
CfB	Colby fine sandy loam, 1 to 3 percent slopes.		12–60+	Silt loam	ML–CL	A–4
CfAB	Colby fine sandy loam, 0 to 3 percent slopes.					
CfC	Colby fine sandy loam, 3 to 5 percent slopes.					
CmA	Colby silt loam, 0 to 1 percent slopes.	Deep, medium-textured, well-drained soils developed in calcareous loess on uplands and on some stream terraces. The areas on stream terraces are	0–60+	Silt loam	ML–CL	A–4
CmB	Colby silt loam, 1 to 3 percent slopes.					

See footnotes at end of table.

and their estimated physical and chemical properties

Percentage passing sieve size—			Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of soil*	*pH*				
100	100	95–100	0. 05–0. 2	0. 32	8. 5 to 9. 0	Moderate	High	Moderate to high.	D
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
100	100	90–100	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Low	Moderate	B
100	100	85–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Moderate	
90–100	90–100	80–95	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Moderate	B
100	100	85–95	0. 05–0. 5	. 32	7. 9 to 8. 4	None	Low	Moderate to high.	C
100	100	80–90	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Moderate	
85–95	35–45	25–35	2. 5–5. 0	. 10	7. 4 to 7. 8	None	Low	Low	A
75–85	30–40	15–25	(2)	. 08	7. 4 to 7. 8	None	Low	Low	
30–40	15–30	5–15	(2)	. 04	7. 9 to 8. 4	None	Low	Low	
100	100	30–40	1. 5–2. 5	. 15	7. 9 to 8. 4	None	Low	Low	B
100	100	80–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Low to moderate.	
100	100	80–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Low to moderate.	B or C

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
CmAB CmC	Colby silt loam, 0 to 3 percent slopes. Colby silt loam, 3 to 5 percent slopes.	underlain in some places by sand or gravel below a depth of about 36 inches. The slopes range from 0 to 5 percent.				
CuB	Colby-Ulysses complex, 1 to 3 percent slopes.	The profile of the Colby soil is like that described for the Colby silt loams. For a profile of the Ulysses soil, see Ulysses silt loam.				
CoA	Colby silt loam, clay substratum, 0 to 1 percent slopes.	Like the Colby silt loams that lack a clay substratum, except that a clay substratum is at a depth of 30 to 60 inches. On terraces along the Arkansas River. The slopes range from 0 to 1 percent.	0–40 40–60	Silt loam Clay	ML MH or CH	A–4 A–7
CsA	Colby silt loam, sand substratum, 0 to 1 percent slopes.	Like the Colby silt loams that lack a clay or sand substratum, except that a sand substratum is at a depth of 20 to 36 inches. On terraces along the Arkansas River. The slopes are between 0 and 1 percent.	0–24 24–60	Silt loam Sand or gravel.	ML SP–SM, GP–GM.	A–4 A–1
Du	Dune land.	Deep, wind-deposited, bare sands on dunes.	0–60+	Sand	SP	A–3
FcB FcC	Fort Collins loam, 0 to 3 percent slopes. Fort Collins loam, 3 to 5 percent slopes.	Moderately deep, mainly upland soils, but some areas are on stream terraces; developed in calcareous gravelly deposits of Tertiary age. The surface layer is loam, and it is underlain by clay loam that extends to a depth of about 30 inches. Below the clay loam is gravelly or sandy material. Some areas on stream terraces are underlain by a deeper, less sandy or gravelly material.	0–10 10–30 30–72	Loam Clay loam Gravelly sandy loam or loam.	ML–CL CL SC, SM, GP, or SP.	A–4 A–6 A–2
FnC	Fort Collins sandy loam, 3 to 5 percent slopes.	Similar to the Fort Collins loams, except that the texture of the surface layer is sandy loam and this soil is all on uplands.	0–7 7–30 30–72	Sandy loam Clay loam Gravelly sandy loam or loam.	SM–SC CL SC, SM, GP, or SP.	A–2 or A–4 A–6 A–2–4
GaA GaB GaAB Gf	Glendive fine sandy loam, 0 to 1 percent slopes. Glendive fine sandy loam, 1 to 3 percent slopes. Glendive fine sandy loam (0 to 3 percent slopes). Glendive fine sandy loam, wet.	Deep soils developed in sandy alluvial material on stream terraces and bottom lands. Consists of about 18 inches of fine sandy loam over about 24 inches of sandy loam or loamy sand. Sand or gravel is below a depth of about 42 inches.	0–42 42–60	Sandy loam Sand	SM–SC SP	A–2 A–1 or A–3
Gc	Glendive fine sandy loam, clay substratum.	Profile is like that of the Glendive fine sandy loams, except that a clay substratum is at a depth below about 36 inches.	0–36 36–60	Fine sandy loam. Clay	SM–SC MH or CH	A–2 or A–4 A–7
GhA GhB	Glendive and Havre fine sandy loams, 0 to 1 percent slopes. Glendive and Havre fine sandy loams, 1 to 3 percent slopes.	Glendive soil: Fine sandy loam to a depth of 10 to 30 inches and loam or stratified loam or loamy fine sand below that depth. Havre soil: See page 82.	0–24 24–60	Fine sandy loam. Loam	SM–SC ML	A–2 A–4

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
95–100	95–100	80–95	0. 8–1. 5	0. 26	7. 9 to 8. 4	None	Low	Low	B
100	100	90–100	(3)	. 32	7. 9 to 9. 0	Slight	High	High	
95–100	95–100	80–95	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Low	B
50–90	50–90	5–10	(2)	. 05	7. 4 to 7. 8	None	Low	Low	
100	100	0–5	(2)	. 07	7. 9 to 8. 4	None	Low	Low	A
90–100	90–100	85–95	0. 8–2. 5	. 24	7. 9 to 8. 4	None	Low	Low	B
90–100	90–100	90–95	0. 2–0. 8	. 29	7. 9 to 8. 4	None	Low	Moderate	
40–95	40–90	5–15	(2)	. 05	7. 9 to 8. 4	None	Low	Low	
90–100	85–95	25–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
90–100	90–100	90–95	0. 2–0. 8	. 29	7. 9 to 8. 4	None	Low	Moderate	
40–95	40–90	5–15	(2)	. 05	7. 9 to 8. 4	None	Low	Low	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
60–100	60–90	0–5	(2)	. 06	7. 4 to 7. 8	None	Low	Low	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
100	100	85–95	0. 05–0. 2	. 32	7. 9 to 9. 0	Moderate	High	High	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
100	100	60–70	0. 8–1. 5	. 24	7. 9 to 8. 4	None	Low	Moderate	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
GhAB	Glendive and Havre fine sandy loams.	Havre soil: Like Havre loams, except that the surface layer is fine sandy loam.	0–8	Fine sandy loam.	SM or SC	A–2 or A–4
			8–45	Loam and sandy loam.	ML or SM	A–2 or A–4
			45–60	Loamy sand	SM–SP	A–1 or A–3
GnA GnB GnAB	Glendive and Havre soils, sand substrata, 0 to 1 percent slopes. Glendive and Havre soils, sand substrata, 1 to 3 percent slopes. Glendive and Havre soils, sand substrata.	Glendive soil: Fine sandy loam to a depth of about 24 inches, and sand and gravel below that depth. Havre soil: In most areas these soils have a slightly finer texture than the Glendive soils in the layer between 7 and 24 inches, but they can be expected to have about the same properties that influence engineering work.	0–24	Fine sandy loam.	SM–SC	A–2–4
			24–60	Loam	ML	A–4
Go	Goshen silt loam.	Deep, medium-textured soil that developed in calcareous material and is on uplands. It occurs in swales and has slopes of 0 to 3 percent.	0–60	Silt loam	ML	A–4
HaA HaB HaAB HaC HaD2	Harvey loam, 0 to 1 percent slopes. Harvey loam, 1 to 3 percent slopes. Harvey loam, 0 to 3 percent slopes. Harvey loam, 3 to 5 percent slopes. Harvey loam, 5 to 9 percent slopes, eroded.	Deep, medium-textured soils developed in calcareous material of Tertiary age. The texture is dominantly loam throughout the profile, and a zone of lime accumulation occurs just below the subsoil. The slopes range from 0 to 9 percent.	0–60	Loam	ML	A–4
Hm	Havre loam.	Moderately shallow to deep soil of bottom lands and low stream terraces. This soil is medium textured and is highly stratified with sandy material. Sand is below a depth of about 45 inches. The slopes are between 0 and 1 percent.	0–8	Loam	ML	A–4
			8–45	Loam and sandy loam.	ML or SM	A–2 or A–4
			45–60	Loamy sand	SM–SP	A–1 or A–3
KcA KcB KwA	Kornman clay loam, 0 to 1 percent slopes. Kornman clay loam, 1 to 3 percent slopes. Kornman clay loam, wet, 0 to 2 percent slopes.	Deep soils of bottom lands and stream terraces. They consist of about 15 inches of clay loam over sandy loam or loamy fine sand. In some areas there is a deep water table.	0–15	Clay loam or loam.	CL	A–6
			15–42	Sandy loam	SM–SC	A–2 or A–4
			42–60+	Sand	SP or SP–SM.	A–1 or A–3
KmA	Kornman clay loam, clay substratum, 0 to 1 percent slopes.	About 10 inches of clay loam over sandy loam that extends to a depth of about 37 inches. Below is a clay substratum. The soils are on bottom lands and on low stream terraces.	0–10	Clay loam	CL	A–6
			10–37	Sandy loam	SM–SC	A–2 or A–4
			37–60	Clay	MH or CH	A–7
KnA	Kornman clay loam, sand substratum, 0 to 1 percent slopes.	About 10 inches of loam or clay loam over about 18 inches of sandy loam. A substratum of sand or gravel is below a depth of about 28 inches. This soil is well drained.	0–10	Clay loam or loam.	CL	A–6
			10–28	Sandy loam	SM–SC	A–2 or A–4
			28–60	Sand or gravel.	SP–SM or GP–GM.	A–1 or A–3
La	Las loam.	Deep, imperfectly drained, medium-textured and moderately fine textured soil developed in alluvium on bottom lands and low stream terraces. Underlain in some places by sand between a depth of 36 and 60 inches.	0–10	Loam	ML	A–4
			10–48	Loam or clay loam.	ML or CL	A–4 or A–6
			48–60	Sand	SP–SM	A–1 or A–3

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size—			Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of soil*	*pH*				
90–100	80–100	15–40	2. 5–5. 0	0. 14	7. 9 to 8. 4	None	Low	Low	
90–100	90–100	25–75	1. 5–5. 0	. 18	7. 9 to 8. 4	None	Low	Low	B
80–100	80–95	5–15	([2])	. 07	7. 9 to 8. 4	None	Low	Low	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
100	100	60–70	0. 8–1. 5	. 24	7. 9 to 8. 4	None	Low	Moderate	
100	100	85–95	0. 8–1. 5	. 28	7. 9 to 8. 4	None	Low	Moderate	B
75–95	70–90	60–85	0. 8–1. 5	. 24	7. 9 to 8. 4	None	Low	Moderate	B
100	100	60–75	0. 8–1. 5	. 25	7. 9 to 8. 4	None	Low	Low	
90–100	90–100	25–75	1. 5–5. 0	. 18	7. 9 to 8. 4	None	Low	Low	B
80–100	80–95	5–15	([2])	. 07	7. 9 to 8. 4	None	Low	Low	
100	100	80–95	0. 5–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
60–100	60–90	0–10	([2])	. 06	7. 4 to 7. 8	None	Low	Low	
100	100	80–95	0. 5–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
100	100	85–95	0. 05–0. 2	. 32	7. 9 to 9. 0	Moderate	High	High	
100	100	80–95	0. 5–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	
90–100	80–100	15–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
50–90	50–90	5–10	([2])	. 05	7. 4 to 7. 8	None	Low	Low	
100	95–100	70–85	1. 5–2. 5	. 24	7. 9 to 9. 0	Moderate	Low	Low	
100	95–100	70–90	0. 2–2. 5	. 27	7. 9 to 9. 0	Moderate	Moderate	Moderate to low.	B
100	90–100	5–15	([2])	. 07	7. 9 to 8. 4	Moderate	Low	Low	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Lb	Las loam, clay substratum.	Profile similar to that of Las clay loam, except that the surface layer is loam and a clay substratum is at a depth of about 36 inches.	0–8 8–36 36–60	Loam Clay loam Clay	ML CL MH or CH	A–4 A–6 A–7
Lc	Las clay loam.	Deep, moderately fine textured, imperfectly drained soil of the bottom lands and low stream terraces. The surface layer is predominantly clay loam, but in some places it is weakly stratified with soil material of other textures. Underlain by sand between a depth of 36 and 60 inches in some places.	0–48 48–60	Clay loam Sand	CL SP–SM	A–6 A–1 or A–3
Ld	Las clay loam, clay substratum.	Profile similar to that of Las clay loam, except that a clay substratum is at a depth of about 36 inches.	0–36 36–60	Clay loam Clay	CL MH or CH	A–6 A–7
Lm	Las clay loam, saline.	Deep, poorly drained, saline soil of the bottom lands. The surface layer is generally clay loam about 12 inches thick, and below it is clay. The slopes are between 0 and 1 percent.	0–12 12–60+	Clay loam Clay	CL MH or CH	A–6 A–7
Ln	Las clay loam, sand substratum.	Profile similar to that of Las clay loam, except that a sand substratum is below a depth of about 24 inches.	0–24 24–60	Clay loam Sand	CL SP–SM	A–6 A–1 or A–3
Lo	Las clay loam, sand substratum, saline.	Profile similar to that of Las clay loam, sand substratum, but the water table is higher and salinity is moderate to severe.	0–24 24–60	Clay loam Sand	CL SP–SM	A–6 A–1 or A–3
Lp	Las clay loam, wet, saline.	Similar to Las clay loam, saline, except that this soil is more saline and has a higher water table. In places it is underlain by sand at a depth of 24 to 60 inches.	0–12 12–36 36–60	Clay loam Clay Sand	CL MH or CH SP–SM	A–6 A–7 A–1 or A–3
Ls	Las sandy loam.	Similar to Las clay loam, except that the surface layer is sandy loam or loamy sand, and the texture of the substratum is clay to sand at a depth between 36 and 60 inches.	0–9 9–36 36–60	Sandy loam or loamy sand. Clay loam Sand to clay	SC–SM CL MH, CH, or SP.	A–2 or A–4 A–6 A–7 or A–1–b.
Lt	Las Animas soils.	Moderately shallow, poorly drained, stratified soils developed in alluvium on the bottom lands. The surface layer is about 6 inches thick and ranges from clay loam to loamy sand in texture. Below the surface layer is sandy loam or loamy sand. Depth to sand and gravel ranges from 20 inches to about 4 feet.	0–6 6–30 30–60	Loam or clay loam. Sandy loam or loamy sand. Sand or gravel.	ML–CL SM or SM–SC. SW–SM or GP–GM.	A–4 to A–6 A–2 or A–4 A–1 or A–3
Lu	Lincoln loam.	Excessively drained soil of the bottom lands. It has a surface layer of loam and a coarse-textured subsoil. Contains some gravel bars. Susceptible to flooding.	0–8 8–30 30–60	Loam Loamy sand Gravelly sand	ML SP or SP-SM. GP–GM	A–4 A–1 or A–3 A–1–a

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
100	95–100	65–85	1. 5–2. 5	0. 26	7. 9 to 9. 0	Moderate	Low	Moderate	C
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Moderate	Moderate	Moderate	
100	100	85–95	(3)	. 32	7. 9 to 9. 0	Moderate	High	High	
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Moderate	Moderate	Moderate	C
100	90–100	5–15	(2)	. 07	7. 9 to 8. 4	Moderate	Low	Low	
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Moderate	Moderate	Moderate	C
100	100	85–95	(3)	. 32	7. 9 to 9. 0	Moderate	High	High	
100	100	75–85	0. 2–0. 5	. 31	7. 9 to 8. 4	Moderate to severe.	Moderate	Moderate	C
100	100	85–95	0. 05–0. 2	. 32	8. 5 to 9. 0	Moderate to severe.	High	Moderate to high.	
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Moderate	Moderate	Moderate	C
100	90–100	5–15	(2)	. 07	7. 9 to 8. 4	Moderate	Low	Low	
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Severe	Moderate	Moderate	C
100	90–100	5–15	(2)	. 07	7. 9 to 8. 4	Moderate	Low	Low	
100	100	75–85	0. 2–0. 5	. 31	7. 9 to 8. 4	Severe	High	Moderate	C
100	100	85–95	0. 05–0. 2	. 32	8. 5 to 9. 0	Severe	High	High	
100	100	5–15	2. 5–5. 0	. 07	7. 9 to 8. 4	Moderate to severe.	Low	Low	
100	95–100	15–45	2. 5–5. 0	. 13	7. 9 to 8. 4	Slight	Low	Low	B
100	100	75–90	0. 2–0. 5	. 31	7. 9 to 9. 0	Moderate	Moderate	Moderate	
90–100	90–100	5–95	(3)	. 06 to . 32	7. 9 to 9. 0	Slight to moderate.	Low to high	Low to high	
100	100	65–85	0. 5–2. 5	. 28	7. 9 to 9. 0	Severe	Moderate	Moderate	B
90–100	90–100	15–45	(4)	. 12	7. 9 to 9. 0	Severe	Low	Low	
25–90	25–90	5–15	(2)	. 05	7. 9 to 9. 0	Moderate	Low	Low	
100	90–100	50–80	1. 5–2. 5	. 26	7.9 to 8.4	None	Low	Low	B
70–95	70–85	10–25	(2)	. 08	7.4 to 7.8	None	Low	Low	
10–35	10–20	5–15	(2)	. 04	7.4 to 7.8	None	Low	Low	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
			Inches			
Lv	Lincoln sand.	Excessively drained soil developed in coarse-textured recent alluvium on the bottom lands. It has a sandy surface layer, and the rest of the soil material in the upper part of the profile is generally loamy sand. Sand and gravel are at a depth of about 30 inches. Contains many gravel bars, and the profile lacks distinct horizons in areas where gravel bars occur. Susceptible to flooding.	0–30	Sand or loamy sand.	SP or SP-SM.	A-1 or A-3
			30–60	Gravelly sand	GP-GM	A-1
Lw Lx	Lismas clay loam. Lismas-Shale outcrop complex.	A soil developed in material weathered from shale and only about 10 inches deep over shale. In some areas shale crops out in many places. No estimates were made for about 50 percent of the acreage of Lismas-Shale outcrop complex that is comprised of outcrops of shale.	0–10	Clay loam	CL	A-6
			10+	Shale	(1)	(1)
Ly	Loamy alluvial land.	Deep, loamy, well-drained, alluvial material in upland swales. No profile has developed in this material.	0–60	Loam	ML	A-4
MaA	Manvel loam, 0 to 1 percent slopes.	Deep, medium-textured, well-drained soil developed in material weathered from limestone. The texture is loam throughout the profile. Limestone is at a depth of about 20 to 60 inches. The slopes range from 0 to 9 percent.	0–40	Loam	ML	A-4
			40+	Limestone	(1)	(1)
MmC	Manvel and Minnequa loams, 1 to 5 percent slopes.	Manvel soil: See Manvel loam, 0 to 1 percent slopes.				
		Minnequa soil: Moderately shallow, loamy material over weathered limestone and shale at a depth of 20 to 40 inches.	0–40	Loam	ML	A-4
			40+	Limestone	(1)	(1)
NmA NmB	Nepesta clay loam, 0 to 1 percent slopes. Nepesta clay loam, 1 to 3 percent slopes.	Deep, moderately fine textured, well-drained soils that have been silted to a depth of about 15 inches with silt and clay. The subsoil extends to a depth of about 30 inches and is moderately fine textured. The substratum is medium textured in most places, but it is gravelly in a few small areas. The slopes range from 0 to 3 percent.	0–32	Silty clay loam.	CL	A-6
			32–60+	Silt loam	ML-CL or CL.	A-4 or A-6
NpA NpB NsA	Nepesta clay loam, saline, 0 to 1 percent slopes. Nepesta clay loam, saline, 1 to 3 percent slopes. Nepesta clay loam, wet, 0 to 1 percent slopes.	Similar to the Nepesta clay loams just described, except that there is a moderate to severe degree of salinity and seepage as the result of irrigation.	0–32	Silty clay loam.	CL	A-6
			32–60+	Silt loam	ML-CL or CL.	A-6 or A-4
NtA NtB NtC	Numa clay loam, 0 to 1 percent slopes. Numa clay loam, 1 to 3 percent slopes. Numa clay loam, 3 to 5 percent slopes.	Deep, well-drained, medium-textured soils of the uplands; developed in calcareous material of Tertiary age. The surface layer is silted to a depth of 7 to 12 inches. Below the surface layer is medium-textured soil material. A zone that is high in content of lime lies below the subsoil. The slopes range from 0 to 3 percent.	0–12	Clay loam	CL	A-6
			12–60	Loam	ML	A-4

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
70–95	70–85	10–25	[2]	0.08	7.4 to 7.8	None	Low	Low	A
10–35	10–20	5–10	[2]	.04	7.4 to 7.8	None	Low	Low	
100	100	70–90	0.2–0.5	.31	7.9 to 8.4	Slight	Moderate	Moderate	D
[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	
100	100	80–95	0.8–1.5	.24	7.9 to 8.4	None	Low	Moderate	B
95–100	90–100	50–75	0.8–1.5	.26	7.9 to 8.4	None	Low	Moderate to low.	B
[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	
95–100	90–100	50–75	0.8–1.5	.26	7.9 to 8.4	None	Low	Moderate to low.	B
[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	
100	100	95–100	0.2–0.5	.32	7.9 to 8.4	Moderate to severe.	Low	Moderate	B
100	100	85–95	0.8–1.5	.29	7.9 to 8.4	Moderate to severe.	Low	Moderate	
100	100	95–100	0.2–0.5	.32	7.9 to 8.4	Moderate to severe.	Low	Moderate	B
100	100	85–95	0.8–1.5	.29	7.9 to 8.4	Moderate to severe.	Low	Moderate	
95–100	95–100	75–90	0.5–0.8	.31	7.9 to 8.4	None	Moderate	Moderate	B
75–95	70–90	60–85	0.8–1.5	.24	7.9 to 8.4	None	Low	Moderate to low.	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
NuB NwB	Numa clay loam, saline, 0 to 3 percent slopes. Numa clay loam, wet, 0 to 3 percent slopes.	Similar to the Numa clay loams just described, except that these soils are moderately to severely saline and seepage has resulted because of irrigation.	0–12 12–60	Clay loam Loam	CL ML	A–6 A–4
OtB OtC	Otero sandy loam, 1 to 3 percent slopes. Otero sandy loam, 3 to 5 percent slopes.	Deep, well-drained soils that developed in calcareous sandy deposits and are on uplands. The surface layer is sandy loam, and sandy loam extends to a depth of about 25 inches. Below this, the texture of the soil material ranges from loam to loamy sand. The slopes range from 1 to 5 percent.	0–25 25–60	Sandy loam Loam or loamy sand.	SM–SC ML or SM	A–2 or A–4 A–2 or A–4
PaC Pk	Penrose loam, 1 to 5 percent slopes. Penrose-Rock outcrop complex.	Loamy soils that are very shallow over limestone and that developed in material weathered from limestone. The soils contain varying amounts of limestone fragments, and limestone crops out in many places. The slopes range from 3 to 25 percent.	0–11 11+	Loam Limestone	ML (1)	A–4 (1)
PnC	Potter and Nihill gravelly soils, 1 to 5 percent slopes.	Potter soils: Surface layer like that of the Nihill soils but underlain by cemented limy gravel at a depth of about 6 inches.	0–6 6–60	Gravelly loam. Gravel	ML or SM GP–GM	A–4 A–1
		Nihill soils: Shallow gravelly soils on uplands; underlain by unconsolidated limy gravel at a depth of about 6 inches.	0–6 6–60	Gravelly loam. Gravel	ML or SM GP–GM	A–4 A–1–a
PsE	Potter and Stoneham gravelly loams, 5 to 35 percent slopes.	Potter soil: See description of Potter soils in Potter and Nihill gravelly soils, 1 to 5 percent slopes.				
		Stoneham soil: Gravelly and loamy soils on uplands. The subsoil is heavy loam, and the substratum below a depth of 20 to 48 inches is firm or hard gravelly loam.	0–4 4–14 14–60	Gravelly loam. Heavy loam or clay loam. Gravel	ML or SM ML or CL GP–GM	A–4 A–4 or A–6 A–1
PuC	Pultney loam, 1 to 5 percent slopes.	Well-drained loamy soil that is moderately shallow to deep over gypsiferous shale. The surface layer is loam and is underlain by clay loam that extends to a depth of 20 to 60 inches. The slopes range from 1 to 5 percent.	0–8 8–31 31+	Loam Clay loam Gypsiferous shale and interbedded limestone.	ML CL (1)	A–4 A–6 (1)
RaB RaC RbB RbC	Renohill loam, 1 to 3 percent slopes. Renohill loam, 3 to 5 percent slopes. Renohill loam, moderately shallow, 1 to 3 percent slopes. Renohill loam, moderately shallow, 3 to 5 percent slopes.	Moderately shallow to deep, well-drained upland soils developed in material weathered from sandstone. The surface layer is loam about 10 inches thick. Below the surface layer is clay loam that extends to a depth of about 42 inches. Depth to sandstone ranges from 20 to 60 inches. The slopes range from 1 to 5 percent.	0–10 10–42 42+	Loam Clay loam Sandstone	ML–CL CL (1)	A–4 A–6 (1)
RdB RdC	Renohill sandy loam, 1 to 3 percent slopes. Renohill sandy loam, 3 to 5 percent slopes.	Similar to the Renohill loams, except that the texture of the surface layer is sandy loam. The slopes range from 1 to 9 percent.	0–10 10–42 42+	Sandy loam Loam or clay loam. Sandstone	SM–SC ML–CL (1)	A–2 or A–4 A–4 or A–6 (1)

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	Percentage passing sieve size— No. 10 (2.0 mm.)	Percentage passing sieve size— No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
95–100	95–100	75–90	0.5–0.8	0.31	7.9 to 8.6	Moderate to severe.	Moderate	Moderate	B
75–95	70–90	60–85	0.8–1.5	.24	7.9 to 8.6	Moderate to severe.	Low	Moderate to low.	
90–100	85–95	20–45	2.5–5.0	.14	7.9 to 8.4	None	Low	Low	B
50–95	50–95	25–85	0.8–5.0	.10 to .26	7.9 to 8.4	None	Low	Low	
70–90	75–85	50–70	0.8–1.5	.16	7.9 to 8.4	None	Low	Low	D
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
60–70	55–65	45–60	5–10	.14	7.8 to 8.4	None	Low	Low	B
10–20	10–20	5–15	(2)	.07	7.8 to 8.4	None	Low	Low	
60–70	55–65	45–60	5–10	.14	7.9 to 8.4	None	Low	Low	
10–20	10–20	5–15	(2)	.07	7.9 to 8.4	None	Low	Low	
60–70	55–65	45–60	1.5–5.0	.14	7.9 to 8.4	None	Low	Low	B
75–100	70–100	50–90	0.5–1.5	28 to .31	7.9 to 8.6	None	Low	Low to moderate.	
10–20	10–20	5–15	(2)	.07	7.9 to 8.4	None	Low	Low	
100	100	50–70	0.8–1.5	.28	7.9 to 8.6	None	Low	Low	C
95–100	95–100	65–85	0.5–0.8	.31	7.9 to 8.6	Moderate	Moderate	Moderate	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
90–100	90–100	60–85	0.8–1.5	.26	7.9 to 8.4	None	Low	Moderate	B
90–100	90–100	65–90	0.2–0.8	.31	7.9 to 8.4	None	Low	Moderate	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
90–100	90–100	25–40	2.5–5.0	.14	7.4 to 7.8	None	Low	Low	B
90–100	90–100	55–85	0.5–1.5	.29	7.9 to 8.4	None	Low	Moderate	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
RhB	Renohill sandy loam, moderately shallow, 1 to 3 percent slopes.					
RhC	Renohill sandy loam, moderately shallow, 3 to 5 percent slopes.					
Rk2	Renohill soils, eroded.					
RmA	Richfield silt loam, 0 to 1 percent slopes.	Deep upland soil developed in loess. The surface layer is silt loam, the subsoil is silty clay loam, and the substratum is silt loam. The slopes range from 0 to 1 percent.	0–8 8–42 42–60	Silt loam Silty clay loam. Silt loam	ML–CL CL ML–CL	A–4 A–6 A–4
RoA RoB RoC	Rocky Ford clay loam, 0 to 1 percent slopes. Rocky Ford clay loam, 1 to 3 percent slopes. Rocky Ford clay loam, 3 to 5 percent slopes.	Deep, well-drained, medium-textured soils that have a clay loam surface layer that is silted to a depth of about 12 inches. The subsoil and substratum are medium textured. These soils are on uplands or stream terraces and developed in loess. The areas on stream terraces are underlain by sand and gravel at a depth between 36 and 60 inches. Some small areas on the uplands are underlain by limestone below a depth of 36 inches. The slopes range from 0 to 5 percent.	0–12 12–60	Silty clay loam. Silt loam	CL ML	A–6 A–4
RpA	Rocky Ford clay loam, clay substratum, 0 to 1 percent slopes.	Similar to the Rocky Ford clay loams just described, except that a clay substratum is at a depth of 30 to 60 inches. On low terraces along the Arkansas River. The slopes range from 0 to 1 percent.	0–12 12–40 40–60	Clay loam Loam Clay	CL ML CH or MH	A–6 A–4 A–7
RsA RsB RsC	Rocky Fórd clay loam, sand substratum, 0 to 1 percent slopes. Rocky Ford clay loam, sand substratum, 1 to 3 percent slopes. Rocky Ford clay loam, sand substratum, 3 to 5 percent slopes.	Similar to the Rocky Ford clay loams that do not have a clay or sand substratum, but these soils have a substratum of sand or gravel at a depth of 20 to 36 inches. On low terraces along the Arkansas River. The slopes range from 0 to 5 percent.	0–10 10–28 28–60	Clay loam Loam Sand or gravel.	CL ML SP–SM or GP–GM.	A–6 A–4 A–1 or A–3
RtB RtC	Rocky Ford clay loam, over limestone, 1 to 3 percent slopes. Rocky Ford clay loam, over limestone, 3 to 5 percent slopes.	Similar to the Rocky Ford clay loams first described, except that these soils overlie limestone that is generally at a depth ranging from 20 to 36 inches. The soils are on uplands. The slopes range from 1 to 5 percent.	0–8 8–28 28+	Clay loam Loam Limestone	CL ML ([1])	A–6 A–4 ([1])
RuA RuB RwA RwB	Rocky Ford clay loam, saline, 0 to 1 percent slopes. Rocky Ford clay loam, saline, 1 to 3 percent slopes. Rocky Ford clay loam, wet, 0 to 1 percent slopes. Rocky Ford clay loam, wet, 1 to 3 percent slopes.	Similar to the Rocky Ford clay loams first described, except that these soils are moderately to severely saline and seepage has occurred as the result of irrigation. In some of the steeper areas, limestone is only 20 inches beneath the surface. The slopes range from 0 to 3 percent.	0–12 12–60+	Silty clay loam. Silt loam	CL CL or ML	A–6 A–4
Sa	Saline wet land.	Deep upland land type that has been severely affected by seepage and is strongly saline. The texture is mainly silty clay loam.	0–60	Silty clay loam.	CL	A–6

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
100	100	80–95	0. 8–1. 5	0. 29	7. 4 to 7. 8	None	Low	Low	B
100	100	85–100	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Low	Moderate	
100	100	80–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Low	
100	100	90–100	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	C
95–100	95–100	85–95	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Low	
100	100	90–100	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	C
95–100	95–100	85–95	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Low	
100	100	90–100	(3)	. 32	7. 9 to 9. 0	Slight	High	High	
100	100	90–100	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	C
95–100	95–100	85–95	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Low	
50–90	50–90	5–15	(2)	. 05	7. 9 to 8. 4	None	Low	Low	
100	100	65–85	0. 2–0. 8	. 31	7. 9 to 8. 4	None	Moderate	Moderate	C
95–100	90–100	50–75	0. 8–1. 5	. 26	7. 9 to 8. 4	None	Low	Moderate to low.	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
100	100	85–95	0. 5–0. 8	. 30	7.9 to 9.0	Moderate to severe.	Moderate	Moderate	C
100	100	80–95	0. 8–1. 5	. 29	7.9 to 9.0	Moderate to severe.	Moderate	Moderate	
100	100	70–90	0. 2–0. 5	. 31	8.5 to 9.0	Severe	Moderate	Moderate	C

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
			Inches			
Tc	Terrace escarpments.	Moderately shallow, moderately coarse textured, well-drained gravelly land type on the edges of terraces. The slopes range from about 4 to 10 percent.	0–30	Gravelly sandy loam.	SM or GM	A–2
			30–60	Loam to gravel.	ML to GM	A–4 to A–1–a.
Td ThE	Tivoli sand. Tivoli sand, hilly.	Deep soil developed in calcareous, wind-deposited sand on the sandhills. The texture throughout the profile is uniform sand or loamy sand. In some places this soil is nearly flat, but the slopes range to steep. Some areas have dune topography.	0–60	Sand or loamy sand.	SP or SP-SM.	A–3 or A–1.
Tm	Tivoli-Dune land complex.	Tivoli soil: See Tivoli sand. Dune land: Active sand dunes that have little or no vegetative cover and change in form because of shifting sand; the surface layer contains little or no organic matter but in other respects has properties similar to those of Tivoli sand.				
Tn Tr	Travessilla sandy loam. Travessilla-Rock outcrop complex.	Upland soils developed in place in material weathered from sandstone; sandstone is generally within 10 inches of the surface, and it crops out in large areas. The surface layer is sandy loam. The slopes range from 3 to 25 percent. In Travessilla-Rock outcrop complex, the Travessilla soil is like Travessilla sandy loam, and Rock outcrop consists of sandstone and does not warrant estimates.	0–8	Sandy loam	SM–SC	A–2 or A–4
			8+	Sandstone	(1)	(1)
TyB TyC Tw2	Tyrone loam, 0 to 3 percent slopes. Tyrone loam, 3 to 5 percent slopes. Tyrone soils, eroded.	Deep soils developed in material weathered from shale and limestone. The soils are on uplands. The surface layer is thin and has a loam texture. The subsoil is clay loam, and the substratum is loam. The slopes range from 0 to 5 percent.	0–6	Loam	ML	A–4
			6–36	Clay loam	CL	A–6
			36–60	Loam	ML	A–4
UnB	Ulysses sandy loam, 0 to 3 percent slopes.	Deep, well-drained soil of uplands. Developed in calcareous loess. The material below the surface layer is medium textured. The slopes range from 0 to 3 percent.	0–10	Sandy loam	SM–SC	A–2 or A–4
			10–60	Silt loam	ML–CL	A–4
UsB	Ulysses silt loam, 0 to 3 percent slopes.	Deep, well-drained soil of uplands; developed in calcareous loess. The profile is generally medium textured throughout. The slopes range from 0 to 3 percent.	0–60	Silt loam	ML–CL	A–4
VaB VaC VsB2 VsD2	Vona loamy sand, 1 to 3 percent slopes. Vona loamy sand, 3 to 5 percent slopes. Vona soils, 1 to 3 percent slopes, eroded. Vona soils, 3 to 9 percent slopes, eroded.	Deep, well-drained soils of uplands. Developed in sandy, wind-deposited material. The surface layer is loamy sand, and the subsoil is sandy loam to a depth of about 36 inches. Below a depth of about 36 inches is loamy sand. The slopes range from 0 to 5 percent.	0–8	Loamy sand	SM	A–2
			8–36	Sandy loam	SC–SM	A–2 or A–4
			36–60	Loamy sand	SM	A–2

See footnotes at end of table.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
50–80	50–80	20–35	2. 5–5. 0	0. 10	7.9 to 8.4	None	Low	Low	A
30–100	15–100	5–90	0. 8–5. 0+	.05 to . 25	7.9 to 8.4	None	Low	Low to moderate.	
100	100	0–15	(2)	. 07	7.4 to 8.4	None	Low	Low	A
75–95	70–90	25–40	2. 5–5. 0	. 12	7. 4 to 8. 4	None	Low	Low	D
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
95–100	95–100	85–95	0. 8–1. 5	. 25	7. 9 to 8. 4	None	Low	Low	B
95–100	95–100	85–95	0. 2–0. 8	. 29	7. 9 to 8. 4	None	Moderate	Moderate	
90–100	90–100	80–95	0. 8–2. 5	. 24	7. 9 to 8. 4	None	Low	Low	
100	100	25–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	B
100	100	80–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Low to moderate.	
100	100	80–95	0. 8–1. 5	. 29	7. 9 to 8. 4	None	Low	Low to moderate.	B
100	100	10–25	(2)	. 10	7. 9 to 8. 4	None	Low	Low	A
100	100	25–40	2. 5–5. 0	. 14	7. 9 to 8. 4	None	Low	Low	
100	95–100	10–25	(2)	. 10	7. 9 to 8. 4	None	Low	Low	

TABLE 4.—*Brief description of soils of Prowers County, Colo.,*

Map symbol	Soil name	Description of soil	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
VoB VoC	Vona sandy loam, 1 to 3 percent slopes. Vona sandy loam, 3 to 5 percent slopes.	Deep, well-drained soils of uplands. Developed in moderately sandy, wind-deposited material. The soils are dominantly sandy loam to a depth of about 36 inches. The substratum, below a depth of about 36 inches, ranges from loamy sand to loam in texture. The slopes range from 0 to 5 percent.	0–36 36–60	Sandy loam Loamy sand to loam.	SC–SM SM or ML	A–2 or A–4 A–2 or A–4
WaB WaC	Wiley silt loam, 0 to 3 percent slopes. Wiley silt loam, 3 to 5 percent slopes.	Deep, well-drained soils of uplands. Developed in calcareous loess. The surface layer is thin and has a texture of silt loam. The subsoil is silty clay loam, and the substratum is silt loam. The slopes range from 0 to 5 percent.	0–6 6–40 40–60+	Silt loam Silty clay loam. Silt loam	ML–CL ML–CL ML–CL	A–4 A–6 A–4
WbB2 WbC2	Wiley and Baca soils, 0 to 3 percent slopes, eroded. Wiley and Baca soils, 3 to 5 percent slopes, eroded.	The Wiley soils of these mapping units are similar to the Wiley silt loams described. For a description of the Baca soils, see the Baca clay loams.				

[1] Properties not estimated.

[2] More than 5.0.

and their estimated physical and chemical properties—Continued

Percentage passing sieve size— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water holding capacity	Reaction	Salinity	Dispersion	Shrink-swell potential	Hydrologic grouping
			Inches per hour	*Inches per inch of soil*	*pH*				
100	100	25–40	2.5–5.0	0.14	7.9 to 8.4	None	Low	Low	B
100	100	10–75	1.5–10.0	.07 to .25	7.9 to 8.4	None	Low	Low	
100	100	90–100	0.8–1.5	.29	7.9 to 8.4	None	Low	Moderate to low.	B
100	100	90–100	0.5–0.8	.30	7.9 to 8.4	None	Low	Moderate	
100	100	90–100	0.8–1.5	.29	7.9 to 8.4	None	Low	Moderate to low.	

[3] Less than 0.05.

[4] More than 2.5.

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TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Arvada (Ac)	Poor	Unsuitable	Unsuitable	Poor	Poor	Poor
Baca (BaB, BaC)	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Breaks-Alluvial land complex (Bk) (Breaks only)[1].	Good	Unsuitable	Unsuitable	Fair	Good	Fair
Campo (CaA)	Fair to poor	Unsuitable	Unsuitable	Poor	Fair	Fair
Cascajo (CdE)	Poor	Fair if screened and washed.	Good	Good	Good	Fair
Colby:						
Colby silt loams and Colby fine sandy loams (CfA, CfB, CfAB, CfC, CmA, CmB, CmAB, CmC).	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Colby silt loam, clay substratum (CoA).	Good	Unsuitable	Unsuitable	Fair above clay substratum.	Poor	Fair
Colby silt loam, sand substratum (CsA).	Good	Good below a depth of 24 inches if screened and washed.	Fair below a depth of 24 inches if screened and washed.	Good	Good	Good
Colby-Ulysses complex (CuB) (Colby soil).[2]	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Dune land (Du)	Poor	Good if screened and washed.	Unsuitable	Fair	Good	Poor

See footnotes at end of table.

properties of soils in Prowers County, Colo.

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Poor internal drainage, poor bearing strength, and low stability.	Highly erodible, has low stability, and cracks badly; contains strata of gypsum.	Low seepage	Slow permeability but has low stability and erodible slopes.	High content of salt and of gypsum; fairly shallow over shale; slow permeability; difficult to drain.	Very slow intake rate, low available water capacity, and high in content of salt; surface layer puddles.
Fair bearing strength; high in content of silt.	Fair stability; slow permeability when packed.	Low seepage	Fair stability and slow permeability when packed.	Not needed	Moderately slow to moderate permeability and intake rate; high water-holding capacity.
Steep and high in content of silt.	Fair stability	In swale areas	Fair stability	Not needed	Steep slopes, but high water-holding capacity.
Susceptible to flooding; highly plastic when wet and slopes are unstable; fair bearing strength.	Cracks when dry; very slow permeability.	Low seepage	Low stability and cracks when dry, but has very slow permeability.	Not needed	Very slow surface drainage, and very slow permeability.
Highly stable, but hilly.	Rapid permeability, but stable slopes.	Rapid permeability.	Rapid permeability, but stable slopes.	Not needed	Very low water-holding capacity; poor agricultural soil; very rapid permeability; hilly.
Nearly level to gently undulating; high content of silt; fair bearing strength.	Erodible slopes; slow permeability when packed; fair stability.	Low seepage	Fair stability; slow permeability when packed; erodible slopes.	Not needed	High water-holding capacity; nearly level to gently rolling; the silt loams have a moderately slow intake rate.
Fair stability and fair bearing strength; high content of silt.	Fair stability and slow permeability when packed; erodible slopes.	Low seepage	Fair stability; erodible slopes; slow permeability when packed.	Clay substratum very slowly permeable; nearly level and is on low stream terraces.	High water-holding capacity; clay substratum very slowly permeable; nearly level.
Good stability; good bearing strength; nearly level.	Moderate permeability; erodible slopes; good stability; rapidly permeable below a depth of 24 inches.	Rapid permeability below a depth of 24 inches.	Rapid permeability below a depth of 24 inches; erodible slopes; good stability.	Sand substratum has rapid permeability; nearly level.	Uppermost 24 inches has high water-holding capacity; substratum rapidly permeable; nearly level.
High content of silt	Fair stability; erodible slopes.	Low seepage	Fair stability; erodible slopes.	Not needed	High water-holding capacity.
Good stability; erodible slopes.	Rapid permeability; erodible slopes.	Rapid permeability.	Rapid permeability	Not needed	Very poor agricultural soil; very low water-holding capacity; highly erodible.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Fort Collins (FcB, FcC, FnC)	Good	Upland areas fair below a depth of 30 inches if soil material is screened and washed; terrace areas contain little or no sand.	Upland areas fair below a depth of 30 inches if soil material is screened and washed; terrace areas contain little or no gravel.	Upland areas good.	Upland areas good; terrace areas fair.	Good
Glendive:						
Glendive fine sandy loams and Glendive and Havre fine sandy loams (GaA, GaB, GaAB, Gf, GhA, GhB, GhAB) (Glendive soil).[3]	Fair	Fair for sand below a depth of about 18 inches if screened and washed.	Fair in places, but gravel is in pockets and may be difficult to locate; in some areas the substratum is loam and there is no gravel.	Good	Good	Fair; subject to flooding in places.
Glendive fine sandy loam, clay substratum (Gc).	Fair	Poor	Unsuitable	Good above the clay substratum.	Fair	Fair; subject to flooding in places.
Glendive and Havre soils, sand substrata)GnA, GnB, GnAB) (Glendive soil).[3]	Fair	Good below a depth of 2 feet if screened and washed.	Good below a depth of 2 feet if screened and washed.	Good	Good	Fair; subject to flooding in places.
Goshen (Go)	Good	Unsuitable	Unsuitable	Fair	Fair	Fair; subject to flooding in places.
Harvey (HaA, HaB, HaAB, HaC, HaD2).	Good	Generally unsuitable, but substratum contains sand in some places.	Generally unsuitable, but substratum contains gravel in some places.	Good	Fair	Good
Havre (Hm)	Good	Fair	Poor	Good	Good	Fair; subject to flooding in places.
Kornman:						
Kornman clay loam (KcA, KcB, KwA).	Good	Fair below a depth of 2 feet if screened and washed.	Fair in places; the gravel is in pockets and may be difficult to locate.	Good	Good	Fair

See footnotes at end of table.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Good bearing strength; good stability; rolling.	Slow permeability when packed; good stability; good bearing strength.	Upland areas have high water seepage below a depth of 30 inches; terrace areas have low seepage.	Slow permeability when packed; good stability; good bearing strength.	Not needed	Upland areas rapidly permeable below a depth of 30 inches; moderate to high water-holding capacity; nearly level to rolling.
Good stability; high bearing strength; subject to flooding in places.	Good stability; good bearing strength.	Rapid permeability.	Good stability; moderate permeability when packed.	Generally not needed, but rapidly permeable in substratum.	Rapidly permeable; low water-holding capacity; fair agricultural soils; nearly level.
Good stability; high bearing strength; subject to flooding in places.	Moderate permeability when packed; slow permeability in substratum.	Low seepage	Good stability; high bearing strength.	Slowly permeable; substratum hard to drain.	Slowly permeable substratum; nearly level.
High bearing strength; good stability; nearly level.	Rapid permeability; good stability in uppermost 24 inches.	Rapid permeability.	Rapid permeability below a depth of 24 inches; uppermost 24 inches has good stability.	Generally not needed, but substratum rapidly permeable.	Very low water-holding capacity; rapidly permeable.
Fair stability; high in content of silt; subject to flooding; fair bearing strength.	Slow permeability when packed; fair stability.	Low seepage	Fair stability; slow permeability when packed.	Not needed	Moderate permeability; high water-holding capacity; nearly level; subject to flooding in places.
Good stability; high bearing strength.	Slow permeability when packed; good stability.	Low seepage	Good stability; slow permeability when packed.	Moderately permeable substratum.	Moderate to slow permeability; high water-holding capacity.
Good stability; high bearing strength; subject to flooding.	Slow permeability when packed.	Moderate seepage.	Slow permeability when packed; good stability.	Generally not needed, but drains easily where drainage is necessary; moderate to moderately rapid permeability.	Medium water-holding capacity; moderate to moderately rapid permeability and water intake rate.
High bearing strength; good stability; nearly level.	Rapid permeability below surface layer; good stability.	Rapid permeability below surface layer.	Uppermost 2 feet good fill material; good stability; slow permeability when packed.	Generally not needed, but rapid permeability in substratum.	Moderate to slow permeability in the surface layer.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Kornman—Continued Kornman clay loam, clay substratum (KmA).	Fair	Poor	Unsuitable	Good above clay substratum.	Fair	Fair
Kornman clay loam, sand substratum (KnA).	Good	Good below a depth of 28 inches if screened and washed.	Good below a depth of 28 inches if screened and washed.	Good	Good	Good
Las: Las loam, Las clay loam, and Las sandy loam (La, Lb, Lc, Ld, Ls).	Fair	Unsuitable, except that (La) is good for sand below a depth of 48 inches if screened and washed.	Unsuitable, except that (La) is fair for gravel below a depth of 48 inches if screened and washed.	Good	Fair to poor	Fair to poor
Las clay loam, saline (Lm).	Fair	Unsuitable	Unsuitable	Poor	Poor	Poor
Las clay loam, sand substratum, and Las clay loam, sand substratum, saline (Ln, Lo).	Fair	(Lo) is good for sand below a depth of 48 inches if screened and washed; (Ln) is good below a depth of 24 inches if screened and washed.	(Lo) is fair for gravel below a depth of 48 inches if screened and washed; (Ln) is fair below a depth of 24 inches if screened and washed.	Good	Good to poor	Fair
Las clay loam, wet, saline (Lp).	Poor	Poor	Unsuitable	Poor	Poor	Poor
Las Animas (Lt)	Poor	Good below a depth of 30 inches.	Good below a depth of 30 inches.	Good below a depth of 30 inches.	Poor without drainage.	Poor
Lincoln (Lu, Lv)	Lincoln sand poor; Lincoln loam fair.	Good	Good	Good	Good	Poor
Lismas: Lismas clay loam and Lismas-Shale outcrop complex (Lw, Lx).	Poor	Unsuitable	Unsuitable	Fair	Poor	Poor

See footnotes at end of table.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Good stability; good bearing strength; subject to flooding in places.	Moderate permeability when packed; slow permeability in substratum.	Low seepage	Upper part good fill material; good stability; slow permeability when packed.	Slowly permeable substratum; hard to drain.	Slowly permeable substratum; nearly level.
Good stability; good bearing strength; subject to flooding in places.	Rapid permeability	Rapid permeability.	Rapid permeability below a depth of 28 inches; uppermost 28 inches has good stability.	Generally not needed; rapidly permeable substratum.	Low water-holding capacity except for surface layer.
Poor drainage; fair bearing strength; susceptible to frost action.	Fair stability; slow permeability when packed.	Low seepage	Fair stability; slow permeability when packed.	Needs drainage; slow permeability; drainage outlets hard to establish in some places.	Poor drainage; saline; slow to moderate permeability and intake rate.
Poor internal drainage; plastic clay; unstable slopes; poor bearing strength; susceptible to frost action; nearly flat.	Unstable slopes for drainage ditches; cracks when dry.	Low seepage	Low strength and stability; slow permeability; cracks when dry.	High water table; slow permeability; outlets may be difficult to obtain because of slope; subsurface drainage difficult; nearly flat.	High in content of salt; low intake rate; high water table.
Imperfect to poor drainage; susceptible to frost action; fair bearing strength.	Fair stability; slow permeability when packed.	Rapid permeability in substratum.	Slow permeability when packed.	Imperfectly to poorly drained; rapid permeability in substratum; nearly level.	Imperfectly to poorly drained; saline; moderate water-holding capacity.
Poor internal drainage; plastic clay; unstable slopes; poor bearing strength; susceptible to frost action.	Unstable slopes; cracks when dry.	Low seepage	Low strength and stability; slow permeability; cracks when dry.	High water table; outlets for drainage hard to establish; clay substratum very slowly permeable.	High content of salt; slow intake rate; high water table.
High water table; poor bearing strength; low stability; saline.	Fair stability; rapid permeability; severely saline.	Rapid permeability.	Fair stability; rapid permeability; severely saline.	High water table; severely saline; subsurface drainage difficult.	High content of salt; high water table; low water-holding capacity; severely saline.
Subject to flooding; good stability; good bearing strength.	Rapid permeability	Rapid permeability.	Rapid permeability	Not needed	Very low water-holding capacity; poor agricultural soils; subject to flooding.
Hilly; fair stability; erodible slopes; fair bearing strength; shallow to shale.	Erodible slopes; low seepage; fair stability.	Low seepage	Erodible slopes; slow permeability; fair stability.	Not needed	Very slow intake rate; very shallow over shale; poor agricultural soils.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of— Topsoil	Sand	Gravel	Road fill	Suitability for— Septic tank fields	Homesites
Loamy alluvial land (Ly)	Good	Unsuitable	Unsuitable	Fair	Fair	Poor
Manvel:						
Manvel loam and Manvel and Minnequa loams (MaA, MmC) (Manvel soil).	Fair	Unsuitable	Unsuitable	Fair	Poor	Fair
Minnequa	Fair	Unsuitable	Unsuitable	Fair	Poor	Fair
Nepesta:						
Nepesta clay loam (NmA, NmB).	Fair to poor	Generally unsuitable, but in some small areas the substratum is suitable as a source of sand.	Generally unsuitable, but in some small areas the substratum is gravelly and is suitable as a source of gravel.	Generally poor in surface layer and fair below the surface layer, but in some small areas the substratum is gravelly and is good for road fill.	Generally fair, but in some small areas the substratum is gravelly and is good for sewage disposal.	Fair
Nepesta clay loam, saline, and Nepesta clay loam, wet (NpA, NpB, NsA).	Poor	Unsuitable	Unsuitable	Poor	Poor	Poor
Numa:						
Numa clay loam (NtA, NtB, NtC).	Good	Unsuitable	Unsuitable	Fair	Good	Good
Numa clay loam, saline, and Numa clay loam, wet (NuB, NwB).	Poor	Unsuitable	Unsuitable	Fair	Fair to poor	Fair to poor
Otero (OtB, OtC)	Fair	Poor below a depth of 25 inches; must be screened and washed; sand is in pockets and may be difficult to find.	Unsuitable	Good	Good	Good

See footnotes at end of table.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds: Reservoir area	Farm ponds: Embankments	Agricultural drainage	Irrigation
Fair bearing strength; fair stability.	Slow permeability when packed; erodible slopes; fair stability.	Low seepage; in swale areas.	Slow permeability when packed; fair stability.	Not needed	Subject to overflow; in swales and nearly level; high water-holding capacity.
Bedrock at a depth of 40 to 60 inches; fair bearing strength; fair stability.	Erodible slopes; slow permeability when packed; fair stability.	Low seepage	Fair stability; slow permeability when packed; erodible slopes.	Not needed	High water-holding capacity to bedrock; limestone at a depth of 20 to 60 inches.
Bedrock at a depth of 20 to 40 inches.	Erodible slopes	Low seepage	Fair stability	Not needed	High water-holding capacity to bedrock; limestone or shale at a depth of 20 to 40 inches.
Fair bearing strength; high content of silt.	Fair stability; slow permeability when packed; surface layer cracks when dry.	Low seepage	Fair stability; slow permeability when packed; surface layer cracks when dry.	Not needed	Slow to very slow permeability and intake rate.
Poor drainage; low bearing strength; susceptible to frost action.	Low stability; slow permeability; surface layer cracks when dry.	Low seepage	Low stability; erodible slopes; surface layer cracks when dry.	Seasonal high water table; highly saline; slowly permeable.	Highly saline; seasonal water table; slow to very slow permeability and intake rate.
Good stability; high bearing strength.	Slow permeability when packed; good stability.	Moderate permeability below surface layer.	Slow permeability when packed; good stability.	Not needed in most places; substratum rapidly permeable.	Moderately permeable; moderate water-holding capacity.
Fair stability; high bearing strength; high water table.	Fair stability; slow permeability when packed.	Low seepage	Good stability; slow permeability when packed.	High water table; moderately to severely saline; moderate permeability.	Moderate water-holding capacity; high water table or seeped; moderately to severely saline.
Good stability; good bearing strength.	Good stability; moderate to rapid permeability.	Moderate to rapid permeability.	Good stability; moderate to rapid permeability.	Not needed	Moderate to rapid permeability and intake rate; low to medium water-holding capacity; variable slopes.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Penrose: Penrose loam and Penrose-Rock outcrop complex (PaC, Pk) (Penrose soil).	Poor	Unsuitable	Unsuitable	Fair	Poor	Poor
Potter and Nihill gravelly soils (PnC) (Potter soil).	Poor	Fair if screened and washed.	Good	Good	Good	Fair to poor
Nihill soil	Poor	Fair if screened and washed.	Good	Good	Good	Fair to poor
Potter and Stoneham gravelly loams (PsE) (Potter soil).	Poor	Fair if screened and washed.	Good	Good	Good	Fair to poor
Stoneham soil	Fair	Poor; 20 to 48 inches of overburden.	Good; 20 to 48 inches of overburden.	Good	Good	Fair to good
Pultney (PuC)	Fair	Unsuitable	Unsuitable	Poor	Poor	Poor
Renohill (RaB, RaC, RbB, RbC, RdB, RdC, RhB, RhC, Rk2).[4]	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Richfield (RmA)	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Rocky Ford: Rocky Ford clay loam (RoA, RoB, RoC).	Good	Generally unsuitable, but some areas have a sand substratum below a depth of 36 inches and are a fair source of sand.	Generally unsuitable, but some areas have a sand substratum below a depth of 36 inches and are a fair source of gravel.	Fair to good	Fair to good	Good

See footnotes at end of table.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Hilly; good stability; stable slopes; limestone at a depth of about 11 inches.	Rapid permeability	Low seepage	Rapid permeability; good stability; stable slopes.	Not needed	Very shallow over limestone; poor agricultural soils; very low water-holding capacity.
Good stability; good bearing strength; hilly.	Rapid permeability; stable slopes.	Rapid permeability.	Rapid permeability but stable slopes.	Not needed	Very low water-holding capacity; poor agricultural soil; very rapidly permeable; hilly.
Good stability	Rapid permeability	Rapid permeability.	Rapid permeability but stable slopes.	Not needed	Very low water-holding capacity.
Good stability; good bearing strength; hilly.	Rapid permeability; stable slopes.	Rapid permeability.	Rapid permeability but stable slopes.	Not needed	Very low water-holding capacity; poor agricultural soil; very rapidly permeable; hilly.
Good stability; good bearing strength; hilly.	Stable slopes	Rapid permeability.	Rapid permeability; stable slopes.	Not needed	Low to moderate water-holding capacity.
Bedrock at a depth of 20 to 60 inches; poor bearing strength; erodible slopes; fair stability.	Erodible slopes; contains gyp strata; fair stability.	Moderate seepage; contains gyp strata.	Erodible slopes; contains gyp strata; fair stability.	Not needed	Shale and limestone at a depth of 20 to 60 inches; high water-holding capacity over bedrock; rolling; medium intake rate.
Bedrock at a depth of 20 to 60 inches; rolling; good bearing strength; good stability.	Good stability; slow permeability when packed.	Low seepage	Slow permeability when packed; good stability.	Not needed	Moderately permeable; impermeable bedrock at a depth of 20 to 60 inches; rough topography.
High in content of silt; fair bearing strength; flat.	Fair stability; slow permeability when packed.	Low seepage	Slow permeability when packed; fair stability.	Not needed	Moderately slow intake rate and permeability; high water-holding capacity; nearly level; good agricultural soil.
Nearly level; fair bearing strength; fair stability.	Slow permeability when packed; erodible slope; fair bearing strength; fair stability.	Low seepage	Slow permeability when packed; erodible slopes; fair bearing strength; fair stability.	Not needed	High water-holding capacity; nearly level; clay loams have moderately slow intake rate; good agricultural soils.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Rocky Ford—Continued						
Rocky Ford clay loam, clay substratum (RpA).	Good	Unsuitable	Unsuitable	Fair above clay substratum.	Fair to poor	Fair
Rocky Ford clay loam, sand substratum (RsA, RsB, RsC).	Good	Fair below a depth of 24 inches if screened and washed.	Fair below a depth of 24 inches if screened and washed.	Fair to good	Good	Good
Rocky Ford clay loam, over limestone (RtB, RtC).	Good	Unsuitable	Unsuitable	Fair	Poor	Fair
Rocky Ford clay loam, saline, and Rocky Ford clay loam, wet (RuA, RuB, RwA, RwB).	Poor	Unsuitable	Unsuitable	Poor	Poor	Poor
Saline wet land (Sa)	Poor	Unsuitable	Unsuitable	Poor	Poor	Poor
Terrace escarpments (Tc)	Poor	Poor	Fair to poor	Good	Good	Poor
Tivoli sand and Tivoli-Dune land complex (Td, ThE, Tm) (Tivoli soil).[5]	Poor	Good if screened and washed.	Unsuitable	Fair; difficult to confine.	Good	Fair to poor
Travessilla sandy loam and Travessilla-Rock outcrop complex (Tn, Tr) (Travessilla soil).	Poor	Unsuitable	Unsuitable	Bedrock at a depth of 8 inches.	Poor	Poor
Tyrone (TyB, TyC, Tw2)	Good	Unsuitable	Unsuitable	Fair	Fair	Good
Ulysses (UnB, UsB)	Good	Unsuitable	Unsuitable	Fair	Fair	Good

See footnotes at end of table.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Nearly level; fair bearing strength; fair stability.	Slow permeability when packed; erodible slopes; fair bearing strength.	Low seepage	Slow permeability when packed; erodible slopes; fair bearing strength.	Clay substratum very slowly permeable.	High water-holding capacity; clay substratum very slowly permeable; flat topography; moderately slow intake rate.
Nearly level; good bearing strength; good stability.	Slow permeability in uppermost 24 inches when packed; erodible slopes; fair bearing strength.	High seepage below a depth of 24 inches.	Slow permeability in uppermost 24 inches when packed; fair bearing strength; erodible slopes.	Not needed	Moderate water-holding capacity; substratum rapidly permeable; flat; moderately slow intake rate.
Rolling topography; good stability; good bearing strength; limestone at a depth of 20 to 36 inches.	Slow permeability when packed; good stability; good bearing strength.	Low seepage	Slow permeability when packed; good stability; good bearing strength.	Impermeable limestone at a depth of 20 to 36 inches.	Moderate water-holding capacity; impermeable limestone; moderately slow intake rate; rolling.
Poor drainage; low bearing strength; high in content of silt.	Low stability; slow permeability when packed; surface layer cracks when dry.	Low seepage	Low stability; slow permeability when packed; high in content of silt.	Moderately permeable subsoil and substratum; in some small areas limestone is in the substratum; seasonally high water table; moderate to severe salinity.	Moderate to severe salinity; high water table or seepage; high water-holding capacity.
Poor drainage; low bearing strength; severe salinity.	Low stability; slow permeability when packed.	Low seepage	Low stability; slow permeability when packed.	Slowly permeable subsoil and substratum; high water table; severe salinity.	Severe salinity; high water table or seepage; high water-holding capacity.
Steep slopes; high bearing strength.	High stability; rapid permeability.	High seepage	High stability; rapid permeability.	Not needed	Steep slopes; low water-holding capacity; gravelly.
Good stability; erodible slopes; hilly in places.	Erodible slopes; good stability; rapid permeability.	Rapid permeability.	Erodible slopes; rapid permeability; good stability.	Not needed	Very low water-holding capacity; poor agricultural soils; rapidly permeable; highly erodible.
Good stability; hilly; bedrock at a depth of about 8 feet.	Rapid permeability; erodible slopes; bedrock at a depth of about 8 feet; hilly.	Low seepage	Rapid permeability; erodible slopes; bedrock at a depth of about 8 feet.	Not needed	Very low water-holding capacity; hilly; bedrock at a depth of about 8 feet; poor agricultural soils.
Gently rolling; high in content of silt; fair bearing strength.	Erodible slopes; slow permeability when packed; fair stability.	Low seepage	Fair stability; slow permeability when packed; erodible slopes.	Not needed	High water-holding capacity; gently rolling.
Nearly level; high in content of silt; fair bearing strength.	Slow permeability when packed; fair stability.	Low seepage	Fair stability; slow permeability when packed.	Not needed	High water-holding capacity; nearly level to gently rolling; moderate intake rate; good agricultural soils.

TABLE 5.—*Interpretation of engineering*

Soil and map symbol	Suitability as source of—				Suitability for—	
	Topsoil	Sand	Gravel	Road fill	Septic tank fields	Homesites
Vona:						
Vona loamy sand and Vona soils, eroded (VaB, VaC, VsB2, VsD2).	Poor	Good if screened and washed.	Unsuitable	Good	Good	Fair to poor
Vona sandy loam (VoB, VoC).	Fair	Fair if screened and washed.	Unsuitable	Good	Good	Good
Wiley silt loam and Wiley and Baca soils (WaB, WaC, WbB2, WbC2) (Wiley soil).[6]	Good	Unsuitable	Unsuitable	Fair	Fair	Good

[1] Interpretations not given for Alluvial land, because Alluvial land is too variable to warrant estimates.
[2] Mostly Colby silt loam. For interpretations for Ulysses soil, see the Ulysses series.
[3] Mostly Glendive fine sandy loam. Interpretations for the Havre soil are like those for the Havre series, except for the surface layer.

properties of soils in Prowers County, Colo.—Continued

Soil features affecting—					
Highway location	Dikes and diversions	Farm ponds		Agricultural drainage	Irrigation
		Reservoir area	Embankments		
Good stability; erodible slopes; rolling.	Rapid permeability; erodible slopes.	Rapid permeability.	Rapid permeability; good stability; erodible slopes.	Not needed	Poor agricultural soils; very low water-holding capacity; rapidly permeable; highly erodible.
Good stability; good bearing strength; gently rolling.	Moderate permeability when packed; good stability; erodible slopes.	Moderate to rapid permeability.	Moderate permeability when packed; good stability.	Not needed	Rapidly permeable; low water-holding capacity; rolling; fair agricultural soils.
Nearly level to gently rolling; high in content of silt; fair bearing strength; fair stability.	Slow permeability when packed; erodible slopes; fair stability.	Low seepage	Slow permeability when packed; erodible slopes; fair stability.	Not needed	Nearly level to gently rolling; high water-holding capacity; good agricultural soils; moderate intake rate.

[4] Somewhat variable because of differences in the texture of the surface layer. In some places the surface layer is loam, and in other places it is sandy loam. Also, bedrock is at variable depths.
[5] For interpretations for Dune land, see Dune land.
[6] For interpretations for Baca soils, see the Baca series.

TABLE 6.—*Engineering*

Soil name and location	Parent material	Bureau of Public Roads report No.	Depth	Horizon
			Inches	
Baca clay loam:				
0.3 mile E. and 0.7 mile S. of NW. corner of sec. 5, T. 21 S., R. 46 W. (Modal profile)	Loess.	S34983	0–2	Ap
		S34984	6–11	B2ca
		S34985	33–44	C2
330 feet E. and 100 feet S. of N¼ corner of sec. 10, T. 21 S., R. 46 W. (Modal profile)	Loess.	S34986	0–3	Ap
		S34987	6–13	B2ca
		S34988	45–60+	C3
0.35 mile N. of SW. corner of sec. 30, T. 27 S., R. 44 W. (Deeply developed B horizon)	Loess.	S35333	0–5	A1
		S35334	5–13	B21
		S35335	45–65+	C
0.4 mile E. and 0.1 mile S. of NW. corner of sec. 30, T. 21 S., R. 44 W. (Coarse-textured B horizon)	Loess.	S35336	0–4	Ap
		S35337	6–18	B2
		S35338	48–65+	C
Colby silt loam:				
540 feet S. and 150 feet E. of W¼ corner of sec. 28, T. 23 S., R. 47 W. (Modal profile)	Loess.	S35003	27–44	C3
150 feet S. and 450 feet E. of NW. corner of sec. 34, T. 23 S., R. 47 W. (Modal profile)	Loess.	S35004	31–60+	C3
600 feet E. and 30 feet N. of SW. corner of sec. 33, T. 23 S., R. 47 W. (Silt loam C horizon)	Loess.	S35005	23–60	C2
0.2 mile E. and 100 feet N. of SW. corner of sec. 1, T. 21 S., R. 45 W. (C2 horizon of reddish loam)	Loess.	S35346	48–60+	C2
Fort Collins loam:				
0.35 mile E. and 100 feet S. of NW. corner of sec. 3, T. 22 S., R. 47 W. (Modal profile)	Material weathered from Tertiary outwash (Ogallala formation).	S35353	0–6	A1
		S35354	10–20	B2
		S35355	30–45	Cca
		S35356	45–72+	D
0.1 mile W. and 150 feet S. of center of sec. 15, T. 26 S., R. 44 W. (Coarse-textured profile)	Material weathered from Tertiary outwash (Ogallala formation).	S35357	0–4	A1
		S35358	4–11	B2
		S35359	20–38	Cca1
		S35360	50–65+	D
0.2 mile S. of NE. corner of sec. 20, T. 27 S., R. 44 W. (Sandy loam C horizon)	Material weathered from Tertiary outwash (Ogallala formation).	S35361	0–4	A1
		S35362	4–11	B2
		S35363	36–54	Cca
		S35364	54–72+	D
Renohill loam:				
700 feet N. and 165 feet W. of SE. corner of sec. 25, T. 26 S., R. 46 W. (Modal profile)	Material weathered from Dakota sandstone with loess influence.	S34998	0–6	Ap
		S34999	6–10	B21
		S35000	15–26	B23
100 feet S. and 200 feet W. of N¼ corner of sec. 10, T. 26 S., R. 46 W. (Shallow profile)	Material weathered from Dakota sandstone.	S35001	0–3	Ap
		S35002	7–20	B22cs
0.4 mile W. of NE. corner of sec. 14, T. 26 S., R. 47 W. (Coarse-textured B horizon)	Material weathered from Dakota sandstone.	S35342	0–4	A1
		S35343	11–19	B22
		S35344	26–41	Cca
		S35345	41–48	C1
Richfield silt loam:				
100 feet S. and 50 feet W. of N¼ corner of sec. 21, T. 26 S., R. 42 W. (Modal profile)	Loess.	S35006	0–3	Ap
		S35007	6–15	B21
		S35008	57–116	C3

See footnotes at end of table.

test data [1]

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage passing sieve [3]—			Percentage smaller than—						AASHO	Unified
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	98	83	68	45	33	26	32	10	A-4(8)	ML-CL.
----------	----------	95	87	62	45	39	49	24	A-7-6(15)	CL.
----------	----------	98	91	55	28	20	33	10	A-4(8)	ML-CL.
100	99	89	76	50	35	29	35	12	A-6(9)	ML-CL.
100	99	94	87	63	44	38	48	23	A-7-6(15)	CL.
----------	----------	98	91	55	27	20	30	8	A-4(8)	ML-CL.
100	99	91	81	45	24	17	28	6	A-4(8)	ML-CL.
100	98	88	81	54	36	31	40	17	A-6(11)	CL.
----------	----------	99	94	61	34	25	33	11	A-6(8)	ML-CL.
100	99	87	72	45	28	22	31	9	A-4(8)	ML-CL.
----------	100	90	78	49	35	30	40	18	A-6(11)	CL.
----------	----------	97	89	56	32	24	32	9	A-4(8)	ML-CL.
----------	----------	83	71	40	19	15	26	4	A-4(8)	ML-CL.
----------	----------	92	80	45	24	18	29	6	A-4(8)	ML-CL.
----------	----------	93	84	48	24	19	29	8	A-4(8)	ML-CL.
96	86	67	62	44	31	26	36	18	A-6(10)	CL.
100	91	69	56	30	18	13	24	4	A-4(7)	ML-CL.
100	93	80	73	53	41	34	36	17	A-6(11)	CL.
90	74	53	50	40	30	22	25	6	A-4(4)	ML-CL.
70	36	22	21	16	13	8	22	9	A-2-4(0)	SC.
100	87	59	49	25	12	9	21	4	A-4(5)	ML-CL.
100	83	47	41	26	16	13	25	7	A-4(2)	SM-SC.
100	66	29	27	18	13	8	22	6	A-2-4(0)	SM-SC.
100	88	37	32	24	19	15	28	12	A-6(1)	SC.
97	83	62	53	27	13	9	24	5	A-4(5)	ML-CL.
100	89	68	61	38	23	19	30	12	A-6(7)	CL.
100	77	37	33	24	18	15	18	5	A-4(0)	SM-SC.
94	52	16	14	10	8	5	[4] NP	[4] NP	A-2-4(0)	SM.
100	96	82	73	42	26	22	28	7	A-4(8)	ML-CL.
100	97	79	70	41	24	21	31	11	A-6(8)	CL.
100	98	82	75	51	36	31	34	15	A-6(10)	CL.
94	90	47	40	24	16	12	20	4	A-4(2)	SM-SC.
97	96	67	63	47	36	30	31	13	A-6(8)	CL.
100	99	79	70	43	27	22	29	9	A-4(8)	CL.
100	97	64	61	46	34	29	30	15	A-6(8)	CL.
94	86	56	54	43	34	26	27	10	A-4(4)	CL.
[5] 100	94	59	55	47	39	31	27	12	A-6(6)	CL.
----------	----------	97	87	48	31	24	31	9	A-4(8)	ML-CL.
----------	----------	96	87	50	32	27	36	15	A-6(10)	CL.
----------	----------	98	92	59	31	23	32	9	A-4(8)	ML-CL.

TABLE 6.—*Engineering*

Soil name and location	Parent material	Bureau of Public Roads report No.	Depth	Horizon
			Inches	
Richfield silt loam—Continued				
700 feet W. and 90 feet N. of S¼ corner of sec. 32, T. 26 S., R. 42 W. (Modal profile)	Loess.	S35009 S35010 S35011	0–4 7–12 49–70	Ap B21 C3
200 feet S. of E¼ corner of sec. 29, T. 27 S., R. 41 W. (Buried B horizon)	Loess.	S35347 S35348 S35349	0–4 6–15 38–64+	Ap B21 C
0.25 mile W. and 100 feet S. of NE. corner of sec. 34, T. 25 S., R. 42 W. (Coarse-textured B2 horizon)	Loess.	S35350 S35351 S35352	0–6 8–17 38–60+	Ap B21 C
Wiley silt loam:				
800 feet E. and 700 feet S. of NW. corner of sec. 8, T. 24 S., R. 45 W. (Modal profile)	Loess.	S34989 S34990 S34991	0–4 10–17 41–60	Ap B22 C2
50 feet E. and 600 feet N. of center of sec. 17, T. 24 S., R. 45 W. (Modal profile)	Loess.	S34992 S34993 S34994	0–5 5–13 43–61	Ap B21 C2
150 feet N. and 250 feet E. of W¼ corner of sec. 8, T. 24 S., R. 45 W. (Maximal profile)	Loess.	S34995 S34996 S34997	2–8 13–27 41–60+	B21 B3ca C
225 feet S. and 360 feet W. of center of sec. 24, T. 21 S., R. 46 W. (Coarse-textured B horizon)	Loess.	S35339 S35340 S35341	0–5 5–13 38–96+	A1 B21 C

[1] Tests performed by the Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

[2] Mechanical analyses according to the American Association of State Highway Officials Designation T88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the

It also affects the rate of soil formation and such soil characteristics as erodibility and natural fertility. Parent material affects the rate of soil formation through resistance or lack of resistance of the parent material to weathering.

In Prowers County the six major kinds of parent material are windblown silty material, windblown sandy material, alluvium, outwash or old alluvium, material weathered from sandstone, and material weathered from limestone and shale. The formations underlying the county and the kinds of material from which parent material has weathered are described in the section "Geology."

Windblown silty material.—This parent material is calcareous and is about 45 to 70 percent silt; only a small amount is coarser than very fine sand. Probably, all of the windblown material was deposited within the same geologic period, but not all of the soils that developed in windblown silty material are of the same age. Certain differences in age may have been brought about because some soils were more eroded than others in prehistoric times. Other differences may have been caused as a result of differences in the climate or in relief.

Soils that developed in windblown silty material occupy the largest acreage in the county. The soils that developed in such material are those of the Goshen, Richfield, Ulysses, Colby, Baca, Campo, and Wiley series. The Nepesta and Rocky Ford soils developed mainly in windblown silty material, but siltation has affected their upper horizons to some extent. In some areas of Rocky Ford soils on stream terraces, alluvium has been mixed with the windblown material.

Windblown sandy material.—This parent material is mainly calcareous fine or medium sand that was deposited in Recent geologic time and is resistant to weathering. This material is generally presumed to have been blown out of the streambeds by wind, for it is deepest and coarsest textured in areas adjacent to the stream valleys and is progressively shallower and finer textured with distance from the stream. The amount of silt and clay in the material back from the stream normally increases with distance from the stream, and eventually it grades to loess.

The soils developed in this sandy material have been affected more by the composition of the parent material *test data* [1]—Continued

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage passing sieve [3]—			Percentage smaller than—							
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified
100	99	92	82	48	28	21	30	8	A-4(8)	ML-CL.
----------	----------	96	88	58	39	34	42	18	A-7-6(12)	ML-CL.
----------	----------	98	94	63	35	26	33	9	A-4(8)	ML-CL.
100	98	90	81	50	35	29	34	14	A-6(10)	CL.
100	99	96	91	61	42	36	48	24	A-7-6(15)	CL.
----------	----------	98	94	66	39	31	42	19	A-7-6(12)	CL.
----------	100	94	83	43	26	21	30	9	A-4(8)	ML-CL.
----------	----------	96	87	56	38	32	42	18	A-7-6(12)	ML-CL.
----------	----------	97	91	58	30	21	34	11	A-6(8)	ML-CL.
----------	----------	94	83	49	29	24	32	10	A-4(8)	ML-CL.
----------	----------	98	91	58	36	29	38	16	A-6(10)	CL.
----------	----------	98	91	55	30	22	32	10	A-4(8)	ML-CL.
----------	----------	96	84	48	28	21	33	11	A-6(8)	ML-CL.
----------	----------	97	91	57	36	30	37	14	A-6(10)	ML-CL.
----------	----------	98	92	55	27	20	30	8	A-4(8)	ML-CL.
----------	----------	96	87	54	35	29	39	14	A-6(10)	ML-CL.
----------	----------	99	94	64	41	35	42	17	A-7-6(11)	ML-CL.
----------	----------	98	92	56	28	22	32	10	A-4(8)	ML-CL.
100	99	93	84	52	31	25	34	10	A-4(8)	ML-CL.
----------	100	93	84	53	35	29	39	15	A-6(10)	ML-CL.
----------	----------	98	91	55	31	25	32	10	A-4(8)	ML-CL.

fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] 100 percent of Sample S35364 passed a 2-inch sieve; 100 percent of Samples S35001, S35355, and S35356 passed a 1½-inch sieve; 100 percent of Sample S35002 passed a ¾-inch sieve; and 100 percent of Samples S35344, S35346, and S35361 passed a ⅜-inch sieve.

[4] NP=Nonplastic.

[5] Based on the total material received. The coarse fragments in the laboratory sample disintegrated while the sample was being prepared. Material larger than 3 inches, about 15 percent of the field sample, was discarded before analyses.

than by other soil-forming factors. They are mostly on the southern and eastern sides of large drainage basins, mainly along the Arkansas River and along the Two Butte, Big Sandy, and Wild Horse Creeks. The soils developed in this material are in the Tivoli and Vona series.

Recent alluvium.—This parent material consists of particles of sand, silt, or clay that have been deposited by water. It varies greatly in texture and in degree of stratification. In some places the alluvium consists of coarse sand or gravel, but the texture ranges to heavy clay. The alluvium has been covered in a few places by a mantle of windblown sandy material of varying thickness. It is calcareous because it was derived from calcareous sandstone, shale, limestone, or other material as the result of weathering or geologic erosion. More alluvium is deposited each year in areas that are subject to frequent flooding.

These soils are young and generally lack profile development. Organic matter has accumulated in some of them, however, and has made the A horizon darker than the lower part of the profile.

Soils formed in alluvium occupy a large part of Prowers County. They occupy all of the bottom lands and stream terraces along the Little Bear Creek and the Arkansas River and its major tributaries, as well as some small areas of upland swales. The soils formed in alluvium are those of the Glendive, Havre, Kornman, Las, Las Animas, and Lincoln series. The Goshen soils formed in local alluvium washed from soils derived from loess and are therefore considered to have formed in loess rather than in alluvium.

Outwash sediments.—This parent material consists of old alluvial material washed from other areas and deposited mainly during the Pliocene geologic epoch. Most of it is gravelly, but it contains some finer textured material and is cemented with lime in many places. Much of this material is resistant to weathering. Differences in soils developed in outwash are caused mainly by differences in the composition of the parent material, in the steepness of the slopes, and in the length of time that soil-forming factors have had time to act upon the parent material. In steep areas of these soils the profile is less mature than in the more nearly level areas, for erosion on the steeper slopes has removed the parent material before a profile has had time to develop.

Soils formed in outwash sediments occupy a fairly large part of the acreage in Prowers County. Large areas are in the southwestern and eastern parts of the county and along Two Butte Creek in the eastern part of the county. Smaller areas are scattered throughout the county. The soils developed in outwash sediments are in the Cascajo, Fort Collins, Harvey, Nihill, Numa, Otero, Potter, and Stoneham series.

Material weathered from sandstone.—This parent material is highly resistant to weathering, and most of it is sandy. It weathered from sandstone and shale of the Dakota formation of Lower Cretaceous age. Some differences in the soils that developed in this material were caused by differences in the composition of the parent material, others were caused by differences in relief, and still others were caused by differences in the length of time the soil-forming factors have acted to change the material to a soil. Where these soils are strongly sloping or steep, their profile is less mature than where they are in nearly level areas, for erosion has removed the soil material from the steeper areas before a profile has had time to develop.

Soils that developed in material weathered from sandstone occupy a large acreage in the southwestern part of the county. The Travessilla soils developed in material weathered from sandstone, and the Renohill soils developed in material weathered from shaly strata of the Dakota formation.

Material weathered from limestone and shale.—This parent material consists of material weathered from limestone and shale of the Niobrara and Benton formations of Upper Cretaceous age. The limestone is more resistant to weathering than the shale. The material is highly calcareous, and in some places it contains a large amount of gypsum and other salts. The texture of the soils formed in this parent material ranges from loam to clay. Differences in the soils were caused by differences in the composition of the parent material, in the length of time that the soil-forming factors have acted upon the material, and in relief. Where these soils are strongly sloping or steep, the profile is less mature than where they are in nearly level areas, for erosion has removed the soil material from the steeper areas before a profile has had time to develop.

Soils formed in material weathered from limestone and shale occupy a fairly small part of the acreage in the county, and the areas are scattered throughout the county. The soils that developed mostly in material weathered from limestone are in the Manvel, Minnequa, and Penrose series, and those that developed mainly in material weathered from shale are in the Arvada, Lismas, and Pultney series. The soils of the Tyrone series developed both in material weathered from limestone and in material weathered from shale.

Climate

Climate influences the physical and chemical weathering of parent material, and it determines to a large extent the kinds of plants in a given area. It also largely determines the kinds of animals and affects their activity. Temperature and moisture are the climatic factors that affect the formation of soils. Generally, the processes of soil formation are more active in a warm climate, where the amount of moisture is ample but not excessive, than they are in a cold, dry or wet climate.

Prowers County has a warm, semiarid, continental type of climate with hot summers and mild winters. The average annual temperature is about 54° F., and the average annual rainfall is slightly more than 15 inches. The amount of annual rainfall is slightly greater in the eastern part of the county than in the western part. Differences in the amount of effective rainfall are reflected in differences in the degree of profile development. They are expressed in the depth to which calcium carbonate has been leached and by the amount of calcium carbonate that has accumulated in certain horizons. In the soils in the eastern part of the county, the calcium carbonate has been leached to a greater depth than in soils in the western part. Only in some of the more sandy soils where more of the rainfall passes through the profile, however, has the calcium carbonate been leached to a depth as great as 2½ feet.

Other indications of the amount of effective rainfall are the downward movement of clay and the depth of weathering in shale, limestone, and sandstone. Additional information about the climate is given in the section "Climate" near the end of this report.

Plants and Animals

Micro-organisms, earthworms, and other animals and plants that live on or in the soil influence the genesis of soils. The kinds of plants and animals, including micro-organisms, have been determined largely by the other four factors of soil formation—climate, parent material, relief, and time, which, in turn, have affected the age of the soils. In this county climate has had a more pronounced influence on the kinds of plants and micro-organisms that have developed, and consequently on the morphology of the soils, than have parent material, relief, and time.

Most of the soils of this county developed under short grasses. The soils of the sandhills, however, developed under a cover of sand sage and sandhill grasses, such as sand bluestem. The poorly drained soils of the bottom lands, on the other hand, developed under a dense stand of sedges, rushes, and other plants that tolerate salt. In all of these plants, the roots absorb bases from the lower horizons of the soil and transmit them to their leaves and stems. When the plant dies, the bases and organic matter are added to the surface layer of the soil as the leaves, stems, and roots are decomposed by soil organisms. The plants and animals that have most affected the genesis of the soils in this county are the native vegetation and micro-organisms. They have affected the genesis of the soils through the process of carrying bases from the lower part of the soil to the upper part.

Man has been here only a short time in relation to soil development, but he has played an important part in the genesis of some soils. For example, he has irrigated with muddy water that has left thick deposits of silt and clay on such soils as the Kornman, Nepesta, Numa, and Rocky

Ford. Also, man has caused many small areas of soils to become seeped because he has not used proper irrigation practices. In the seeped areas the soils appear to be developing into Solonchak and Humic Gley (Wiesenboden) soils.

Relief

Relief modifies the effects of climate and vegetation, chiefly by controlling the amount of runoff. The more nearly level areas have less runoff than steep areas, and in many nearly level areas the soils receive runoff from adjacent soils. As a result, these soils are leached to a greater depth and generally have a better developed profile than steeper soils. The Baca soils, for example, have more slope and do not receive so much runoff as the Campo soils, which are in nearly level or in slightly concave areas of the uplands. They are not leached to so great a depth as the Campo soils.

In many steep areas, geologic erosion takes place nearly as rapidly as the parent material weathers and becomes a soil. In the steep areas the soils are considered young because the parent material does not remain in place long enough for genetically related horizons to form.

Relief affects the drainage of some soils, such as those on bottom lands and low stream terraces. Such soils are nearly level, have a high water table, and are poorly drained or somewhat poorly drained. Because of the nearly level relief and resulting lack of runoff that would carry away soil material and organic matter, the surface layer of these soils has a higher content of organic matter than has the surface layer of more sloping soils. Also, soluble salts have accumulated in their profile. The poor drainage has caused mottling in the subsoil and substratum and has affected the kind of plant cover. Even though many of the upland soils are nearly level, most of them do not have a high water table.

Time

Time or age refers to the length of time the other soil-forming factors have been active. Old soils normally have better defined horizons than soils that are young. They have a textural B horizon and horizons where calcium carbonate has accumulated, but younger soils lack those horizons. Younger soils generally lack a B horizon, and their normal sequence of horizons is A and C or A, C, and R.

In some places soils of different age have developed in parent material of the same age, but in one of the soils geologic erosion has kept up with weathering and the development of horizons, and in the other, geologic erosion has not been active. The depth to which parent material is weathered is a clue to the age of the soil.

The age of soils is difficult to determine, and only a relative age can be estimated. Soils developed in alluvium on bottom lands are relatively young; some of them receive new material each time the area is flooded.

Classification of Soils

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparison of large areas such as continents. In the comprehensive system of soil classification followed in the United States (*15*), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. The subdivision of soil types into phases provides finer distinctions significant to use and management of soils, although the soil phase is not a category of soil classification. Soil series, type, and phase are defined in the section "How This Soil Survey Was Made."

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*15*). Soils in the zonal order have evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. Soils in the intrazonal order have evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and plant and animal life. Soils of the azonal order lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

The classification of soil series in Prowers County into great soil groups is shown in the following tabulation.

Order and great soil group:	*Series*
Zonal—	
Brown	Baca, Campo,[1] Fort Collins, Nepesta, Renohill, Stoneham, Tyrone, Vona, Wiley.
Chestnut	Goshen,[2] Richfield, Ulysses.[2]
Intrazonal—	
Calcisol	Cascajo, Harvey, Numa.
Solodized-Solonetz	Arvada.
Azonal—	
Regosol	Colby, Manvel, Minnequa, Nihill, Otero, Pultney, Rocky Ford, Tivoli.
Lithosol	Lismas, Penrose, Potter, Travessilla.
Alluvial	Glendive, Havre, Kornman, Las, Las Animas, Lincoln.

[1] Intergrading toward Planosols.
[2] Intergrading toward Regosols.

Morphology of Soils

In the following paragraphs some of the processes that have brought about the development of well-defined or poorly defined horizons in the soil profiles in Prowers

County are named; the great soil groups are discussed; and a profile that is considered typical for each soil series is described in alphabetic order. The soil development reflected in the formation of certain horizons is the result of one or more of the following processes: (1) Accumulation of organic matter, principally in the A horizon; (2) leaching of calcium carbonate from the upper horizons, and accumulation of the calcium carbonate in the lower horizons; (3) translocation of silicate clay from the A horizon to the B; (4) accumulation of soluble salts in the profile; (5) mottling and gleying as the result of poor drainage; and (6) oxidation of iron minerals.

Brown soils.—In the Brown great soil group are zonal soils that have a brown A horizon and a lighter colored subsoil that grades to calcareous material at a depth of a few inches. These soils developed in calcareous parent material by the process of calcification in a warm semiarid climate. The native vegetation was short grasses. The A1 horizon is thin and is low in content of organic matter. The soils have a textural B horizon. The calcareous material consists of calcium carbonate that has accumulated as soft concretions and in a finely divided form. Under native vegetation the normal sequence of horizons is A1, B2, B3ca, Cca, and C.

In Prowers County all of the soils of the Brown great soil group are naturally well drained. Generally, the soils are on uplands, but the Fort Collins soils are also on stream terraces. Most areas of these soils are nearly level to moderately sloping.

Chestnut soils.—In the Chestnut great soil group are zonal soils that have a dark grayish-brown surface layer that grades to lighter colored horizons. Calcareous material is at a depth of about 1½ feet. These soils have developed in calcareous parent material through the process of calcification. They developed under a warm, semiarid climate in a zone of higher rainfall than that in which the Brown soils developed. The native vegetation was short grasses. The Chestnut soils have an A1 horizon that is thicker and darker colored than that of the Brown soils. They have a textural B horizon that normally has prismatic structure. Generally, the upper horizons are leached of calcium carbonate, which has accumulated lower in the profile as soft concretions and in a finely divided form. Under native vegetation the normal sequence of horizons is A1, B2, B3ca, Cca, and C.

In Prowers County all of the soils of the Chestnut great soil group are naturally well drained. They are on uplands and are nearly level or gently sloping.

Calcisols.—In this county the soils classified as Calcisols formed in parent material weathered from the Ogallala formation. They are intrazonal soils that developed in a warm, semiarid climate. These soils have a thin, light-colored A horizon and a prominent horizon of lime accumulation. They lack a textural B horizon. The parent material has a high or very high content of carbonates. It ranges from loam to sand or gravel in texture. The native vegetation was short grasses.

In Prowers County soils of the Calcisol great soil group are naturally well drained. They are in areas of gravelly breaks and are nearly level to steep. Generally, water enters these soils at a medium to rapid rate, but the rate of infiltration in the silted Numa soils is slower.

Solodized-Solonetz soils.—In the solodized-Solonetz great soil group are intrazonal soils that have a thin, friable surface horizon, a thin, light-colored A2 horizon, and a darker colored textural B horizon that is extremely hard when dry. The soils have an accumulation of calcium sulfate and other salts in the C horizon. They developed in a warm, semiarid climate in material weathered from shale that is high in soluble salts. The vegetation was a mixture of short grasses and bunch grasses. Water penetrates these soils very slowly, but the natural drainage is good. The soils are in slightly concave areas or in gently rolling uplands.

Planosols.—In the Planosol great soil group are intrazonal soils that have one or more horizons abruptly separated from and sharply contrasting to an adjacent horizon because of high clay content, cementation, or compactness. Some Planosols have a B horizon very high in content of clay beneath an A horizon that is low in content of clay; the two horizons are separated by an abrupt boundary. Other Planosols have a fragipan, a compact, or brittle, seemingly cemented horizon, below a B horizon with some clay accumulation. Planosols have been formed under both grass and forest in a temperate to subtropical, subhumid to humid climate.

No soils of the Planosol great soil group occur in Prowers County, but the Campo soils of the Brown great soil group have some characteristics of Planosols. They are therefore classified as Brown soils that are intergrading toward Planosols.

Regosols.—In the Regosol great soil group are azonal soils that have very weakly defined or no clearly defined horizons, except for an A1. These soils developed in unconsolidated material that is moderately shallow to deep. Only a small amount of soil material is present because these soils are young, steep, or developed in material that is resistant to weathering. The normal sequence of horizons is A1, AC, and C, but many profiles lack the AC horizon.

In Prowers County these soils developed in loess, in wind-deposited sand, or in material weathered from shale and limestone. They are naturally well drained to excessively drained.

Lithosols.—In the Lithosol great soil group are azonal soils that have no clearly expressed soil morphology and consist of a freshly and imperfectly weathered mass of rock fragments. These soils are generally steep. The normal sequence of horizons is A1, AC, and R, but many profiles lack the AC horizon. In this county unweathered or only slightly weathered sandstone, limestone, shale, or caliche is at a depth of less than 20 inches from the surface, and these rocks crop out in many places.

Alluvial soils.—In the Alluvial great soil group are azonal soils that developed in transported material that has been deposited in relatively recent time. The profile of these soils has not been modified or has been only slightly modified by soil-forming processes.

In Prowers County the material in which these soils formed has been transported from various sources. It is mostly either fine textured or coarse textured, but the Rocky Ford soils developed in medium-textured material. Organic matter has accumulated in the A1 horizon of these soils. These soils vary in age because the parent material is alluvium ranging from that deposited very recently in geologic time to that deposited each year in areas that are subject to frequent flooding. Drainage ranges from poor in the Las Animas soils to excessive in the Lincoln soils. Because of the poor or somewhat poor drainage of the Las and Las Animas soils, these soils are somewhat mottled and contain an accumulation of salts.

Descriptions of Soil Series

This section was prepared for those who need more technical information about the soils in the county than is given elsewhere in the report. Described in alphabetic order are the soil series in the county. The procedure is to name characteristics common to the soils of the series and to describe, by horizons, a profile at a stated location. The profile is representative of the series. After the profile is described, variations from this profile are given.

Soil descriptions that are probably easier for the general reader to understand are given in the section "Descriptions of the Soils." They contain some interpretations and other information that are not in this section.

Arvada Series

In the Arvada series are deep, well-drained solodized-Solonetz soils that developed in clayey material derived from shale. These soils are in slightly concave areas or in gently sloping areas of uplands. They are very hard when dry. Surface drainage is slow, and internal drainage is very slow. The native vegetation is galleta and alkali sacaton.

The Arvada soils are similar to the Campo soils in texture and structure, but they are more alkaline and were derived from shale rather than loess. They occur with the Pultney soils, but they have a finer textured profile than those soils and are deeper over shale.

The normal sequence of horizons in the profile is A2, B2t, B3sa, Csa, and Ccs. The following describes a typical profile of Arvada silt loam in range (0.25 mile north and 50 feet east of the SW. corner of sec. 5, T. 25 S., R. 47 W.):

A2—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam; grayish brown (10YR 5/2) when moist; weak, medium, platy structure breaking to weak to moderate, fine, subangular blocky; soft when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

B2t—2 to 11 inches, light brownish-gray (10YR 6/2) silty clay; grayish brown (10YR 5/2) when moist; weak, medium, columnar structure breaking to moderate, medium, subangular blocky; extremely hard when dry, firm when moist; strongly calcareous (approximate pH 9.0); has thin, patchy clay skins on both the horizontal and vertical surfaces of the soil aggregates; clear, smooth boundary.

B3sa—11 to 20 inches, pale-brown (10YR 6/3) silty clay; brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; extremely hard when dry, very firm when moist; very strongly calcareous; gradual, smooth boundary.

This is a horizon of weak salt accumulation; crystals of gypsum and other salts occur throughout the horizon.

C1sa—20 to 28 inches, light yellowish-brown (2.5Y 6/4) silty clay loam; light olive brown (2.5Y 5/4) when moist; massive or very weak, medium, subangular blocky structure; extremely hard when dry, very firm when moist; very strongly calcareous; gradual, smooth boundary.

This is a horizon of weak salt accumulation; crystals of calcium sulfate and other salts occur throughout the horizon.

C2cs—28 to 40 inches +, variegated light yellowish-brown (2.5Y 6/4) and dark-gray (2.5Y 4/1) silty clay loam; very dark gray (2.5Y 3/1) or light olive brown (2.5Y 5/4) when moist.

This is partly weathered, highly gypsiferous shale containing a large amount of calcium sulfate in crystalline form and in a finely divided form. A field estimate indicates that the content of calcium sulfate in this horizon is roughly 20 to 30 percent, by volume.

The main variations are in the thickness of horizons and in the amount of gypsum and other salts in the profile. In many small areas, however, that are slightly higher than the surrounding areas, the surface layer is loam. These raised areas support most of the vegetation on this soil. They are separated by truncated areas where the surface layer is clay. In some places thinly layered gypsiferous silty shale underlies this soil below a depth of 24 inches. This shale contains some dark layers, some layers of bentonite, and some thin layers of limestone.

Baca Series

Soils of the Baca series are deep, well drained, and nearly level to moderately sloping. They developed in calcareous loess on the uplands. These soils are in the Brown great soil group. Surface drainage is moderately slow or medium, and internal drainage is medium. The native vegetation is buffalograss, blue grama, and other short grasses.

The profile of the Baca soils is similar to that of the Richfield soils, but it has a thinner, lighter colored surface layer, has a slightly less clayey B horizon, and is shallower over calcareous material. The Baca soils occur with the Campo and Wiley soils. They have a less clayey B horizon than the Campo soils, have less well defined structure, and are calcareous nearer the surface. The Baca soils have a more strongly developed profile than the Wiley soils. They also have a more clayey B horizon, have darker colored upper horizons, and generally, are deeper to calcareous material.

The profile of the Baca soils is moderately well developed; the normal sequence of horizons in areas that have not been cultivated is A1, B2t, B3ca, C1ca, and C2. The following describes a typical profile of Baca loam under dryland cultivation (0.42 mile west and 100 feet south of the NE. corner of sec. 10, T. 21 S., R. 46 W.):

Ap—0 to 3 inches, brown (10YR 5/3) loam; dark brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly calcareous; abrupt, smooth boundary (plow layer).

B21t—3 to 6 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, friable when moist; thin, nearly continuous clay skins; noncalcareous; clear, smooth boundary.

B21t—3 to 6 inches, brown (10YR 5/3) silty clay loam; dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, firm when moist; thin, nearly continuous clay skins; strongly calcareous and has a scattering of spots caused by accumulations of lime; clear, smooth boundary.

B3ca—13 to 18 inches, light brownish-gray (10YR 6/2) silty clay loam; grayish brown (10YR 5/2) when moist;

weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, firm when moist; thin, patchy clay skins; very strongly calcareous and has prominent mottles caused by accumulations of lime; gradual, smooth boundary.

C1ca—18 to 25 inches, pale-brown (10YR 6/3) light silty clay loam; grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, firm when moist; very strongly calcareous and has prominent mottles caused by accumulations of lime; gradual, smooth boundary.

C2ca—25 to 36 inches, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist; very weak, very coarse, prismatic structure breaking to weak, coarse, subangular blocky; slightly hard when dry, friable when moist; very strongly calcareous and has a few streaks and mottles caused by accumulations of lime; gradual, smooth boundary.

C3ca—36 to 45 inches, very pale brown (10YR 7/3) loam; brown (10YR 5/3) when moist; very weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist; very strongly calcareous; gradual, smooth boundary.

C4—45 to 60 inches +, very pale brown (10YR 7/3) loam; brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.

This layer continues without change to a depth of 10 feet.

These soils are fairly uniform in profile characteristics. They vary mainly in the thickness of the horizons and in the depth to calcareous material. The surface layer ranges from 2 to 7 inches in thickness but is normally the thinnest in dry-farmed areas. It ranges from loam to clay loam in texture. The B2 horizon ranges from clay loam to silty clay loam in texture. The depth to which these soils are leached of lime ranges from 6 to 14 inches. In some places a reddish buried soil is at a depth of 9 to 26 inches. This buried soil ranges from light silty clay loam to sandy loam in texture and contains varying amounts of gravel.

Campo Series

In the Campo series are deep, well-drained Brown soils that are intergrading toward Planosols. These soils developed in light-colored calcareous loess. They are in nearly level areas and in slightly concave areas of the uplands. Surface drainage is slow to medium, and internal drainage is slow. The native vegetation is grama, buffalograss, and other short grasses.

The Campo soils occur with the Baca soils. Their profile is similar to that of the Baca soils, but it is leached of lime to a greater depth and has a finer textured B horizon. The profile of the Campo soils is similar to that of the Richfield soils, but it is thinner, has a lighter colored surface layer, and has a finer textured B horizon. Unlike the Baca and the Richfield soils, the Campo soils have a thin, incipient A2 horizon in areas that have not been cultivated. In most cultivated areas this A2 horizon can no longer be detected.

The profile of the Campo soils is moderately well developed; the normal sequence of horizons in areas that have not been cultivated is A1, A2, B2t, B3ca, C1ca, and C2. The following describes a typical profile of Campo loam under dryland cultivation (.1 mile south and 75 feet east of the NW. corner of sec. 36, T. 27 S., R. 44 W.):

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; moderate or strong, very fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

B21t—4 to 8 inches, grayish-brown (10YR 5/2) light silty clay; very dark grayish brown (10YR 3/2) when moist; strong, medium, prismatic structure breaking to strong, medium, angular blocky; extremely hard when dry, very firm when moist; noncalcareous; thick, continuous clay films on the surfaces of the soil aggregates; most of the aggregates have gray coatings consisting of bleached particles of sand and silt; clear, smooth boundary.

B22t—8 to 14 inches, grayish-brown (10YR 5/2) light silty clay; dark grayish brown (10YR 4/2) when moist; strong, medium, prismatic structure breaking to strong, fine, angular blocky; very hard when dry, very plastic when wet; weakly calcareous; some gray coatings on the surfaces of the soil aggregates, and thick, continuous clay skins; gradual, smooth boundary.

B23tca—14 to 19 inches, grayish-brown (slightly yellower than 10YR 5/2) light silty clay; dark grayish brown (slightly yellower than 10YR 4/2) when moist; moderate, medium, prismatic structure breaking to strong, fine, angular blocky; very hard when dry, very plastic when wet; strongly calcareous; moderately thick, continuous clay skins on the surfaces of the soil aggregates; gradual, smooth boundary.

This is a weak ca horizon; some calcium carbonate occurs as concretions.

B3ca—19 to 30 inches, light brownish-gray (10YR 6/2) silty clay loam; brown (10YR 4/3) when moist; weak, medium, prismatic structure breaking to moderate, fine, angular blocky or subangular blocky; hard when dry, friable when moist; very strongly calcareous; thin, continuous clay skins on the surfaces of the soil aggregates; gradual, smooth boundary.

This is a moderate ca horizon; some calcium carbonate occurs as concretions.

C1ca—30 to 38 inches, pale-brown (10YR 6/3) silty clay loam; brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; very strongly calcareous; thin, patchy clay skins on most of the soil aggregates; gradual, smooth boundary.

This is a moderate ca horizon; some calcium carbonate occurs as concretions.

C2—38 to 60 inches +, very pale brown (10YR 7/3) silty clay loam; brown (10YR 5/3) when moist; massive; hard when dry, friable when moist; very strongly calcareous.

These soils are fairly uniform in profile characteristics; they vary mainly in thickness of the horizons and in depth to calcareous material. Also the surface layer ranges from loam to clay loam in texture, and a weakly defined A2 horizon occurs in some areas that have not been cultivated. The B horizon ranges from heavy silty clay loam to light silty clay in texture. In general the thickness of the B horizon ranges from 14 to 26 inches over calcareous material, but in some cultivated areas calcareous material is higher in the profile. The C horizon is generally loessal silt loam, but it is reddish clay loam in some areas.

Cascajo Series

Soils of the Cascajo series are excessively drained Calcisols developed in coarse-textured outwash of Tertiary age. They are moderately shallow over the outwash. These soils are on complex slopes in areas of rough gravelly breaks in the uplands. They have medium surface drainage and very rapid internal drainage. The native vegetation is sideoats grama, blue grama, buffalograss, little bluestem, yucca, and some sand sage.

Cascajo soils occur with Stoneham and Potter soils. Their profile is similar to that of the Stoneham soils, but it is coarser textured than that of the Stoneham soils and it lacks a textural B horizon. Their profile is thicker than that of the Potter soils and contains less gravel and lime. The profile of the Cascajo soils is similar to that of the Nihill soils, but it has a coarser textured surface layer and is less gravelly and more limy.

In the Cascajo soils the development of the profile is generally weak, but the ca horizons are well defined. The normal sequence of horizons is A1, color B, B3ca, and Cca. The following describes a typical profile of Cascajo sandy loam in range (0.1 mile north and 0.1 mile west of the center of sec. 17, T. 27 S., R. 47 W.):

A1—0 to 4 inches, light brownish-gray (10YR 6/2) sandy loam; dark grayish brown (10YR 4/2) when moist; moderate, very fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B (color)—4 to 12 inches, dark grayish-brown (10YR 4/2) coarse sandy loam; dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B3ca—12 to 22 inches, light brownish-gray (10YR 6/2) heavy loamy coarse sand; brown (10YR 5/3) when moist; very weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

This is a moderate ca horizon in which calcium carbonate occurs as concretions, as thin seams and streaks, and in a finely divided form.

C1ca—22 to 30 inches, white (10YR 8/2) gravelly loamy coarse sand; light gray (10YR 7/2) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

This is a strong ca horizon, and much of the calcium carbonate occurs in a finely divided form; the horizon is marrowlike; approximately 20 percent of the horizon, by volume, is quartzitic gravel.

C2ca—30 to 36 inches +, stratified gravelly sandy loam, sand, and gravel; in the upper parts of this bed are alternate layers of strong lime accumulation separated by lenses of sand and gravel that contain only a small amount of lime.

The main variations in the profile are in the thickness of the horizons, in the amount of gravel, and in the characteristics of the substratum. The amount of gravel ranges from a small amount to enough that the soil material may be classified as gravelly. In general the texture in the thin layers of the substratum ranges from gravelly sandy loam to gravel, but in a few places it is clay loam. Where the texture is clay loam, the color of the soil material is reddish brown.

Colby Series

In the Colby series are deep, well-drained, calcareous Regosols of the Brown and Chestnut soil zones. The Colby soils developed in light-colored, medium-textured, calcareous loess and alluvium on moderately sloping or rolling uplands and on nearly level stream terraces. Surface drainage is medium. Generally, internal drainage is medium, but it is rapid in places where the substratum is gravelly. In some irrigated areas these soils have been affected by seepage. The native vegetation is blue grama, buffalograss, and other short grasses.

Colby soils occur with the Ulysses, Wiley, Richfield, and Baca soils, but they have a less well developed profile than any of those soils. They have a lighter colored, more calcareous surface layer than the Ulysses soils. The Colby soils lack a B2 horizon and the ca horizons that are typical of the Wiley soils. They are lighter colored, more calcareous, and coarser textured than the Richfield and Baca soils, and they have a less well developed profile. The normal sequence of horizons in the profile is A1, AC, and C.

Generally, the Colby soils are uniform in profile characteristics, but there is some variation in texture. The texture of the surface layer ranges from fine sandy loam to silt loam. In some places where the Colby soils are near other sandy soils, they have a substratum of very fine sandy loam. In many places where they are on stream terraces, the substratum is weakly stratified, and in some places it is gravelly.

A profile considered typical of the Colby series is not described in this section. For a description of a profile that is considered typical, see the section "Mechanical and Chemical Analyses."

Fort Collins Series

Soils of the Fort Collins series are moderately deep or deep and well drained. They are in the Brown great soil group and developed mostly in calcareous alluvium on nearly level stream terraces, alluvial fans, and moderately sloping or rolling uplands. The parent material is moderately fine textured to moderately coarse textured and contains varying amounts of gravel. Surface drainage is medium, and internal drainage is medium to rapid. The native vegetation is blue grama, buffalograss, sideoats grama, yucca, and sand sage.

Fort Collins soils have a profile similar to that of the Baca soils, but they have a weaker structure, are coarser textured, and generally are less deeply leached of lime. Their profile is better developed than that of the Harvey soils; generally the upper horizons are darker colored and are leached of lime.

The normal sequence of horizons in the profile is A1, B2t, B3ca, Cca, and C. The following describes a typical profile of Fort Collins loam in range (0.35 mile east and 100 feet south of the NW. corner of sec. 3, T. 22 S., R. 47 W.):

A1—0 to 6 inches, grayish-brown (10YR 5/2) loam; dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; noncalcareous; clear, smooth boundary.

AB—6 to 10 inches, dark grayish-brown (10YR 4/2) loam; dark or very dark grayish brown (10YR 3/2) when moist; very weak, fine, subangular blocky structure breaking to weak, fine, granular; soft when dry, friable when moist; thin, patchy clay skins; noncalcareous; clear, smooth boundary.

B2t—10 to 20 inches, brown (7.5YR 5/4) clay loam; brown or dark brown (7.5YR 4/4) when moist; weak to moderate, medium, subangular blocky structure; hard when dry, firm when moist; thin, nearly continuous clay skins; strongly calcareous; gradual, smooth boundary.

B3ca—20 to 30 inches, brown (7.5YR 5/4) clay loam; brown or dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist; thin, patchy clay skins; very strongly calcareous and has some fine gravel and spots caused by accumulations of lime; clear, smooth boundary.

C1ca—30 to 45 inches, very pale brown (10YR 8/3) gravelly sandy loam; very pale brown (10YR 7/3) when moist; massive; slightly hard when dry, friable when moist; very strongly calcareous; gradual, wavy boundary.

C2—45 to 72 inches +, highly calcareous sand and gravel. The pieces of gravel are all less than 3 inches in diameter.

These soils vary mainly in the thickness and texture of the horizons and in the amount of gravel in the profile and parent material. In some places the texture of the surface layer is sandy loam instead of loam. The texture of the B2t horizon ranges from loam to clay loam. In most places these soils are leached of lime to a depth of 8 to 15 inches, but in some places they are leached to a depth of about 18 inches. Depth to sandy and gravelly material ranges from 24 to 48 inches. The underlying material varies greatly. In general it ranges from loam to marl that is 50 percent lime, but in places it consists of sand and gravel with only a small amount of soil material.

Where these soils are on stream terraces, their profile is deeper, more silty, and less gravelly and sandy than the modal Fort Collins profile. Also the substratum is not gravelly like that underlying the modal Fort Collins profile. The Fort Collins soils on stream terraces have developed in alluvial material washed from silty uplands, and their profile is generally more than 5 feet deep. Their texture ranges from clay loam to silt loam. These soils of stream terraces receive more runoff than the Fort Collins soils on uplands, and as a result, they produce better field crops and more grass.

Glendive Series

Soils of the Glendive series are in the Alluvial great soil group and are moderately shallow to deep, somewhat excessively drained, moderately coarse textured, and nearly level or gently sloping. In most areas these soils developed on bottom lands and stream terraces in calcareous, stratified sandy alluvium, but in some areas they developed in sandy material that has been reworked and redeposited by wind. Generally, surface drainage is slow. In most places internal drainage is medium to very rapid, depending upon the kind of material in the substratum. In many irrigated areas, these soils have a high water table and poorer drainage as the result of seepage. The native vegetation varies from place to place and ranges from blue grama and buffalograss to sand sage. Cottonwood trees and tamarisk grow in some areas along the Arkansas River.

The profile of these soils is similar to that of the Havre and Lincoln soils. The Glendive soils occur with the Havre soils but are coarser textured than those soils. They are finer textured than the Lincoln soils and generally are less subject to flooding. The Glendive soils are coarser textured than the Rocky Ford soils.

The normal sequence of horizons in the profile is A, AC, and C. The following describes a typical profile of Glendive fine sandy loam under irrigation (0.14 mile east and 0.39 mile south of the NW. corner of sec. 5, T. 23 S., R. 44 W.):

Ap—0 to 6 inches, brown (10YR 5/3) fine sandy loam; dark brown (10YR 4/3) when moist; very weak, fine, granular structure to single grain; loose when dry or moist; slightly calcareous; contains a few small pebbles; clear, smooth boundary.

AC—6 to 18 inches, yellowish-brown (10YR 5/4) sandy loam; dark yellowish brown (10YR 4/4) when moist; very weak, coarse, subangular blocky structure to very weak, fine, granular; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C1—18 to 33 inches, light yellowish-brown (10YR 6/4) loamy fine sand; yellowish brown (10YR 5/4) when moist; massive or single grain; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C2—33 to 48 inches, pale-brown (10YR 6/3) loamy fine sand; brown (10YR 5/3) when moist; massive or single grain; soft when dry, very friable when moist; strongly calcareous; contains a few pebbles; clear, smooth boundary.

C3—48 to 60 inches +, grayish-brown (10YR 5/2) loamy fine sand; dark grayish brown (10YR 4/2) when moist; massive; very friable when moist; very strongly calcareous; contains a few pebbles.

The water table is at the top of this horizon.

These soils vary mainly in texture and in arrangement of the various strata. In most areas the surface layer is fine sandy loam to loamy sand, but in some areas it is gravelly. The texture of the AC horizon ranges from stratified sandy loam to fairly uniform loamy fine sand. Generally, the substratum is stratified sandy loam or loamy fine sand. In some places, however, sand, gravel, or loam is within 20 inches of the surface, and those areas are mapped as a sand substrata phase. In most areas the soils are calcareous throughout the profile, but in some areas where they developed in reworked wind-deposited material, they are not calcareous.

Goshen Series

In the Goshen series are deep, dark-colored, well-drained soils that are in the Chestnut great soil group but are intergrading toward Regosols. These soils developed on uplands in local alluvium washed from soils of loessal origin. They have a weakly developed profile. These soils are in nearly level or gently sloping areas or in slightly concave areas. Surface drainage and internal drainage are medium. The native vegetation of buffalograss, blue grama, and other short grasses is abundant because runoff from higher soils supplies additional moisture.

Goshen soils occur with the Richfield, Baca, Campo, Ulysses, and Colby soils. They have thicker A horizons than the Richfield, Baca, and Campo soils, and they lack a B horizon. They have thicker A horizons than the Ulysses soils, occupy lower positions than those soils, and receive runoff and deposition from the surrounding areas. The Goshen soils are darker colored than the Colby soils. They have a darker colored, coarser textured surface layer than the Rocky Ford soils.

The normal sequence of horizons in the profile is A11, A12, AC, and C. The following describes a typical profile of Goshen silt loam (0.1 mile east and 0.1 mile south of the NW. corner of sec. 34, T. 24 S., R. 43 W.):

A11—0 to 2 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, thick, platy structure to moderate, very fine, granular; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A12—2 to 12 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure to moderate, fine, granular; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

A13—12 to 20 inches, dark-gray (10YR 4/1) silt loam; very dark gray (10YR 3/1) when moist; weak, medium, subangular blocky structure to weak, fine, granular; slightly hard when dry, friable when moist; weakly calcareous; clear, smooth boundary.

AC—20 to 29 inches, dark grayish-brown (10YR 4/2) silt loam; dark grayish brown (10YR 4/2) when moist; very weak, medium, subangular blocky structure to very weak, fine, granular; slightly hard when dry, friable when moist; weakly calcareous and a few small lime seams; clear, smooth boundary.

C1—29 to 44 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist; weak to moderate, medium, subangular blocky structure to weak, fine, subangular blocky; slightly hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C2—44 to 60 inches +, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist; massive; soft when dry, friable when moist; strongly calcareous.

These soils vary mainly in the thickness and color of the A horizons. Their texture ranges from silt loam to light silty clay loam. In places these soils are noncalcareous to a depth of about 30 inches, and in other places they are calcareous to the surface.

Harvey Series

Soils of the Harvey series are deep, well-drained, medium-textured Calcisols. They developed on uplands in calcareous, medium-textured material of Tertiary age, mainly of the Ogallala formation. These soils are nearly level to moderately steep. Surface drainage and internal drainage are medium to rapid. The native vegetation is blue grama, buffalograss, sideoats grama, and yucca.

Harvey soils have a profile similar to that of the Colby and Numa soils. They formed in parent material that is different from that of the Colby soils; however, they have less silt and more gravel and sand throughout the profile and they have a ca horizon that contains a strong accumulation of calcium carbonate. The surface layer of the Harvey soils is not silted like that of the Numa soils. Harvey soils occur with the Stoneham and Nihill soils. Unlike the Stoneham soils, they are calcareous throughout the profile and lack a B horizon. Their profile is much thicker and less gravelly than that of the Nihill soils.

The normal sequence of horizons in the profile is A, AC, Cca, and C. The following describes a typical profile of Harvey loam in range (on the east edge of a gravel pit in the SE. quarter of sec. 19, T. 22 S., R. 44 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam; dark grayish brown (10YR 4/2) when moist; mainly weak, fine, granular structure but weak, thin, platy structure in upper half inch; soft when dry, friable when moist; gravel on the surface and throughout the horizon; strongly calcareous; clear, smooth boundary.

AC—4 to 12 inches, light brownish-gray (10YR 6/2) loam; grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; a few pebbles throughout the horizon; strongly calcareous; gradual, wavy boundary.

C1ca—12 to 43 inches, very pale brown (10YR 8/3) loam; pale brown (10YR 6/3) when moist; massive; slightly hard when dry, friable when moist; contains a thin layer of gravel; very strongly calcareous; clear, wavy boundary.

This is a strong ca horizon that is highly variable in thickness and depth.

C2—43 to 60 inches +, varicolored sand and gravel; calcareous in the upper part; depth to this horizon is variable.

The main variations in this soil are differences in the texture of the surface layer and in the thickness and in the content of gravel in the different horizons. In some places the surface layer is sandy loam instead of loam. A substratum of sand and gravel is at a depth below 2 feet in some places. The gravel in individual horizons ranges from only a small amount to enough for classifying the horizon as gravelly. In many places the C1ca horizon lacks the thin layer of gravel.

Havre Series

In the Havre series are moderately shallow to deep, highly stratified, medium-textured soils of the Alluvial great soil group. These soils developed in stratified, calcareous alluvium on nearly level bottom lands and low terraces along the Arkansas River and its tributaries. Surface drainage is slow, and internal drainage is moderately rapid or rapid. The native vegetation is blue grama, alkali sacaton, and some inland saltgrass. Tamarisk and cottonwood trees grow along the streams.

Havre soils occur with the Glendive soils and have a profile that is similar to the profile of those soils. They are finer textured, however, than the Glendive soils. They are much more stratified than the Rocky Ford soils, have a thinner surface layer, and occupy bottom lands and low stream terraces instead of uplands and stream terraces. Havre soils are finer textured than the Lincoln soils and are less subject to damaging flooding than those soils. They are better drained and coarser textured than the Las soils.

The profile of the Havre soils is weakly developed. The sequence of horizons is commonly A, AC, and C. The following describes a typical profile of Havre loam in native grass (0.8 mile south and 0.1 mile east of the NW. corner of sec. 29, T. 22 S., R. 45 W.):

A1—0 to 6 inches, light brownish-gray (2.5Y 6/2) loam; dark grayish brown (2.5Y 4/2) when moist; weak, medium, subangular blocky structure breaking to moderate, very fine, granular; moderate, medium, platy structure in uppermost 1 inch; slightly hard when dry, very friable when moist; very strongly calcareous; abrupt, smooth boundary.

AC—6 to 15 inches, light brownish-gray (10YR 6/2) very fine sandy loam stratified with some clay loam; dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; abrupt, smooth boundary.

C1—15 to 22 inches, light brownish-gray (10YR 6/2) fine sandy loam stratified with loam and clay loam; dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; abrupt, smooth boundary.

C2—22 to 32 inches, grayish-brown or light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; very strongly calcareous; clear, smooth boundary.

This horizon has a very weak accumulation of calcium carbonate and salts; these salts are presumed to be calcium sulfate.

C3—32 to 45 inches, light brownish-gray (2.5Y 6/2) very fine sandy loam stratified with loam; dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

C4—45 to 60 inches +, pale-brown (10YR 6/3) loamy fine sand; brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.

These soils vary mainly in the texture of the stratified material and in depth to the underlying sand and gravel. The texture of the stratified material ranges from light clay loam to loamy sand, and depth to the underlying sand and gravel ranges from 20 inches to more than 60 inches. The texture of the surface layer ranges from sandy loam to loam. The strata in any individual horizon are generally thin; the strata of clay loam are so thin and discontinuous that they have no marked effect on permeability.

Kornman Series

In the Kornman series are moderately shallow to deep, somewhat excessively drained soils of the Alluvial great soil group. In most places these soils developed in calcareous, stratified sandy alluvium, but in some places they developed in reworked wind-deposited sandy material. Generally, they have moderately coarse textured lower horizons, but the surface layer is moderately fine textured because it has been silted. These soils are on stream terraces and are nearly level or gently sloping. Surface drainage is medium. Internal drainage is moderately rapid or rapid, except in areas where seepage has occurred or there is a high water table.

Kornman soils occur with the Glendive soils. Their profile is similar to that of the Glendive soils, but it has much finer textured and darker colored surface horizons. Kornman soils are coarser textured than the Havre soils. The Kornman soils are generally finer textured than the Lincoln soils and have a much finer textured surface layer. They are less subject to flooding than the Lincoln soils because they are on stream terraces instead of bottom lands.

The normal sequence of horizons in the profile is Ap1, Ap2, and C. The following describes a typical profile of Kornman clay loam (0.31 mile north and 100 feet west of the SE. corner of sec. 1, T. 23 S., R. 45 W.):

Ap1—0 to 6 inches, light brownish-gray (10YR 6/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure to weak to moderate, fine, granular; hard when dry, firm when moist; strongly calcareous; clear, smooth boundary.

Ap2—6 to 13 inches, light brownish-gray (10YR 6/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak, coarse subangular blocky structure to weak to moderate, fine, granular; hard when dry, very firm when moist; strongly calcareous; clear, smooth boundary.

C1—13 to 22 inches, brown (10YR 4.5/3) sandy loam; (10YR 4/3) when moist; single grain; loose when dry or moist; strongly calcareous; gradual, smooth boundary.

C2—22 to 31 inches, brown (10YR 5/3) loamy fine sand; (10YR 4/3) when moist; single grain; loose when dry or moist; slightly calcareous; gradual, smooth boundary.

C3—31 to 60 inches +, light yellowish-brown (10YR 6/4) loamy fine sand or fine sand; brown (10YR 5/3) when moist; single grain; loose when dry or moist; slightly calcareous.

Generally, these soils are fairly uniform in profile characteristics; they vary mainly in the texture of the various strata in the substratum and in depth to these strata, but the texture and thickness of the silted surface layer also vary. The texture of the surface layer ranges from loam to heavy clay loam, and the thickness from 8 to 18 inches. The soil material in the substratum ranges from stratified sandy loam to uniform loamy fine sand. In some areas the substratum is gravel or sand below a depth of 20 inches instead of stratified sandy loam or loamy fine sand. In some areas where these soils formed in reworked wind-deposited material, they are noncalcareous throughout the profile.

Las Series

In the Las series are moderately deep to deep, imperfectly drained, saline soils of the Alluvial great soil group. These soils developed in stratified, medium-textured to fine-textured alluvium on bottom lands along the Arkansas River and its major tributaries. They are nearly level and are calcareous. Surface drainage is slow to medium, and internal drainage is medium to very slow. In most areas where the soils are not drained, a water table is at a depth of 3 to 6 feet, but in some places the water table is at a depth of 20 inches. Because of the imperfect drainage, the C horizon is generally mottled. In most cultivated areas these soils are moderately saline. The native vegetation is alkali sacaton and inland saltgrass.

Las soils occur with Las Animas, Glendive, Havre, and Kornman soils, but they are finer textured in the upper 36 inches of the profile than those soils. They are somewhat better drained than the Las Animas soils. In contrast to the Havre, Glendive, and Kornman soils, they are mottled, are saline, and have a high water table if they are not drained.

The normal sequence of horizons in the profile is A, AC, and C, and commonly Ccs. The following describes a typical profile of Las clay loam under irrigation (0.15 mile south and 45 feet east of the NW. corner of sec. 6, T. 23 S., R. 47 W.):

Ap1—0 to 4 inches, dark-gray (10YR 4/1) heavy clay loam; very dark gray (10YR 3/1) when moist; weak, fine, granular structure; hard when dry, very firm when moist; strongly calcareous; clear, smooth boundary.

Ap2—4 to 16 inches, grayish-brown (10YR 5/2) heavy silty clay loam; dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; strongly calcareous; few seams of salt; clear, smooth boundary.

AC—16 to 24 inches, gray (10YR 5/1) heavy silty clay loam; very dark gray (10YR 3/1) when moist; weak, medium, subangular blocky structure; very hard when dry, very firm when moist; strongly calcareous; some concentration of salt and a few small pockets of sand; clear, smooth boundary.

C1cs—24 to 36 inches, grayish-brown (10YR 5/2) clay loam; very dark grayish brown (10YR 3/2) when moist; massive; firm when moist; very strongly calcareous and has a concentration of salt in seams; common, fine, distinct, rust-colored mottles; clear, smooth boundary.

C2cs—36 to 41 inches, gray (10YR 5/1) clay loam; dark gray (10YR 4/1) when moist; massive; friable when moist; very strongly calcareous and has a concentration of salt in seams; common, fine, distinct, rust-colored mottles, clear, smooth boundary.

C3cs—41 to 46 inches, light brownish-gray (10YR 6/2) clay loam; dark grayish brown (10YR 4/2) when moist; massive; firm when moist; very strongly calcareous and has a concentration of salt in seams; common, medium, distinct, rust-colored mottles; clear, smooth boundary.

C4cs—46 to 60 inches +, gray (10YR 5/1) clay loam; dark gray (10YR 4/1) when moist; massive; friable when moist; very strongly calcareous and has a concentration of salt in seams; common, fine, distinct, rust-colored mottles.

These soils are highly variable in profile characteristics. The main variations are in texture and thickness of the different horizons, in depth to the underlying sand or clay, in degree of mottling, and in degree of salinity. In general, the texture of the surface layer ranges from heavy clay loam to sandy loam, but in a few areas it is loamy sand. The texture of the upper C horizon ranges from loam to clay. In some places there is no stratification in the upper C horizon, and in others there are alternating layers of clay loam, silty clay loam, loam, and thin layers of sandy loam. Depth to the substratum ranges from 20 inches to more than 60 inches. The substratum is like the material above it in some places, and in others it is sand, gravel, or clay. Depth to rust-colored mottles ranges from about 12 inches to 36 inches. The degree of salinity ranges from slight to severe.

Las Animas Series

In the Las Animas series are moderately deep or deep, poorly drained, moderately to severely saline soils of the Alluvial great soil group. These soils developed in stratified sandy alluvium on bottom lands of the Arkansas River and its major tributaries. They are nearly level and have a high water table. Depth to the water table is variable, depending on the season. If these soils are not drained, the water table fluctuates between a depth of 4 feet and the surface. Because of the poor drainage, the lower part of the profile is mottled in most places. The native vegetation is inland saltgrass, alkali sacaton, sedges, and rushes.

Las Animas soils occur with the Lincoln, Glendive, and Las soils. Their profile is similar to that of the Lincoln and Glendive soils, but it is mottled throughout. Unlike those soils, Las Animas soils are saline, are poorly drained, and have a high water table. They are coarser textured than the Las soils and have somewhat poorer drainage.

The sequence of horizons in the profile is A, AC, and C. The following describes a representative profile of Las Animas loam in native meadow grass (0.4 mile west and 100 feet south of the NE. corner of sec. 26, T. 22 S., R. 45 W.):

A1g—0 to 6 inches, gray (2.5Y 5/1) loam; dark gray (2.5Y 4/1) when moist; moderate, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

Soil material that has many medium-sized, prominent, yellowish-brown (10YR 5/6) mottles makes up about 5 percent, by volume, of the soil mass.

ACcag—6 to 10 inches, light olive-gray (5Y 6/2) sandy loam; olive gray (5Y 5/2) when moist; very weak, coarse, subangular blocky structure breaking to weak, fine, granular; slightly hard when dry, very friable when moist; clear, smooth boundary.

This is a weak ca horizon in which some calcium carbonate occurs as concretions. Soil material that has a moderate number of medium-sized, prominent, yellowish-brown (10YR 5/4) mottles makes up about 5 percent, by volume, of the soil mass.

C1cag—10 to 16 inches, light olive-gray (5Y 6/2) sandy loam; olive gray (5Y 5/2) when moist; massive; soft when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

This is a weak ca horizon in which some calcium carbonate occurs as concretions. Soil material that has many large, prominent, light olive-brown (2.5Y 5/6) mottles makes up about 20 percent, by volume, of the soil mass.

C2cag—16 to 60 inches +, light olive-gray (5Y 6/2) loamy fine sand; olive gray (5Y 5/2) when moist; single grain; loose when dry or moist; noncalcareous or only weakly calcareous.

Soil material that has many large, prominent, light olive-brown (2.5Y 5/6) mottles makes up about 25 percent, by volume, of the soil mass. In this profile the water table is at a depth of about 16 inches.

These soils are highly variable in profile characteristics. In general the texture of the surface layer ranges from clay loam to sandy loam, but in some small areas it is loamy sand. The C horizon ranges from loamy sand to sandy loam in texture, and it is stratified with lenses of material that range from sand to clay. In some places, clay strata occur, generally at a depth below 30 inches, but these strata are so thin and discontinuous that they have little effect on drainage. In a few areas, the substratum is medium textured, and as a result, permeability and drainage are affected. In some places these soils are gleyed throughout the profile.

Lincoln Series

In the Lincoln series are excessively drained, coarse-textured soils of the Alluvial great soil group. These soils developed in coarse-textured alluvium on bottom lands of the Arkansas River and its tributaries. These nearly level soils are calcareous and have little profile development. They are subject to frequent flooding and deposition of soil material. Internal drainage is very rapid. The native vegetation varies considerably, depending on the amount of flooding. It ranges from sand sage to grass of some value for grazing. In some places tamarisk and cottonwood trees grow.

Lincoln soils occur with the Glendive, Havre, Las Animas, and Las soils, but they are coarser textured than any of those soils. In contrast to the Las Animas and Las soils, they are free of salts, are excessively drained, are more subject to flooding and deposition, and lack a high water table.

Generally, the sequence of horizons is A, AC, and C, but the A horizon is weakly defined. The following describes a typical profile of Lincoln fine sandy loam in range (0.1 mile east of bridge across the Arkansas River, or 0.2 mile south and 0.2 mile east of the NW. corner of sec. 31, T. 22 S., R. 45 W.):

A1—0 to 5 inches, light brownish-gray (10YR 6/2) fine sandy loam, stratified with loamy fine sand; dark grayish brown (10YR 4/2) when moist; moderate, very fine, granular structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C1—5 to 16 inches, pale-brown (10YR 6/3) stratified loamy fine sand and fine sandy loam; brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C2—16 to 24 inches, pale-brown (10YR 6/3) loamy fine sand stratified with fine sand; brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous; abrupt, broken boundary.

C3—24 to 40 inches, pale-brown (10YR 6/3) sand; brown (10YR 5/3) when moist; single grain; loose when dry or moist; strongly calcareous; abrupt, smooth boundary.

C4—40 to 48 inches, grayish-brown (10YR 5/2) fine sandy loam stratified with loamy fine sand; dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C5—48 to 60 inches, pale-brown (10YR 6/3) sand; brown (10YR 5/3) when moist; single grain; loose when moist or dry; strongly calcareous.

These soils vary in texture to some extent. The texture of the surface layer ranges from loam to loamy sand, but in many places the texture is loamy fine sand or loamy sand instead of fine sandy loam. The areas where the texture is loam occupy only a small acreage. Stratification is variable, and the strata of loamy sand, sandy loam, and sand range from thin to thick. Depth to noncoherent sand and gravel ranges from a few inches to more than 5 feet.

Lismas Series

Soils of the Lismas series are well-drained, fine-textured Lithosols that developed on the uplands in material weathered from gypsiferous shale of Cretaceous age. These soils are moderately sloping or rolling. The native vegetation is a sparse cover of blue grama, buffalograss, and ring muhly. In most areas snakeweed is prevalent.

Lismas soils are finer textured than the Pultney and Penrose soils. They have a thinner profile than the Pultney soils. Unlike the Penrose soils they formed in material weathered from shale instead of limestone.

The normal sequence of horizons in the profile is A, C, and R. The following is a typical profile of Lismas silty clay loam under dryland cultivation (0.2 mile south and 0.3 mile west of the NE. corner of sec. 25, T. 21 S., R. 44 W.):

A1—0 to 5 inches, light yellowish-brown (2.5Y 6/3) silty clay loam; olive brown (2.5Y 4/4) when moist; moderate, very fine, granular structure; soft when dry, very friable when moist; very strongly calcareous; abrupt, smooth boundary.

Ccs—5 to 9 inches, olive-yellow (2.5Y 6/6) silty clay loam; light olive brown (2.5Y 5/6) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.
This horizon contains much crystalline gypsum.

R—9 to 18 inches +, olive-yellow (2.5Y 6/6) partly weathered shale that is about silty clay loam in texture; light olive brown (2.5Y 5/6) when moist; highly gypsiferous.

These soils vary mainly in depth to underlying shale. The texture of the surface layer ranges from clay to silty clay loam. In most places shale is at a depth of 5 to 18 inches, but it crops out in a few places.

Manvel Series

In the Manvel series are moderately deep or deep, normally well-drained, highly calcareous Regosols of the Brown soil zone. These soils developed on uplands in medium-textured material weathered from limestone and interbedded shale of Cretaceous age, chiefly limestone and shale of the Niobrara and Benton formations. The limestone or shale is generally at a depth below 40 inches. These soils are nearly level to moderately steep. Surface drainage is medium to rapid. The native vegetation is mainly buffalograss and blue grama, but in some places it is snakeweed.

Manvel soils occur with the Minnequa and Tyrone soils and have a profile similar to that of the Minnequa and Tyrone soils. They are deeper over bedrock than the Minnequa soils. They are slightly coarser textured than the Tyrone soils, and they lack a B2 horizon. Unlike the Colby soils, they developed in material weathered from limestone and shale, contain more calcium carbonate, and have limestone fragments throughout the profile.

The normal sequence of horizons in the profile is A, AC, Cca, and R. The following describes a typical profile of Manvel loam under dryland cultivation (0.35 mile north and 0.25 mile west of the SE. corner of sec. 7, T. 21 S., R. 47 W.):

Ap—0 to 6 inches, pale-brown (10YR 6/3) loam; brown (10YR 4/3) when moist; moderate, very fine, granular structure; slightly hard when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

AC—6 to 17 inches, pale-brown (10YR 6/3) loam; brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure breaking to weak, fine, granular; slightly hard when dry, very friable when moist; strongly calcareous; few small calcium carbonate concretions; gradual, smooth boundary.

C1ca—17 to 24 inches, very pale brown (10YR 7/4) loam; light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous; a few small concretions of calcium carbonate; a few small limestone fragments; gradual, smooth boundary.

C2ca—24 to 48 inches, very pale brown (10YR 7/4) loam; light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; a few small limestone fragments throughout the horizon; gradual, smooth boundary.
This is a weak ca horizon in which some calcium carbonate occurs as concretions.

R—48 to 54 inches +, partly weathered limestone of the Niobrara formation and some fine material in the fractured rock. Between the layers of limestone are thin lenses of highly calcareous shale, but limestone predominates.
This horizon grades to consolidated limestone at a depth of about 54 inches.

These soils vary mainly in depth to bedrock. In general depth to bedrock ranges from 40 to 60 inches, but bedrock is at a depth of more than 60 inches in a few areas. In some places the texture of the A horizon is very fine sandy loam instead of loam. The texture of the C horizon ranges from very fine sandy loam to light clay loam. The number of limestone fragments is variable throughout the profile.

Minnequa Series

Soils of the Minnequa series are well-drained, highly calcareous Regosols of the Brown soil zone. They developed on uplands in medium-textured material weathered from limestone and interbedded shale of Cretaceous age, chiefly limestone and shale of the Niobrara and Benton formations. The soils are gently sloping to moderately steep and are moderately shallow over limestone or shale. They are normally well drained, but seepage has occurred in some irrigated areas. The native vegetation is mainly buffalograss and blue grama, but in some places it is snakeweed.

Minnequa soils occur with the Penrose and Tyrone soils. Their profile is similar to that of the Penrose and Tyrone soils. They are deeper over bedrock than the Penrose soils. They are shallower over bedrock than the Tyrone soils, and they do not have a B2 horizon. The Minnequa soils contain more calcium carbonate than the Colby soils. Also they developed in material weathered from limestone and shale, and they are less than 40 inches deep over bedrock. Unlike the Manvel soils, the Minnequa soils overlie consolidated limestone at a depth of less than 40 inches. These soils have a poorly developed profile.

The normal sequence of horizons in the profile is A, AC, and R. The following describes a typical profile of Minnequa loam under dryland cultivation (0.5 mile east and 0.2 mile south of the NW. corner of sec. 32, T. 21 S., R. 45 W.):

A1—0 to 4 inches, pale-brown (10YR 6/3) loam; brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; strongly calcareous; contains few fragments of limestone; clear, smooth boundary.

AC—4 to 14 inches, pale-brown (10YR 6/3) loam; brown (10YR 5/3) when moist; weak, fine, subangular blocky structure to massive; slightly hard when dry, very friable when moist; very strongly calcareous; contains small fragments of limestone; clear, smooth boundary.

C1—14 to 30 inches, very pale brown (10YR 7/4) loam or very fine sandy loam; light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; contains many small limestone fragments; abrupt, smooth boundary.

R—30 to 32 inches +, partly weathered white limestone that grades to consolidated limestone at a depth of about 32 inches.

These soils vary mainly in depth to bedrock. Depth to bedrock ranges from 20 to 40 inches. In minor areas the texture of the A horizon is fine sandy loam instead of loam. The texture of the C horizon ranges from very fine sandy loam to light clay loam. The number of limestone fragments is variable throughout the profile.

Nepesta Series

In the Nepesta series are deep, well-drained soils of the Brown great soil group. These soils developed on uplands, are calcareous, and are medium textured to moderately fine textured. The surface layer is fine textured because silt and clay have been deposited from irrigation water. Its texture is normally heavy silty clay loam. These soils are nearly level or gently sloping. Surface drainage is moderately slow to medium. In most areas these soils have medium internal drainage and are slightly saline, but in some areas where seepage has occurred, they have slower internal drainage and are more saline. They have rapid internal drainage in places where the substratum is gravelly.

The profile of the Nepesta soils is similar to that of the Baca soils, but the A horizon is finer textured and darker colored, and the surface layer contains calcium carbonate. The Nepesta soils occur with the Rocky Ford soils, but below the silted surface layer their profile is finer textured. The Nepesta soils have weaker ca horizons than the Numa soils. Unlike the Rocky Ford and Numa soils, the Nepesta soils have a textural B horizon.

These soils have a moderately well developed profile. The normal sequence of horizons in areas that have been cultivated is Ap1, Ap2, AB, B21t, B22t, B3ca, C1ca, and C2.

The Nepesta soils are fairly uniform in profile characteristics. They vary mainly in the thickness and texture of the silted surface layer. Depth of siltation ranges from 8 to 20 inches. The texture of the surface layer ranges from heavy loam to clay, and in some small areas, the substratum is gravelly.

A profile considered typical of the Nepesta series is not described in this section. For a description of a profile that is considered typical, see the section "Mechanical and Chemical Analyses."

Nihill Series

Soils of the Nihill series are shallow, excessively drained Regosols that developed on uplands in calcareous outwash material, mostly gravel and sand. These soils are in areas of gently sloping and rolling or steep convex slopes. Surface drainage is medium to rapid, and internal drainage is very rapid. The native vegetation is buffalograss, sideoats grama, blue grama, and yucca.

The profile of the Nihill soils is similar to that of the Stoneham soils, but it is more gravelly, coarser textured, and lacks a B2 horizon. The Nihill soils have a profile similar to that of the Potter soils, but they are slightly deeper and overlie gravel instead of caliche.

These soils have a weakly developed profile. The normal sequence of horizons in the profile is A, AC, and Cca. The following describes a typical profile of Nihill gravelly loam in range (sec. 16, T. 22 S., R. 47 W.):

A1—0 to 4 inches, light brownish-gray (10YR 6/2) gravelly loam; dark grayish brown (10YR 4/2) when moist; moderate, very fine, granular structure; soft when dry, very friable when moist; strongly calcareous; approximately 30 percent, by volume, is gravel; clear, smooth boundary.

AC—4 to 8 inches, very pale brown (10YR 7/3) very gravelly loam; brown (10YR 5/3) when moist; weak to moderate, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; approximately 65 percent, by volume, is gravel; clear, smooth boundary.

C1ca—8 to 18 inches, very pale brown (10YR 7/3) very gravelly light loam; brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; very strongly calcareous; approximately 85 percent, by volume, is gravel; gradual, wavy boundary.

This is a weak ca horizon in which some calcium carbonate occurs, mostly as a coating on the pebbles.

C2ca—18 to 25 inches, very pale brown (10YR 8/3) very gravelly light loam; pale brown (10YR 6/3) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous; approximately 85 percent, by volume, is gravel.

This is a moderate to strong ca horizon in which much calcium carbonate occurs in some places as concretions, as a coating on the pebbles, and in a finely divided form. The calcium carbonate is present in some places and not in others, probably because of the movement of ground water. Its presence is not considered to be inherent in the development of the soil profile.

C3ca—25 to 60 inches, very pale brown (10YR 7/3) very gravelly sand; brown (10YR 5/3) when moist; single grain; loose when dry or moist; very strongly calcareous; approximately 90 percent, by volume, is gravel. Some of the pieces of gravel have a coating of calcium carbonate.

The main variations in the profile are in the amount of gravel in the A1 horizon and in depth to the underlying gravel. Depth to the underlying gravel ranges from 8 to 18 inches.

Numa Series

In the Numa series are deep, well-drained, medium-textured Calcisols that developed on uplands in calcareous, medium-textured outwash material, principally of the Ogallala formation. These soils are nearly level to moderately sloping. In most of the nearly level areas, where the soils are deeply silted, the texture of the surface layer is clay loam. In many of the more sloping areas, however, where silting has been less deep and where more erosion has occurred, the texture is loam. Surface drainage is medium and internal drainage is medium or rapid, except in areas where seepage has occurred.

The profile of the Numa soils is similar to that of the Rocky Ford soils, but it contains less silt and more gravel and sand. The Numa soils also have strong ca horizons and developed in outwash instead of loess and alluvium. The Numa soils occur with the Stoneham and Harvey soils. Their profile is less well developed than that of the Stoneham soils; it has silted A horizons, lacks a B horizon, and is calcareous to the surface. The Numa profile is similar to that of the Harvey soils, but the surface layer is thicker, darker colored, and finer textured as the result of siltation, especially in the more gently sloping areas that are not eroded.

The Numa soils have light-colored A horizons and very strong ca horizons. The A horizons have been made thicker as the result of irrigating these soils with muddy water. The normal sequence of horizons in the profile is A, AC, Cca, and C. The following describes a typical profile of Numa clay loam under irrigation (0.5 mile north and 200 feet west of the SE. corner of sec. 4, T. 23 S., R. 42 W.):

Ap1—0 to 4 inches, grayish-brown (10YR 5/2) light clay loam; dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure breaking to moderate, fine, granular; slightly hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

Ap2—4 to 8 inches, mixed colors ranging from grayish-brown (10YR 5/2) to pale-brown (10YR 6/3) heavy loam or light clay loam; dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure breaking to weak to moderate, fine, granular; hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

At different seasons of the year, the material in this horizon appears to have been mixed somewhat by tilling at different depths.

C1ca—8 to 17 inches, light yellowish-brown (10YR 6/4) heavy loam or light clay loam; yellowish brown (10YR 5/4) when moist; massive or very weak, subangular blocky structure; hard when dry, very friable when moist; very strongly calcareous; gradual, wavy boundary.

This is a moderate ca horizon in which much calcium carbonate occurs as large concretions that make up approximately 25 percent, by volume, of the soil mass.

C2ca—17 to 30 inches, very pale brown (10YR 7/3) heavy loam or light clay loam; light yellowish brown (10YR 6/4) when moist; massive; hard when dry, very friable when moist; very strongly calcareous; gradual, wavy boundary.

This is a strong ca horizon in which much calcium carbonate occurs, mostly as soft concretions or in a finely divided form.

C3—30 to 49 inches, light yellowish-brown (10YR 6/4) loam or sandy clay loam; yellowish brown (10YR 5/4) when moist; massive; hard when dry, very friable when moist; very strongly calcareous; gradual, wavy boundary.

Some calcium carbonate has accumulated in this horizon but less than in the C1ca and C2ca horizons.

C4—49 to 60 inches +, light yellowish-brown (10YR 6/4) sandy clay loam; yellowish brown (10YR 5/4) when moist; massive; hard when dry, very friable when moist; strongly calcareous.

These soils vary mainly in the texture of the surface layer and in the thickness and content of gravel of the different horizons. In some places the surface layer is heavy loam instead of light clay loam. The texture of the substratum varies. In some places the substratum is sand or gravel. In some areas that have been irrigated, these soils are seeped and saline.

Otero Series

Soils of the Otero series are deep, well drained, calcareous, and sandy. They are Regosols that developed on uplands in calcareous, moderately coarse textured material, mostly outwash of Tertiary age. In some places this material includes sand that has been deposited or reworked by wind. These soils are in gently rolling to moderately sloping areas and on breaks. Internal drainage is medium to rapid. The native vegetation is sideoats grama, blue grama, buffalograss, sand dropseed, yucca, and sand sage.

The profile of the Otero soils is similar to that of the Cascajo soils, but it is calcareous, contains less gravel, and has a lighter colored surface layer. Otero soils are lighter colored than Vona soils, they have a less well developed profile, and they are calcareous throughout the profile. The Otero soils are coarser textured than the Harvey soils.

These soils have a weakly developed profile. The normal sequence of horizons is A, AC, and C. The following describes a typical profile of Otero sandy loam under dryland cultivation (0.1 mile east and 0.3 mile north of the SW. corner of sec. 8, T. 27 S., R. 43 W.):

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) sandy loam; dark grayish brown (10YR 4/2) when moist; very weak, fine, granular structure to single grain; loose when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC—4 to 12 inches, pale-brown (10YR 6/3) sandy loam; brown (10YR 4/3) when moist; massive or single grain; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

C1—12 to 25 inches, pale-brown (10YR 6/3) coarse sandy loam; brown (10YR 5/3) when moist; massive to single grain; slightly hard when dry, very friable when moist; very strongly calcareous; clear, smooth boundary.

C2—25 to 60 inches, light yellowish-brown (10YR 6/4) loamy coarse sand, yellowish brown (10YR 5/4), when moist; single grain; loose when dry or moist; very strongly calcareous.

These soils vary mainly in texture of the surface layer and substratum. The texture of the surface layer ranges from sandy loam to loamy sand. The texture of the substratum, which begins at a depth of about 2 feet, ranges from loamy coarse sand to heavy sandy loam.

Penrose Series

Soils of the Penrose series are well-drained, medium-textured Lithosols of the Brown soil zone. They developed in material weathered from limestone of Cretaceous age, chiefly limestone of the Niobrara and Benton formations. These soils are on uplands and are shallow over limestone. They are in rolling areas and in areas of limestone breaks. Surface drainage is rapid to very rapid. The native vegetation is blue grama, buffalograss, sideoats grama, snakeweed, and yucca.

Penrose soils occur with the Minnequa soils and developed from the same kind of parent material, but they are less thick over bedrock and have more limestone fragments throughout. Their profile is similar to that of the Lismas soils, but they are coarser textured and they developed in material weathered from limestone instead of in material weathered from shale.

The normal sequence of horizons in this profile is A, C, and R. The following describes a typical profile of Penrose loam in range (0.6 mile east and 200 feet north of the SW. corner of sec. 20, T. 21 S., R. 45 W.):

A1—0 to 5 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure breaking to moderate, very fine, granular; soft when dry, very friable when moist; strongly calcareous; approximately 5 percent, by volume, is channery limestone fragments, many of which have accumulated at or near the surface; clear, smooth boundary.

C—5 to 11 inches, pale-brown (10YR 6/3) channery loam; brown (10YR 5/3) when moist; very weak, medium, subangular blocky structure or massive; slightly hard when dry, very friable when moist; strongly calcareous; approximately 15 percent, by volume, is channery limestone fragments; clear, wavy boundary.

R—11 to 14 inches +, limestone bedrock, partly fractured and weathered, and some fine material in the cracks between the rocks.

These soils vary mainly in depth to bedrock and in the amount of limestone fragments throughout the profile. Depth to bedrock ranges from 6 to about 18 inches. As much as 40 percent of the soil material, by volume, consists of fragments of limestone, and fragments of limestone are on the surface.

Potter Series

In the Potter series are very shallow, excessively drained Lithosols. These soils developed in material weathered from caliche and lime-cemented gravel. Generally, the areas are gently rolling to steep; some areas are in gravelly breaks. Surface drainage is rapid to very rapid. The native vegetation is buffalograss, blue grama, sideoats grama, and yucca.

Potter soils occur with the Nihill soils, but they are less gravelly than those soils, and they have an indurated substratum instead of a substratum consisting of sand and gravel and other loose outwash material. The profile of these soils is similar to that of the Penrose soils, but Potter soils developed in material weathered from caliche and lime-cemented gravel, rather than in material weathered from fractured limestone.

The normal sequence of horizons in the profile is A1, C1, and C2m. The following describes a typical profile of Potter gravelly fine sandy loam in range (0.15 mile west and 0.1 mile north of the SE. corner of sec. 15, T. 21 S., R. 42 W.):

A1—0 to 4 inches, light brownish-gray (10YR 6/2) gravelly fine sandy loam; dark grayish brown (10YR 4/2) when moist; moderate, very fine, granular structure; soft when dry, very friable when moist; very strongly calcareous; approximately 15 percent, by volume, is gravel; clear, smooth boundary.

C1—4 to 9 inches, light-gray (10YR 7/2) gravelly light loam or fine sandy loam; grayish brown (10YR 5/2) when moist; massive or very weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; contains much soft, partly weathered material from caliche fragments and is approximately 15 percent, by volume, quartzitic gravel weathered from lime-cemented gravel; abrupt, smooth boundary.

C2m—9 inches +, indurated caliche bedrock that has gravel embedded in the matrix.

The depth to caliche or gravel varies slightly, and this parent material is exposed in many places. The amount of gravel in the upper horizons ranges from 10 to 50 percent, by volume.

Pultney Series

Soils of the Pultney series are well-drained, moderately shallow to moderately deep Regosols. They developed on uplands in material weathered from yellowish-brown gypsiferous shale of Upper Cretaceous age. These soils are calcareous and moderately fine textured and are gently sloping or rolling. Surface drainage is moderately rapid. The native vegetation is buffalograss, blue grama, western wheatgrass, alkali sacaton, and in some places yucca.

The profile of the Pultney soils is similar to that of the Minnequa soils, but it is gypsiferous and somewhat finer textured. Pultney soils occur with the Lismas soils, but they are coarser textured than those soils and deeper to bedrock.

The profile of these soils is weakly developed. The normal sequence of horizons is A1, AC, Ccs, and R. The following describes a typical profile of Pultney loam in range (0.48 mile east and 25 feet north of the SW. corner of sec. 6, T. 25 S., R. 47 W.):

A1—0 to 4 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure breaking to moderate, fine, granular; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC—4 to 9 inches, pale-brown (10YR 6/3) light clay loam; brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to weak to moderate, medium, subangular blocky; slightly hard when dry, very friable when moist; effervesces violently when hydrochloric acid is added; gradual, smooth boundary.

Ccs—9 to 20 inches, light yellowish-brown (2.5Y 6/3) silty clay loam; light olive brown (2.5Y 5/3) whe moist; weak to moderate, medium, subangular blocky structure; hard when dry, friable when moist; very strongly calcareous; abrupt, smooth boundary.

This is a weak horizon of lime and gypsum accumulation. The line (calcium carbonate) occurs as fine concretions and in a finely divided form, and the gypsum (calcium sulfate) occurs as small crystals. The approximate conductivity is 2.7 millimhos.

R—20 to 31 inches +, pale-yellow (2.5Y 8/3) to yellow (10YR 7/8), partly weathered gypsiferous shale and saline, weakly cemented soil material; highly gypsiferous; the content of calcium sulfate is estimated as about 15 percent, by volume.

These soils vary mainly in depth to shale, but the texture of the surface layer and the content of gypsum crystals and other salts also vary. In some areas the surface layer developed partly in loess. Depth to shale ranges from 20 to 40 inches. The texture of the surface layer ranges from loam or silt loam to clay loam.

Renohill Series

In the Renohill series are well-drained, moderately shallow to deep soils of the Brown great soil group. These soils developed on uplands in moderately fine textured to medium-textured material that weathered from sandstone and interbedded shale, chiefly of the Dakota formation. These soils are gently sloping to moderately steep. Surface drainage is medium or moderately rapid. The native vegetation is blue grama, buffalograss, and yucca. In areas of sandy loam, there are also little bluestem, some sand sage, and scattered cedar trees.

Unlike the Baca soils, the Renohill soils developed in material weathered from sandstone and interbedded shale, and they have somewhat less well defined B horizons than the Renohill soils. They occur with the Travessilla soils and developed in material weathered from the same geologic formation, but they are deeper and have better defined horizons. They also occur with the Stoneham soils, but they developed in different parent material, are somewhat finer textured, are less gravelly, and are underlain by sandstone instead of gravel or gravelly material.

These soils have light-colored A horizons, textural B horizons that are calcareous in the lower part, and strong Cca horizons. In areas that have not been cultivated, the normal sequence of horizons in the profile is A1, A3, B2t, B3ca, Cca, and R. The following describes a typical profile of Renohill loam under dryland cultivation (0.13 mile north and 165 feet west of the SE. corner of sec. 25, T. 26 S., R. 46 W.):

Ap1—0 to 3 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; moderate, very fine, granular structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

Ap2—3 to 6 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; massive or very weak, coarse, subangular blocky structure; very hard when dry, firm when moist; very weakly calcareous; clear, smooth boundary.

This horizon appears to be a weakly developed traffic pan and is not normal for soils in this series.

A3—6 to 10 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, very friable when moist; very weakly calcareous; gradual, wavy boundary.

B21t—10 to 16 inches, pale-brown (10YR 6/3) clay loam; brown (10YR 5/3) when moist; moderate, medium, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, very friable when moist; calcareous; gradual, wavy boundary.

Thin, nearly continuous clay skins are on the surfaces of the soil aggregates, and small sandstone fragments occur throughout this horizon.

B22tca—16 to 27 inches, pale-brown (10YR 6/3) clay loam; brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky; very hard when dry, friable when moist, strongly calcareous; gradual, wavy boundary.

Thin, nearly continuous clay skins are on the surfaces of the soil aggregates. This is a very weak ca horizon in which a small amount of calcium carbonate has accumulated in the form of concretions. Small sandstone fragments occur throughout the horizon.

B3ca—27 to 32 inches, light yellowish-brown (10YR 6/4) light clay loam; yellowish brown (10YR 5/4) when moist; fine, subangular blocky structure; very hard when dry, friable when moist; strongly calcareous; gradual, wavy boundary.

This is a weak ca horizon in which calcium carbonate occurs as concretions and in thin seams and streaks. Small fragments of sandstone occur throughout the horizon. Thin, patchy clay skins are on both the horizontal and vertical surfaces of the soil aggregates.

Cca—32 to 42 inches, very pale brown (10YR 7/3) sandy clay loam; light yellowish brown (10YR 6/4) when moist; massive; very hard when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

This is a strong ca horizon in which a large amount of calcium carbonate has accumulated, mostly in a finely divided form. Small fragments of sandstone occur throughout the horizon.

R—42 to 50 inches +, soft, partly weathered, calcareous Dakota sandstone grading to consolidated sandstone within a few inches.

The profile characteristics of these soils are extremely variable. The main variations are in texture, thickness, and color of the horizons. The A horizons range from sandy loam to clay loam in texture, though the areas of clay loam are of minor extent. In some areas the surface horizons developed partly in loess. The texture of the B horizons ranges from loam to heavy clay loam. The color of the B horizons is variable; normally, however, it ranges from 7.5YR to 10YR in hue, from 3 to 5 (moist) in value, and from 3 to 5 in chroma. The chroma of the mottles in the C horizon and in the lower part of the B horizon may be higher. In places some salt from the shale in the Dakota formation has accumulated in the C horizon and in the lower part of the B horizon. Depth to bedrock ranges from 20 to more than 60 inches. Throughout the profile are varying amounts of small sandstone fragments.

Richfield Series

In the Richfield series are deep, well-drained, nearly level Chestnut soils. These soils developed on uplands in calcareous loess. They are dark colored and have a moderately fine texture throughout the profile. The native vegetation is buffalograss, blue grama, and other short grasses.

Richfield soils have a profile similar to that of the Baca soils, but they have a darker colored A horizon and are leached of lime to a greater depth. They are slightly coarser textured than the Campo soils and have a darker colored A horizon. In addition, they lack strong blocky structure in the B horizons. The Richfield soils occur with the Ulysses soils, but they are finer textured than those soils, are leached of lime to a greater depth, and have B horizons that have moderate instead of weak to moderate structure.

The normal sequence of horizons in the profile is A1, B2t, B3ca, Cca, and C. The following describes a typical profile of Richfield silt loam under dryland cultivation (0.37 mile east and 90 feet north of the SW. corner of sec. 32, T. 26 S., R. 42 W.):

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; loose when dry, very friable when moist; noncalcareous; abrupt, smooth boundary (plow layer).

AB—4 to 7 inches, grayish-brown (10YR 5/2) light silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, thick, platy structure; very hard when dry, friable when moist; thin, nearly continuous clay skins on the horizontal surfaces of peds; noncalcareous; clear, smooth boundary.

B21t—7 to 12 inches, grayish-brown (10YR 5/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure breaking to strong, fine, angular and subangular blocky structure; very hard when dry, firm when moist; moderately thick, nearly continuous clay skins; noncalcareous; clear, smooth boundary.

B22t—12 to 18 inches, grayish-brown (10YR 5/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure breaking to moderate, fine, subangular blocky; very hard when dry, firm when moist; thin, nearly continuous clay skins; noncalcareous; clear, smooth boundary.

B3ca—18 to 26 inches, light brownish-gray (10YR 6/2) silty clay loam; dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, firm when moist; very thin, patchy clay skins; slightly calcareous in matrix and has numerous small lime spots; clear, smooth boundary.

C1ca—26 to 34 inches, grayish-brown (10YR 5/2) silty clay loam; dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky; hard when dry, firm when moist; strongly calcareous, and contains prominent lime nodules about one-fourth inch in diameter; clear, smooth boundary.

C2ca—34 to 42 inches, pale-brown (10YR 6/3) light silty clay loam; grayish brown (10YR 5/2) when moist; very weak, coarse, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, friable when moist; many krotovinas; very strongly calcareous and has numerous large lime spots; clear, smooth boundary.

C3—42 to 49 inches, light-gray (10YR 7/2) silt loam; grayish brown (10YR 5/2) when moist; very weak, medium, prismatic structure breaking to very weak, medium, subangular blocky; hard when dry, friable when moist; considerable mixing with material from upper horizons, associated with krotovinas and worm casts, the larger amounts of this material are very dark grayish brown (10YR 3/2) when moist; very strongly calcareous; clear, smooth boundary.

C4—49 to 70 inches, light-gray (10YR 7/2) silt loam; grayish brown (10YR 5/2) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; clear, smooth boundary.

C5—70 to 90 inches, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; very strongly calcareous; clear, smooth boundary.

IIC6—90 to 110 inches, pink (7.5YR 7/4) silt loam; brown (7.5YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; clear, smooth boundary.

IIC7—110 to 132 inches, pink to reddish-yellow (7.5YR 7/5) silt loam; strong brown (7.5YR 4/5) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous and contains large white lime spots.

The profile characteristics of these soils are nearly uniform. The main variations are in depth to calcareous material and in the thickness of horizons. These soils are leached of lime to a depth of about 15 inches, and depth to lime ranges from 10 to 24 inches. In many places a dark-gray buried soil is deep in the profile of this soil. This buried soil is calcareous silt loam.

Rocky Ford Series

Soils of the Rocky Ford series are moderately shallow to deep, well-drained Regosols. These soils developed on uplands and stream terraces in light-colored, medium-textured loess and uniform alluvium. In the upper horizons silt and clay from muddy irrigation water have been deposited. These soils are nearly level to moderately sloping. In most areas they are well drained, but in some irrigated areas seepage has occurred and the soils are saline.

The profile of the Rocky Ford soils is similar to that of the Kornman, Colby, and Numa soils, but below the silted surface layer it is finer textured than that of the Kornman soils. Because they are silted, the Rocky Ford soils have upper horizons that are darker and finer textured than those of the Colby soils. Unlike the Numa soils, they lack strong Cca horizons. The Rocky Ford soils are coarser textured than the Nepesta soils and lack a textural B horizon. The normal sequence of horizons is Ap1, Ap2, AC, and C.

The Rocky Ford soils vary mainly in thickness and texture of the silted horizons and in depth to and in the kind of underlying substratum. In some areas the texture of the silted surface layer is heavy loam to clay loam instead of silty clay loam. In general the depth of siltation ranges from plow depth to about 15 inches, but near the ends of fields in many areas, the silted layer is thicker. In many places the C horizon is stratified. In some places the Rocky Ford soils are moderately shallow over limestone instead of deeper than 5 feet. In some areas where the soils are on terraces along the Arkansas River, they are underlain by sand, gravel, or clay at a depth of 60 inches or less.

A profile considered typical of the Rocky Ford series is not described in this section. For a description of a profile that is considered typical, see the section "Mechanical and Chemical Analyses."

Stoneham Series

In the Stoneham series are moderately shallow, well-drained soils of the Brown great soil group. These soils developed on uplands in medium-textured to moderately coarse textured Tertiary material, principally of the Ogallala formation. They contain varying amounts of gravel throughout the profile, and in most areas they are underlain by gravel or gravelly material. These soils are moderately sloping or rolling; the slopes range from 3 to 9 percent. The native vegetation is blue grama, buffalograss, sideoats grama, yucca, and sand sage.

Stoneham soils occur with the Cascajo, Nihill, Harvey, and Fort Collins soils. They are finer textured and less gravelly than the Cascajo and Nihill soils, and they have a textural B horizon. Unlike the Harvey soils, their upper horizons are leached of lime and they have a textural B horizon. Their profile is similar to that of the Fort Collins soils, but it is thinner and slightly coarser textured.

In most places the A horizon of the Stoneham soils is thin and the ca horizons are strongly developed. The normal sequence of horizons is A, B2t, B3ca, and Cca. The following describes a typical profile of Stoneham fine sandy loam in range (50 feet south and 50 feet west of the N¼ corner of sec. 32, T. 26 S., R. 43 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam; dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure to weak, fine, granular; soft when dry, very friable when moist; noncalcareous; some fine gravel; clear, smooth boundary.

B2t—4 to 10 inches, brown (10YR 4/3) heavy loam; dark brown (10YR 3/3) when moist; weak to moderate, coarse, subangular blocky structure; hard when dry, friable when moist; thin, nearly continuous clay skins; noncalcareous; some fine gravel; clear, smooth boundary.

B3ca—10 to 14 inches, light brownish-gray (10YR 6/2) gravelly loam; brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; very hard when dry, firm when moist; thin, very patchy clay skins; very strongly calcareous; clear, smooth boundary.

C1ca—14 to 23 inches, light brownish-gray (10YR 6/2) gravelly loam; brown (10YR 5/3) when moist; massive; very hard when dry, firm when moist; very strongly calcareous; clear, smooth boundary.

C2ca—23 to 30 inches, light-gray (10YR 7/2) light gravelly loam or loamy gravel; the gravel is coated with lime; very pale brown (10YR 7/3) when moist; massive; hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

C3—30 to 50 inches +, yellowish-brown (10YR 5/6) gravel; same color when moist; strongly calcareous in upper part of the horizon.

The main variations in the profile are in the thickness and texture of the horizons, in the amount of gravel in the profile, and in the characteristics of the parent material. The texture of the surface layer ranges from loam to sandy loam, and the texture of the B horizon ranges from gravelly loam or clay loam to sandy clay loam. The amount of gravel in the lower horizons ranges from only a small amount to enough for classifying the horizon as gravelly. In most areas these soils are underlain by sandy and gravelly material and have only a small amount of soil material at a depth of 20 to 48 inches.

Tivoli Series

In the Tivoli series are deep, excessively drained, coarse-textured, noncalcareous Regosols of the Brown and Chestnut soil zones. These soils developed on sandhills in wind-deposited sandy material. They are in gently rolling areas to hilly or dunelike areas. The water does not run off these areas in any well-defined drainage pattern. The native vegetation is mainly sand sage and little bluestem, but it includes a small amount of blue grama and buffalograss, and, in the eastern part of the county, some dryland sedge.

Tivoli soils occur with the Vona soils and with Dune land. They are coarser textured than the Vona soils, are noncalcareous to a greater depth, and lack a B horizon. In contrast to Dune land, they have some profile development and are covered by vegetation.

The Tivoli soils have only slight profile development. The normal sequence of horizons is A, AC, and C, but the AC horizon is lacking in some profiles. The following describes a typical profile of Tivoli sand in range (0.4 mile west of the NE. corner of sec. 19, T. 23 S., R. 46 W.):

A1—0 to 9 inches, light brownish-gray (10YR 6/2) sand; dark grayish brown (10YR 4/2) when moist; single grain; loose when dry or moist; noncalcareous; clear, smooth boundary.

C1—9 to 48 inches, pale-brown (10YR 6/3) sand; dark brown (10YR 4/3) when moist; single grain; loose when dry or moist; noncalcareous; diffuse, smooth boundary.

C2—48 to 60 inches +, very pale brown (10YR 7/3) sand; brown (10YR 5/3) when moist; single grain; loose when dry or moist; weakly calcareous. No calcium carbonate is visible in this horizon.

These soils are fairly uniform in profile characteristics and vary mainly in the texture of the horizons. In the eastern part of this county, the A1 horizon is loamy fine sand instead of sand and is thicker and darker colored than in other areas. In other areas the texture of the A1 horizon is loamy sand to sand or fine sand. The texture of the AC and C horizons ranges from loamy sand to sand. In some places where these soils are transitional to the soils of some other series, the substratum is finer textured than normal or these soils are underlain by sandstone or limestone.

Travessilla Series

Soils of the Travessilla series are medium-textured to moderately coarse textured Lithosols of the Brown soil zone. They developed on uplands in material weathered from sandstone, chiefly of the Dakota formation. These soils are shallow or very shallow over sandstone. They are in rolling or steep areas, or in areas of breaks. In most places they are calcareous. The native vegetation is blue grama, buffalograss, sideoats grama, yucca, and cedar trees.

Travessilla soils occur with the Renohill soils, but they are thinner and coarser textured than those soils and lack a B horizon. Unlike the Penrose soils, they developed in material weathered from sandstone instead of limestone.

The common sequence of horizons in this profile is A, C, and R. The following describes a typical profile of Travessilla sandy loam in range (0.4 mile north and 0.2 mile west of the SE. corner of sec. 20, T. 26 S., R. 46 W.):

A1—0 to 4 inches, light brownish-gray (10YR 6/2) sandy loam; dark grayish brown (10YR 4/2) when moist; weak to moderate, thin, platy structure breaking to moderate, very fine, granular; soft when dry, very friable when moist; noncalcareous; approximately 10 percent, by volume, is channery sandstone fragments; clear, smooth boundary.

C—4 to 7 inches, light brownish-gray (10YR 6/2) sandy loam; dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, very friable when moist; calcareous; contains some partly weathered fragments of sandstone; abrupt, smooth boundary.

R—7 to 14 inches +, hard Dakota sandstone, partly weathered in the upper 1 to 2 inches.

These soils vary mainly in the depth to sandstone, in the number of sandstone outcrops, and in the number of stones on the surface. The depth to bedrock ranges from as much as 20 inches to 0. The surface layer ranges from loam to sandy loam.

Tyrone Series

In the Tyrone series are deep, well-drained, medium-textured to moderately fine textured soils of the Brown great soil group. These soils developed on uplands in material weathered from shale and limestone, which are of Cretaceous age and chiefly of the Benton and Niobrara formations. They are highly calcareous throughout. These soils are nearly level to moderately sloping. Surface drainage is medium to moderately rapid, and internal drainage is medium. The native vegetation is blue grama and buffalograss.

Tyrone soils occur with the Minnequa soils, but they are finer textured than those soils and have B2 horizons. In some characteristics their profile is similar to that of the Wiley soils, but the Tyrone soils are more saline, contain some fragments of limestone, and developed in material weathered from shale and limestone instead of from loess.

The A1 and textural B horizons in the profile are weakly defined. The normal sequence of horizons is A1, B2t, and Cca. The following describes a typical profile of Tyrone loam in range (0.37 mile north and 0.3 mile west of the SE. corner of sec. 7, T. 27 S., R. 47 W.):

A1—0 to 3 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure breaking to moderate, very fine, granular; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

B1—3 to 6 inches, light brownish-gray (10YR 6/2) light clay loam; dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, subangular blocky structure breaking to moderate, very fine, subangular blocky; slightly hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

B21t—6 to 16 inches, light brownish-gray (10YR 6/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, very friable when moist; strongly calcareous; thin, patchy clay skins on both the horizontal and vertical surfaces of the soil aggregates; clear, smooth boundary.

B22tca—16 to 22 inches, pale-brown (10YR 6/3) clay loam; brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

On both the horizontal and vertical surfaces of the soil aggregates are thin, patchy clay skins. This is a horizon of weak calcium carbonate accumulation. Some of the calcium carbonate occurs as concretions, and some is in thin seams and streaks.

B3ca—22 to 36 inches, pale-yellow (2.5Y 7/3) light clay loam; light olive brown (2.5Y 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

This is a horizon of weak calcium carbonate accumulation. Some of the calcium carbonate occurs as concretions, and some is in thin seams and streaks.

C1ca—36 to 61 inches, pale-yellow (2.5Y 7/3) light clay loam; light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

This is a ca horizon of weak calcium carbonate accumulation. Some of the calcium carbonate occurs as concretions, and some is in thin seams and streaks.

C2ca—61 to 70 inches +, pale-yellow (2.5Y 7/3) light clay loam or heavy loam; light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist; strongly calcareous.

Some calcium carbonate has accumulated in this horizon but there is less than in the C1ca horizon.

These soils vary mainly in thickness and texture of the horizons. The surface layer ranges from loam to clay loam in texture. In some places the substratum is light clay loam, and in other places it is loam or silt loam.

Ulysses Series

In the Ulysses series are deep, well-drained Chestnut soils that are intergrading toward Regosols. These soils developed on uplands in calcareous loess. They are medium textured, and in most areas where they are in range, their upper horizons are noncalcareous. They are nearly level or gently sloping. Internal drainage is medium. The native vegetation is mainly blue grama and buffalograss, but in sandy areas it includes some little bluestem, sideoats grama, sand sage, and yucca.

Ulysses soils occur with the Colby and Richfield soils. Their surface layer is leached of lime and is darker colored than that of the Colby soils, and they have more structural development in the profile. They have a slightly coarser textured subsoil than the Richfield soils, and they are not leached of lime to so great a depth.

The following describes a typical profile of Ulysses loam under dryland cultivation (0.23 mile east and 75 feet north of the SW. corner of sec. 30, T. 27 S., R. 41 W.):

Ap—0 to 4 inches, grayish-brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure breaking to moderate, very fine, granular; soft when dry, very friable when moist; weakly calcareous; clear, smooth boundary.

A3—4 to 7 inches, grayish-brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) when moist; weak to moderate, medium, subangular blocky structure; slightly hard when dry, very friable when moist; weakly calcareous; clear, smooth boundary.

B21t—7 to 10 inches, brown (10YR 5/3) heavy loam or light clay loam; dark brown (10YR 3/3) when moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, very friable when moist; weakly calcareous; a moderate number of thin, patchy clay skins on both the horizontal and vertical surfaces of the soil aggregates; clear, smooth boundary.

B22t—10 to 15 inches, light brownish-gray (10YR 6/2) heavy loam or light clay loam; dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, very friable when moist; strongly calcareous; a moderate number of thin, patchy clay skins on both the horizontal and vertical surfaces of the soil aggregates; clear, smooth boundary.

B3—15 to 23 inches, pale-brown (10YR 6/3) heavy loam; brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, very friable when moist; strongly calcareous; gradual, wavy boundary.

C1ca—23 to 33 inches, light yellowish-brown (10YR 6/4) loam; yellowish brown (10YR 5/4) when moist; massive; hard when dry, very friable when moist; very strongly calcareous; gradual, wavy boundary.

This is a horizon of weak calcium carbonate accumulation; some of the lime occurs as concretions, and some of it is in thin seams and streaks.

C2ca—33 to 45 inches, pale-brown (10YR 6/3) heavy loam or light clay loam; brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, wavy boundary.

This is a horizon of weak calcium carbonate accumulation; some of the calcium carbonate occurs as concretions or is in thin seams and streaks.

C3—45 to 60 inches +, very pale brown (10YR 7/3) loam; yellowish brown (10YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.

In this horizon a small amount of calcium carbonate has accumulated, but less than is in the C2ca horizon.

These soils vary mainly in the degree of profile development and in depth to calcareous material. In some areas illuvial clay is not evident in the B horizon, but it can be seen in most profiles. The content of clay in the B horizon ranges from 25 to 32 percent, by volume. In most areas under grass, these soils are leached of lime to a depth of 5 to 15 inches, but in some dry-farmed areas they are calcareous to the surface.

Vona Series

In the Vona series are deep, well-drained to excessively drained Brown soils. These soils developed in wind-deposited, calcareous sandy material. They are moderately coarse textured, and their upper horizons are noncalcareous. These soils are gently rolling to steep. The native vegetation is yucca, sand sage, buffalograss, blue grama, sand dropseed, and little bluestem.

Vona soils occur with the Tivoli soils, but they are finer textured than those soils and have a B horizon. They are more deeply leached of lime than are the Otero soils, and unlike those soils, they have a B2 horizon.

The normal sequence of horizons in this profile is A1, B2t, B3, Cca, and C. The following describes a typical profile of Vona sandy loam under native vegetation (0.37 mile east and 0.17 mile north of the SW. corner of sec. 1, T. 23 S., R. 45 W.):

A1—0 to 9 inches, grayish-brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 4/2) when moist; weak, very fine, granular structure to single grain; loose when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A3—9 to 12 inches, grayish-brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure to weak, very fine, granular; hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2t—12 to 18 inches, grayish-brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 3/2) when moist; weak, medium or coarse, subangular blocky structure; hard when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

B3—18 to 23 inches, brown (10YR 5/3) sandy loam; dark brown (10YR 4/3) when moist; weak, medium, subangular blocky to weak, fine, granular structure; slightly hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C1ca—23 to 34 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) when moist; very weak, coarse, subangular blocky structure to massive; slightly hard when dry, very friable when moist; effervescence with HCl is violent; clear, smooth boundary.

C2ca—34 to 40 inches, pale-brown (10YR 6/3) fine sandy loam; grayish brown (10YR 5/2) when moist; massive or single grain; slightly hard when dry, very friable when moist; effervescence with HCl is violent; clear, smooth boundary.

C3—40 to 60 inches, light yellowish-brown (10YR 6/4) loamy sand; yellowish brown (10YR 5/4) when moist; single grain; loose when dry or moist; effervescence with HCl is violent.

These soils vary mainly in depth to lime, in characteristics of the substratum, and in texture and thickness of their horizons. In general, the depth to lime ranges from 15 to 28 inches, but in places where these soils are eroded, lime is nearer the surface. The substratum ranges from fine sand to loam in texture and from 30 to 42 inches in depth. Where these soils are close to the sandhills, the substratum is generally coarse textured, but where the soils are close to areas that are transitional to hardlands, the substratum is finer textured.

Wiley Series

In the Wiley series are deep, well-drained soils of the Brown great soil group. These soils are in the drier areas of the Brown soil zone. They are medium textured to moderately fine textured. They developed on uplands in calcareous loess and are calcareous within 6 inches of the surface. These soils are nearly level to moderately sloping. The native vegetation is blue grama and buffalograss.

Wiley soils occur with the Baca and Colby soils. They are somewhat finer textured than the Colby soils, and they have B and ca horizons. They are shallower to calcareous material than the Baca soils, and their B2 horizon is less clayey. Their A horizon is lighter colored than that of the Ulysses soils.

The normal sequence of horizons in this profile is A1, B2t, B3ca, Cca, and C. The following describes a typical profile of Wiley silt loam under dryland cultivation (0.15 mile east and 0.13 mile south of the NW. corner of sec. 8, T. 24 S., R. 45 W.):

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silt loam; dark grayish brown (10YR 4/2) when moist; weak, thick, platy structure breaking to weak, fine, granular; hard when dry, friable when moist; slightly calcareous; clear, smooth boundary.

B21t—4 to 10 inches, grayish-brown (10YR 5/2) silty clay loam; dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, friable when moist; thin, patchy clay skins; strongly calcareous; gradual, smooth boundary.

B22t—10 to 17 inches, pale-brown (10YR 6/3) silty clay loam; brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, firm when moist; very thin, nearly continuous clay skins; very strongly calcareous and has a few scattered lime spots; gradual, smooth boundary.

B3ca—17 to 29 inches, pale-brown (10YR 6/3) silty clay loam; brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to weak, medium to coarse, subangular blocky; hard when dry, firm when moist; thin, patchy clay skins; very strongly calcareous and has numerous lime spots; clear, smooth boundary.

C1ca—29 to 41 inches, very pale brown (10YR 7/3) light silty clay loam; brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; very strongly calcareous; gradual, smooth boundary.

C2—41 to 60 inches, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist; very weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

C3—60 to 90 inches, very pale brown (10YR 7/3) silt loam; yellowish brown (10YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.
C4—90 to 105 inches, light-brown (7.5YR 6/4) silt loam; brown (7.5YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.
IIC5—105 inches +, pink (7.5YR 7/5) light silty clay loam; brown (7.5YR 5/5) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous; contains some salt and has some lime spots.

Generally, these soils are fairly uniform in profile characteristics, but they vary slightly in thickness of horizons and in texture. The surface layer ranges from silt loam to light silty clay loam in texture and from 3 to 8 inches in thickness. The B horizon ranges from heavy silt loam to light silty clay loam in texture. In some places calcareous material is at a depth of a few inches, and in others it is at the surface.

Mechanical and Chemical Analyses

Table 7 gives the results of mechanical and chemical analyses of samples taken from representative profiles of the Baca, Colby, Nepesta, Richfield, Rocky Ford, and Wiley soils. The data given in the table are useful to soil scientists in classifying soils and in developing concepts of soil genesis. In addition they can be used for estimating the water-holding capacity, susceptibility to wind erosion, fertility, tilth, and other soil properties that affect soil management. The facts about reaction, electrical conductivity, and percentage of exchangeable sodium will also be helpful in determining whether saline-alkali soils can be reclaimed and in deciding what management practices to use for such soils.

Field and laboratory methods

All samples used to obtain the data in table 7 were collected from carefully selected pits. The samples are representative of the soil material made up of particles less than three-fourths of an inch in diameter. During the sampling, estimates of the fraction of the sample consisting of particles larger than three-fourths of an inch were made. If necessary, the sample was sieved after it was dried, and fragments of rock larger than three-fourths of an inch in diameter were discarded. Then the material made up of particles less than three-fourths of an inch was rolled, crushed, and sieved by hand to remove fragments of rock larger than 2 millimeters in diameter.

The fraction that consists of particles between 2 millimeters and three-fourths of an inch in diameter is recorded in the table as a trace. The amount was calculated from the total weight of the particles smaller than three-fourths of an inch in diameter.

The content given for the fractions that consist of particles larger than three-fourths of an inch and of particles between 2 millimeters and three-fourths of an inch in diameter is somewhat arbitrary. The accuracy of the data depends on the severity of the preparative treatment, which may vary with the objectives of the study. The two fractions, however, do contain relatively unaltered fragments of rock that are larger than 2 millimeters in diameter, and they do not contain slakable clods of earthy material.

Unless otherwise noted, all laboratory analyses were made on ovendried material that passed the 2-millimeter sieve. In table 7 the values shown for exchangeable sodium and potassium are for amounts of sodium and potassium that have been extracted by the ammonium acetate method, minus the amounts that are soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 7. Determinations of clay were made by the pipette method (*5*, *6*, *9*). The reaction of a saturated paste and that of a 1:10 water suspension were measured with a glass electrode. Organic carbon was determined by wet combustion, and a modification of the Walkley-Black method (*10*) was used. The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples that had been treated with concentrated hydrochloric acid. The cation-exchange capacity was determined by direct distillation of absorbed ammonia (*10*). The extractable calcium and magnesium was determined by separating the calcium as calcium oxalate and the magnesium as magnesium ammonium phosphate (*10*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*13*). Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

Interpretation of laboratory data

Laboratory data for the soil types named in table 7 show that the predominant sand fraction is very fine sand throughout the profile. The upper horizons in all the profiles contain a small amount of fine sand, but there is only a small amount of sand coarser than fine sand in any of the profiles. The content of sand is generally greatest in the upper two or three horizons than in the lower horizons. The Colby profile has the largest amount of sand throughout, and the Baca, Richfield, and Wiley soils have approximately the same amount of sand throughout. The upper horizons of the Nepesta and Rocky Ford soils have the least amount of sand. The lower horizons of the Nepesta and Rocky Ford were not sampled.

The silt fraction dominates the texture throughout the entire profile of all six soils analyzed. These profiles generally contain from 50 to 65 percent silt, but in some of the surface horizons, they have lost silt through wind erosion. The Nepesta soil, on the other hand, has accumulated clay through siltation. The profiles of the Colby and Nepesta soils contain slightly less silt than the profiles of the other soils.

The Baca, Richfield, and Wiley soils have a significant accumulation of clay in their B2 horizons, which is evidence of the movement of clay downward from the surface layer. The Colby soil also has more clay in the horizons below the surface layer, but this is because clay has been lost from the surface layer through wind erosion, rather than because clay has accumulated in the B horizon. The Baca, Nepesta, and Richfield soils have approximately the same amount of clay in their B hori-

TABLE 7.—*Mechanical and chemical properties*

[Analyses made at the Soil Survey Laboratory, Soil Conservation

Soil name, sample number, and location	Horizon	Depth	Particle size distribution—									Textural class	Moisture tension—	
			Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (0.002 mm.)	(0.2 to 0.02 mm.)	(0.02 to 0.002 mm.)		1/10 atmosphere	1/3 atmosphere
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*		*Pct.*	*Pct.*
Baca clay loam:														
S58 Colo–50–10 (1–8); 0.42 mile W. and 100 feet S. of NE. corner of sec. 10, T. 21 S., R. 46 W.	Ap	0–3	0.1	0.9	1.0	2.7	22.1	42.8	30.4	53.9	12.9	Clay loam	38.5	22.4
	B21t	3–6	.1	1.1	1.1	2.5	17.6	41.2	36.4	47.0	13.6	Clay loam	38.8	26.8
	B22t	6–13	.2	.5	[1] .6	[1] 1.3	[1] 9.6	50.3	37.5	40.3	20.5	Silty clay loam.	38.3	28.8
	B3ca	13–18	.1	.1	[1] .1	[1] .5	[1] 7.9	57.9	33.4	42.3	23.9	Silty clay loam.	39.2	28.3
	C1ca	18–25	<.1	.1	[1] .1	[1] .5	[1] 8.1	60.6	30.6	45.2	23.9	Silty clay loam.	40.9	28.6
	C2ca	25–36	.1	.1	[2] .1	.6	[2] 8.5	65.3	25.3	67.7	26.6	Silt loam	44.2	29.2
	C3ca	36–45	<.1	<.1	[1] .1	[1] .5	[1] 9.1	69.9	20.4	51.5	27.9	Silt loam	45.0	27.6
	C4	45–60+	<.1	<.1	[1] <.1	[1] .5	[1] 9.6	72.1	17.8	52.7	29.4	Silt loam	45.3	25.2
Colby silt loam:														
S58 Colo–50–2 (1–7); 0.4 mile N. and 50 feet E. of SW. corner of sec. 28, T. 23 S., R. 47 W.	Ap1	0–2	.2	.4	[1] .6	[1] 11.1	[1] 33.6	38.2	15.9	70.3	11.1	Loam	35.9	16.2
	Ap2	2–4	<.1	.1	[1] .2	[1] 8.1	[1] 25.2	47.7	18.7	64.5	15.4	Loam	37.0	20.7
	AC	4–11	<.1	.1	[1] .2	[1] 5.6	[1] 21.8	54.7	17.6	62.5	18.9	Silt loam	35.2	20.4
	C1	11–18	<.1	.1	[1] .1	[1] 3.5	[1] 18.8	59.6	17.9	60.7	[3] 20.8	Silt loam	37.0	21.8
	C2	18–27	<.1	.1	[2] .1	[2] 5.5	[2] 21.2	56.2	16.9	63.8	18.5	Silt loam	36.4	20.6
	C3	27–44	<.1	.1	[2] .2	[2] 7.6	[2] 23.1	55.6	13.4	68.1	17.2	Silt loam	36.0	19.4
	C4	44–60+	<.1	.1	[2] .1	[2] 6.2	[2] 25.5	56.2	11.9	69.8	17.4	Silt loam	36.7	18.6
Nepesta clay loam:														
S60 Colo–50–9 (1–7); 150 feet N. and 66 feet W. of S¼ corner of sec. 22, T. 22 S., R. 43. W.	Ap1	0–7	[4] 1.0	[2] 1.1	[2] .6	[2] 1.6	[2] 8.8	45.5	41.4	32.2	[3] 23.2	Silty clay	------	------
	Ap2	7–11	.7	[2] 1.2	[2] .8	[2] 2.0	[2] 10.9	43.4	41.0	34.9	[3] 20.8	Silty clay	[5] 28.3	33.3
	B21t	11–16	1.2	[2] 2.1	[2] 1.3	[2] 3.0	[2] 15.9	41.5	35.0	44.0	[3] 15.4	Clay loam	[5] 26.4	31.5
	B22t	16–26	3.2	[2] 2.7	[2] 1.2	[2] 2.5	[2] 13.7	43.7	33.0	45.4	[3] 13.6	Clay loam	------	------
Richfield silt loam:														
S58 Colo–50–6 (1–12); 0.37 mile E. and 90 feet N. of SW. corner of sec. 32, T. 26 S., R. 42 W.	Ap	0–4	.2	.6	.5	1.9	17.3	52.7	26.8	57.0	14.4	Silt loam to silty clay loam.	40.4	21.4
	AB	4–7	<.1	.3	.4	1.4	14.4	53.4	30.1	53.5	15.4	Silty clay loam.	40.1	25.3
	B21t	7–12	<.1	.2	.3	1.2	1.6	49.6	37.1	47.4	14.7	Silty clay loam.	40.1	28.4
	B22t	12–18	.1	.1	.2	.8	9.3	53.5	36.0	45.6	17.8	Silty clay loam.	40.1	29.9
	B3ca	18–26	<.1	.1	[1] .1	[1] .5	[1] 6.2	59.1	34.0	42.1	23.6	Silty clay loam.	41.2	29.4
	C1ca	26–34	<.1	<.1	[1] .1	[1] .3	[1] 5.2	57.8	36.6	38.5	24.7	Silty clay loam.	42.7	31.6
	C2ca	34–42	<.1	<.1	<.1	[1] .2	[1] 5.2	60.3	34.3	39.6	26.1	Silty clay loam.	42.2	31.6
	C3	42–49	<.1	<.1	<.1	[1] .2	[1] 5.2	62.5	32.1	40.4	27.5	Silty clay loam.	43.7	32.4
	C4	49–70	<.1	<.1	<.1	[1] .3	[1] 6.4	67.2	26.1	45.5	28.4	Silt loam	44.7	27.8

See footnotes at end of table.

of selected soils in Prowers County, Colo.

Service, Lincoln, Nebr. Dashes indicate values were not determined]

15 atmospheres	Reaction	Organic matter			Estimated salts (bureau cup)	Electrical conductivity EC×10³ millimhos per cm. at 25° C.	$CaCO_3$ equivalent	Cation-exchange capacity NH_4Ac	Extractable cations					Exchangeable sodium percentage	Saturation extract, soluble		Moisture at saturation
		Organic carbon	Nitrogen	C/N ratio					Ca	Mg	H	Na	K		Na	K	
Pct.	*pH*	*Pct.*	*Pct.*		*Pct.*		*Pct.*	*Meq./100 gr.*	*Meq./100 gr.*	*Meq./100 gr.*	*Meq./100 gr.*	*Meq./100 gr.*	*Meq./100 gr.*	*Pct.*	*Meq./l.*	*Meq./l.*	*Pct.*
11.4	7.9	0.96	0.108	9	<0.20	1.0	1	20.8	28.2	4.0	<0.1	<0.1	2.0	<1	0.4	1.0	57.5
14.2	7.9	.94	.104	9	<.20	.7	1	25.2	25.7	6.1	.4	<.1	1.5	<1	.4	.4	62.9
15.4	7.9	.84	.096	9	<.20	.7	5	25.1	------	------	------	<.1	1.2	<1	.5	.4	68.0
13.9	8.0	.48	.061	8	<.20	.7	10	22.1	------	------	------	.3	1.0	1	1.2	.3	67.8
12.7	8.1	.38	.044	9	<.20	.7	12	20.7	------	------	------	.8	1.0	3	2.4	.3	63.0
11.8	8.3	.26	------	------	<.20	.8	10	21.1	------	------	------	1.6	1.1	7	4.2	.3	57.0
11.1	8.5	.19	------	------	<.20	.8	9	20.8	------	------	------	2.0	1.1	8	5.1	.2	52.5
10.3	8.2	.16	------	------	<.20	1.5	6	21.5	------	------	------	2.0	1.1	7	7.8	.4	54.4
7.3	7.9	.72	.082	9	<.20	.7	5	11.2	------	------	------	<.1	1.0	<1	.4	1.0	44.4
9.5	7.8	.72	.081	9	<.20	.5	8	11.6	------	------	------	<.1	.7	<1	.3	.5	51.2
8.6	7.9	.51	.057	9	<.20	.5	9	12.0	------	------	------	<.1	.5	<1	.3	.3	51.2
8.4	8.0	.34	.043	8	<.20	.5	8	15.5	------	------	------	.1	.7	1	.4	.3	49.2
7.6	8.0	.34	.039	9	<.20	.7	7	14.4	------	------	------	.1	.7	1	.8	.3	45.9
6.7	8.2	.16	------	------	<.20	1.0	6	13.0	------	------	------	.8	.8	5	4.1	.4	43.6
6.5	8.5	.14	------	------	<.20	.9	6	13.2	------	------	------	1.6	.8	10	5.9	.3	44.0
16.7	7.8	2.06	.180	11	--------	1.0	4	24.9	------	------	------	.6	1.8	2	2.9	.8	65.0
17.3	7.9	1.43	.142	10	--------	.9	4	24.6	------	------	------	.9	1.4	3	3.8	.4	67.1
15.5	7.8	1.11	.118	9	--------	1.2	3	23.0	------	------	------	.9	1.1	3	4.5	.4	62.2
14.3	7.8	.69	.080	9	--------	1.5	7	20.3	------	------	------	.9	.9	3	5.2	.3	60.7
10.0	7.8	1.20	.111	10.8	<.20	.7	<1	20.7	17.3	3.6	1.2	<.1	3.0	<1	.2	1.8	47.8
11.5	7.2	1.01	.100	10.1	<.20	.5	<1	21.4	16.1	4.6	2.4	.1	1.8	<1	.3	.7	52.9
14.6	7.0	.78	.086	9	<.20	.5	<1	25.5	18.1	6.0	2.5	.1	1.6	<1	.3	.4	62.4
15.0	7.4	.60	.073	8	<.20	.8	1	26.0	25.0	7.3	.4	.1	1.4	<1	.5	.4	64.9
14.1	7.8	.50	.060	8	<.20	.9	6	22.8	------	------	------	.1	1.3	<1	.7	.4	64.1
15.0	7.9	.48	------	------	<.20	.6	6	24.2	------	------	------	.3	1.4	1	1.0	.4	65.3
14.1	8.0	.34	------	------	<.20	.5	12	22.2	------	------	------	.6	1.4	2	1.8	.4	63.8
13.4	8.2	.26	------	------	<.20	.6	12	21.3	------	------	------	1.1	1.4	4	2.6	.4	57.2
12.0	8.3	.29	------	------	<.20	.6	7	21.4	------	------	------	1.5	1.5	6	3.4	.3	58.6

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TABLE 7.—*Mechanical and chemical properties*

Soil name, sample number, and location	Horizon	Depth	Particle size distribution— Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (0.002 mm.)	(0.2 to 0.02 mm.)	(0.02 to 0.002 mm.)	Textural class	Moisture tension— 1/10 atmosphere	1/3 atmosphere
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*		*Pct.*	*Pct.*
Rocky Ford clay loam:														
S60 Colo-50-4 (1-3); 0.3 mile N. and 100	Ap1	0-4	[4] 0.3	[1] 0.5	[2] 0.4	[2] 1.4	[2] 7.4	56.5	33.5	30.8	[3] 34.1	Silty clay loam.	[5] 27.8	30.6
feet E. of S¼	Ap2	4-9	[4] .2	[2] .3	[2] .3	[2] 1.1	[2] 6.5	54.8	36.8	28.6	[3] 33.5	Silty clay loam.	[5] 27.8	30.8
corner of sec. 34, T. 22 S., R. 43 W.	AC	9-18	[2] .2	[2] .4	[2] .6	[2] 2.8	[2] 16.0	55.8	24.2	52.2	[3] 21.7	Silt loam	------	------
Wiley silt loam:														
S58 Colo-50-8	Ap	0-4	<.1	.2	.3	1.5	19.9	55.5	22.6	60.8	15.7	Silt loam	36.0	21.4
(1-9); 0.15 mile E. and 0.13 mile S. of	B21t	4-10	.1	.1	[1] .2	[1] 1.1	[1] 14.4	57.5	26.6	53.5	19.3	Silt loam to silty clay loam.	35.9	23.6
NW. corner of sec. 8, T. 24 S., R. 45 W.	B22t	10-17	.1	.1	[1] .1	[1] .8	[1] 9.7	62.2	27.0	51.0	21.5	Silty clay loam to silt loam.	37.7	24.4
	B3ca	17-29	<.1	.1	[1] .1	[1] .5	[1] 8.4	65.8	25.1	50.0	24.6	Silt loam	39.9	26.9
	C1ca	29-41	<.1	.1	[1] .1	[1] .6	[1] 9.8	66.1	23.3	52.0	24.4	Silt loam	41.7	28.5
	C2	41-60	<.1	.1	[1] .1	[1] .8	[1] 10.9	67.3	20.8	54.5	24.3	Silt loam	42.8	27.7

[1] Contains a trace of calcium carbonate concretions.
[2] Contains a few calcium carbonate concretions.
[3] The C1 horizon of Sample No. S58 Colo-50-2 (1-7) and all of the horizons in Sample Nos. S60 Colo-50-9 (1-7) and S60 Colo-50-4 (1-3) contained a few grains (trace) between 2 millimeters and ¾ inch in diameter. A trace is less than 5 percent.

zons. The Wiley soil has less clay in the B horizon than do the Baca, Nepesta, and Richfield soils, and the Colby soil has less clay throughout the profile. The Nepesta and Rocky Ford soils have more clay in the surface layer than they do in the horizons below the surface layer. This is the result of siltation, which has caused clay to accumulate in the surface layer.

Table 7 also gives the chemical characteristics for the profiles sampled. The analyses of these profiles show generally a mildly or moderately alkaline reaction. In general, the pH ranges mostly from 7.8 to 8.2, but the lower C horizons of some of the profiles are slightly more alkaline and in places their pH is as high as 8.6. The Richfield soil is the most nearly neutral; the pH of its B21t horizon, which is noncalcareous, is 7.0. The pH for a 1:5 dilution, not given in the table, is about 0.5 higher than that for a 1:1 dilution.

The carbon-nitrogen ratio in the upper horizons of these profiles ranges from 9 to 12, but the Richfield soil has the widest ratio of the nonirrigated soils. The Nepesta and Rocky Ford soils that are irrigated have a wider ratio than the other soils. The content of organic carbon and of nitrogen in the upper horizons is highest in the Nepesta and Rocky Ford soils and lowest in the Colby soils. The Baca and Wiley soils have about the same amount of organic carbon and nitrogen in the A horizon, but the Baca soils have more organic carbon and nitrogen in the B horizon than the Wiley soils. Of the nonirrigated soils, the Baca, Colby, Richfield, and Wiley, the Richfield soil has the widest carbon-nitrogen ratio and the highest content of organic carbon. In all the profiles, there is a gradual decrease in the content of organic carbon and nitrogen with increasing depth.

The Baca, Richfield, and Wiley soils have an accumulation of calcium carbonate in the ca horizons. The ca horizons contain much more calcium carbonate than the horizons above or below them, which is evidence of leaching of lime. The Baca and Richfield soils have stronger ca horizons than the Wiley. The Colby profile, on the other hand, does not show a strong accumulation of lime. The surface layer of the Colby soil contains less lime than the lower horizons because much of the lime formerly in the surface layer has been lost through wind erosion when the particles of silt and clay were blown away. The parent material of all of these soils contains about 6 to 7 percent calcium carbonate. In the *of selected soils in Prowers County, Colo.*—Continued

15 atmospheres	Reaction	Organic matter			Estimated salts (bureau cup)	Electrical conductivity EC×10³ millimhos per cm. at 25° C.	$CaCO_3$ equivalent	Cation-exchange capacity NH_4Ac	Extractable cations					Exchangeable sodium percentage	Saturation extract, soluble		Moisture at saturation
		Organic carbon	Nitrogen	C/N ratio					Ca	Mg	H	Na	K		Na	K	
Pct.	pH	Pct.	Pct.		Pct.		Pct.	Meq./100 gr.	Meq./100 gr.	Meq./100 gr.	Meq./100 gr.	Meq./100 gr.	Meq./100 gr.	Pct.	Meq./l.	Meq./l.	Pct.
15. 0	7. 9	1. 66	0.140	12	--------	1. 2	7	22. 5	------	------	------	0. 8	1. 5	2	4. 6	0. 8	58. 7
15. 7	7. 9	1. 53	.132	12	--------	. 8	7	22. 9	------	------	------	. 6	1. 2	2	2. 8	. 4	61. 4
12. 2	7. 9	. 69	.087	8	--------	. 9	11	17. 0	------	------	------	. 6	. 9	2	3. 3	. 4	53. 5
10. 1	7. 8	. 98	.108	9	<. 20	. 7	2	18. 7	------	------	------	<. 1	1. 4	<1	. 4	. 7	53. 2
11. 6	7. 9	. 78	.088	9	<. 20	. 6	7	18. 7	------	------	------	. 1	. 8	<1	. 5	. 3	58. 9
11. 5	7. 9	. 52	.062	8	<. 20	. 7	9	18. 6	------	------	------	. 3	. 7	1	1. 4	. 3	58. 3
10. 9	8. 2	. 33	.040	8	<. 20	1. 0	9	18. 8	------	------	------	1. 6	. 7	7	5. 4	. 2	58. 0
11. 3	8. 6	. 22	------	------	<. 20	. 9	8	18. 7	------	------	------	3. 1	. 7	14	6. 8	. 1	55. 9
10. 8	8. 5	. 18	------	------	<. 20	2. 2	6	19. 2	------	------	------	4. 5	. 6	19	16. 6	. 1	54. 1

[4] Fragments of organic matter are common.
[5] Determinations made on fragments at ⅓ atmosphere.

mechanical analysis of these and other calcareous soils such as these, most of the calcium carbonate is in the clay and silt fractions. Therefore, horizons that contain a large amount of calcium carbonate may appear to contain more silt and clay than they actually do.

The cation-exchange capacity of these soils appears to be roughly proportional to the amount of 2-micron clay in any given horizon. Horizons that contain a larger proportion of clay also have a higher cation-exchange capacity than horizons that contain less clay. The Baca and Richfield soils have the highest cation-exchange capacity of the nonirrigated soils analyzed, and the Colby soil has the lowest. Because the surface layer of the Nepesta and Rocky Ford soils is finer textured than that of the other soils, the cation-exchange capacity is higher in their surface layer than in the surface layer of the other soils.

The amount of exchangeable sodium increases with increasing depth in the Baca, Colby, Richfield, and Wiley soils, but the A and B horizons of these soils do not contain a significant amount. The strongest accumulation of exchangeable sodium is in the lower part of the C horizon of these soils. The Wiley soil has the highest concentration, and the Richfield has the lowest.

Descriptions of soils analyzed

A typical profile of each of the Baca, Richfield, and Wiley soils is given in the section "Descriptions of Soil Series." A profile of the Colby, Nepesta, and Rocky Ford soils that were analyzed is described in the following pages.

The following describes a profile of a dry-farmed, gently rolling Colby soil that has slopes of 2 percent and is under wheat stubble (Sample No. S58 Colo–50–2 (1–7), 0.4 mile north and 50 feet east of the SW. corner of sec. 28, T. 23 S., R. 47 W.):

Ap1—0 to 2 inches, pale-brown (10YR 6/3) loam; brown (10YR 5/3) when moist; weak, fine, subangular blocky structure breaking to weak, fine, granular; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

Ap2—2 to 4 inches, pale-brown (10YR 6/3) loam; brown (10YR 5/3) when moist; massive to weak, thick, platy structure; very hard when dry, friable when moist; this horizon is a tillage pan that has very pale brown (10YR 7/3) streaks; strongly calcareous; clear, smooth boundary, appears to be a plow layer.

AC—4 to 11 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist and crushed; very weak, coarse, prismatic structure breaking to very weak, coarse, subangular blocky; hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C1—11 to 18 inches, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist; weak, coarse, prismatic structure breaking to very weak, medium to coarse, subangular blocky; slightly hard when dry, very friable when moist; very strongly calcareous and contains a few nodules of lime; gradual, smooth boundary.

C2—18 to 27 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist; massive to very weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; many krotovinas; very strongly calcareous; gradual, smooth boundary.

C3—27 to 44 inches, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist and crushed; massive to very weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; very strongly calcareous; gradual, smooth boundary.

C4—44 to 60 inches +, very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) when moist and crushed; massive; slightly hard when dry, very friable when moist; very strongly calcareous.

The following describes a profile of a nearly level, irrigated Nepesta soil that has slopes of 0 to 1 percent, under corn (Sample No. S60 Colo–50–9 (1–7), 150 feet north and 66 feet west of S¼ corner of sec. 22, T. 22 S., R. 43 W.):

Ap1—0 to 7 inches, grayish-brown (10YR 5/2) silty clay; dark grayish brown (10YR 4/2) when moist and crushed; moderate, medium, granular structure; hard when dry, firm when moist; strongly calcareous; clear, smooth boundary.

Ap2—7 to 11 inches, grayish-brown (10YR 5/2) silty clay; dark grayish brown (10YR 4/2) when moist and crushed; moderate, medium, angular and subangular blocky structure to moderate, medium, granular; hard when dry, firm when moist; strongly calcareous; clear, smooth boundary.

B21t—11 to 16 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic and subangular blocky structure to moderate, fine, subangular blocky; hard when dry, friable when moist; slightly calcareous; thin, nearly continuous clay skins; clear, smooth boundary.

B22t—16 to 26 inches, grayish-brown (10YR 5.5/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak to moderate, fine, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; thin, nearly continuous clay skins; clear, smooth boundary.

B3ca—26 to 39 inches, light brownish-gray (10YR 6/2) silty clay loam; dark grayish brown (10YR 4/2) when moist and crushed; weak, fine, subangular blocky structure; slightly hard when dry, very friable when moist; very strongly calcareous; thin, patchy clay skins and few lime spots; gradual, smooth boundary.

C1ca—39 to 50 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist and crushed; massive; soft when dry, very friable when moist; very strongly calcareous; few lime spots; gradual, smooth boundary.

C2—50 to 60 inches, light yellowish-brown (10YR 6/4) silt loam; yellowish brown (10YR 5/4) when moist and crushed; massive; soft when dry, very friable when moist; very strongly calcareous.

The following describes a profile of nearly level, irrigated Rocky Ford clay loam that has slopes of 0 to 1 percent, under sorghum (Sample No. S60 Colo–50–4 (1–3), 0.3 mile north and 100 feet east of the S¼ corner of sec. 34, T. 22 S., R. 43 W.):

Ap1—0 to 4 inches, grayish-brown (10YR 5/2) silty clay loam; dark grayish brown (10YR 4/2) when moist and crushed; weak, very fine, granular structure; slightly hard when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

Ap2—4 to 9 inches, grayish-brown (10YR 5/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; dark grayish brown (10YR 4/2) when moist and crushed; weak to moderate, medium, subangular blocky structure to moderate, fine, granular; hard when dry, firm when moist; strongly calcareous; abrupt, smooth boundary.

AC—9 to 18 inches, brown (10YR 5/3) silt loam; brown (10YR 4/3) when moist and crushed; weak, medium, subangular blocky structure to very weak, very fine, granular; slightly hard when dry, very friable when moist; very strongly calcareous; few worm casts; clear, smooth boundary.

C1—18 to 30 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist and crushed; very weak, medium, subangular blocky structure to massive; soft when dry, very friable when moist; very strongly calcareous and has some mycelial lime; clear, smooth boundary.

C2—30 to 60 inches +, very pale brown (10YR 7/3) silt loam; yellowish brown (10YR 5/4) when moist and crushed; massive; soft when dry, very friable when moist; very strongly calcareous.

Geology

The surface of Prowers County is almost entirely covered with windblown silt and sand, or alluvium. The thickness of these deposits varies from place to place. The windblown silt that covers the surface in a large part of the county is as much as 30 feet thick and consists mostly of fine silt and clay. The windblown sand is as much as 20 feet thick and occupies an area about 4 miles wide immediately south of the Arkansas River and another area about 1 mile wide on the east side of Two Butte and Big Sandy Creeks. The alluvium is mainly in the valley of the Arkansas River, where it is 50 to 150 feet thick and occupies an area 3 miles wide. This alluvium consists of a mixture of sand, gravel, silt, and clay. The windblown sand and the alluvium are of Recent age, but the windblown silt is probably of Pleistocene age.

Most of the uppermost geologic formations in Prowers County are younger than Jurassic. Formations of the Jurassic period, however, are uppermost in small areas north of Two Buttes, and formations of the earlier Triassic and Permian periods are uppermost in even smaller areas along Two Butte Creek southeast of Two Buttes (*7, 19*).

The Ogallala formation is of the Tertiary period and consists of poorly sorted sand, gravel, silt, and limestone from caliche and algal sources. Its thickness ranges from 200 or 300 feet to 0. The Ogallala formation underlies about one-fourth of the county, including the southeastern and the extreme northeastern parts. It is discontinuous in the southwestern part of the county. In the areas where the Ogallala formation is not present, Dakota sandstone or members of the Benton formation occur. In various places the Ogallala formation overlies one of the Niobrara, Benton, or Dakota groups (*2, 7*).

The Niobrara formation of the Upper Cretaceous period is made up of white or pale-colored limestone and interbedded calcareous shale and yellowish marl. The thickness of this formation is not known, but it is probably several hundred feet at the northern edge of the county. The Niobrara formation is uppermost in most of the area north of the Arkansas River, which makes up about a fourth of the county. Toward the Arkansas River it grades to the underlying Benton group.

The Benton group is of the Upper Cretaceous period and consists mostly of fossiliferous limestone, dark-gray to black shale, and thin layers of bentonite. The members of this group are Carlile shale, Greenhorn limestone, and Graneros shale. The Benton group is about 400 feet thick at the northern edge of the county, but it crops out in some places, and in those areas it is only a few feet thick. The shale in this formation erodes into long gentle slopes, but the limestone erodes in a pattern resembling stairsteps. The Benton group is the uppermost geologic formation in about one-third of the county and lies just north of the valley of the Arkansas River in the extreme western part of the county along the Bent County line. It is also discontinuous and irregular in some areas that extend south of Carlton for about 15 miles and south of Holly for about 6 miles. It grades to the underlying Dakota formation.

The Dakota formation is the youngest formation of the Lower Cretaceous period and is thin bedded to massive (fig. 29). It consists of fine-grained sandstone and sandy shale that is buff in most places but ranges from white to brown in color. Large areas of this formation that are exposed are not capped with loess. They have eroded into sharp escarpments, bluffs, and canyons, and in some places they have a barrel-shaped form. The Dakota formation is uppermost in about one-sixth of the county south of Lamar, and it underlies most of the county. It is about 100 feet thick at the southern edge of the county. It overlies the Purgatoire formation.

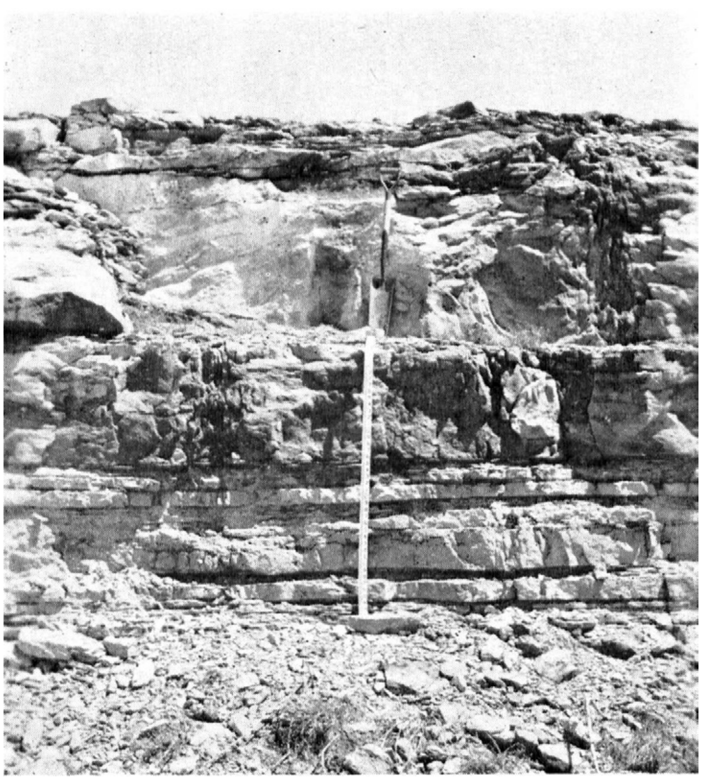

***Figure 29.*—Dakota sandstone that has cropped out about 20 miles south of Lamar. It contains thick strata of sandstone.**

Locally, the Purgatoire formation is the oldest formation of the Lower Cretaceous period. It consists of dark-gray to black, fossiliferous shale and of an underlying white, friable, conglomeritic sandstone. This formation has had little influence on the development of soils in Prowers County. It crops out only in small areas along Two Butte Creek near Two Buttes Dome and in other small areas where it is exposed in the deeper canyons of the southwestern part of the county. In these canyons the overlying Dakota formation has eroded away and has exposed the Purgatoire formation. The Purgatoire formation is underlain by the Morrison formation.

The Morrison formation underlies small areas of Prowers County. It is the youngest of the formations of the Jurassic period, and it ranges from 100 to 200 feet in thickness. It consists of sandstone and of varicolored marl, siltstone, clay, and shale. The varicolored material is principally gray, red, green, and maroon. The individual layers of sandstone are hard and are less than 2 feet thick. They weather to brown or reddish-brown material. This formation has had little influence on the development of soils in Prowers County, for it crops out only in small areas near Two Buttes Dome. It is underlain by the Entrada formation.

The Entrada formation, locally the oldest formation of the Jurassic period, is massive, cross-bedded, fine-grained to medium-grained sandstone. It ranges from white to buff in color and from 390 feet to 0 in thickness. It has had little influence on the development of soils in this county, as it crops out only near Two Buttes Dome along Two Butte Creek. The Entrada sandstone is underlain by the Dockum group.

The Dockum group is of the Triassic period and appears to be red or buff, fine-grained sandstone, though its characteristics are not well defined. It is believed to range from 570 feet to 0 in thickness, but information on its extent is not available. The Dockum group crops out in some places along Two Butte Creek near Two Buttes Dome, but it has had little influence on the development of soils in that area. It probably grades to underlying formations toward the east. Underlying this group is the Taloga formation.

The Taloga formation is of Permian age and consists of red siltstone and fine-grained sandstone. In some places soils have developed in material weathered from this formation. This formation crops out below the dam on Two Buttes Reservoir along Two Butte Creek and underlies the cap of sandstone on Two Buttes Dome.

Two Buttes Dome (fig. 30) is the most prominent topographic feature in the southeastern part of Colorado. It is in the southwestern part of Prowers County and is slightly less than a half mile north of the Baca County line. This double-capped butte is 400 feet higher than the surrounding plains.

The buttes of the Two Buttes Dome consist of Taloga redbeds made up of sandstone and shale of the Permian period. They are capped by resistant Entrada sandstone of the Jurassic period and are underlain by Day Creek dolomite. These buttes lie on the northwestern side of a large structural dome, or laccolith, that pushed up the resistant dolomite and overlying redbeds, probably in the

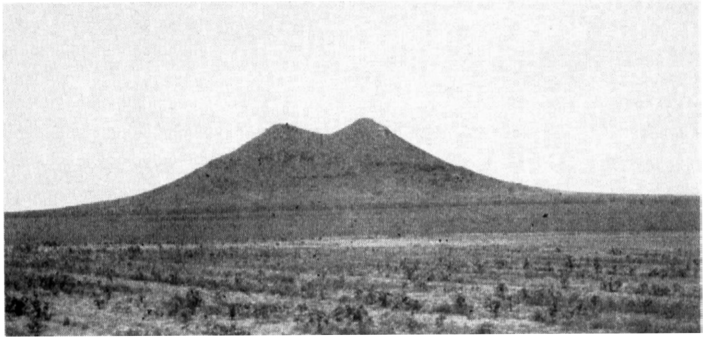

Figure 30.—**Two Buttes Dome, which is 400 feet higher than the surrounding plains, is in the southwestern part of Prowers County. It is the most prominent physiographic feature in the southeastern part of Colorado.**

late Miocene epoch of the Tertiary period. In some places near the apex of the dome, igneous rocks, or andesite porphyry, broke through the Day Creek dolomite to the base of the Entrada sandstone and are exposed in an area more than a quarter of a mile square. Dikes of basalt and andesite porphyry, radiating out from the laccolith, intruded all the sediments up to the Tertiary period. A number of these dikes radiate out from the buttes, but in many places they are obscured by erosion or are partly covered by more recent deposits. In this area sediments from the Permian to the Tertiary period, including the Jurassic, are exposed by erosion of the entire uplifted dome. The influence of this intrusion, or laccolith, on the geology and relief in this part of Prowers County has been considerable (*14*).

Eleven miles south of the Arkansas River in Prowers County, a small geologic fault extends across the State line southeasterly into Hamilton County, Kans. This is part of the same fault on which the geologic sink south of Coolidge, Kans., occurs. It runs in a northwesterly direction, but it cannot be traced very far into Prowers County (*12*).

Apparently, from all information available, the geologic formations underlying Prowers County slope toward the north and slightly toward the east. For example, well logs show that the Dakota formation, which crops out south of Lamar at an elevation of 4,000 feet, is several hundred feet below the surface at the same elevation along the line between Kiowa and Prowers Counties.

The cross sections in figure 31 show the relationship of the soils in eastern and western Prowers County to the landscape and to the geologic formations from which the parent material weathered. The sequence of underlying geologic formations is also shown.

The upper cross section, representing an area in the western part of Prowers County that extends horizontally north and south, shows the various soils that formed in parent material weathered from the outcropping or uppermost geologic formation. The Fort Collins and Cascajo soils are associated with the Ogallala formation; the Travessilla and Renohill soils, with the Dakota formation; the Arvada, Pultney, Minnequa, and Manvel soils, with the Niobrara formation and the Benton group; the Baca and Wiley soils, with windblown silt; and the Tivoli and Vona soils, with windblown sand.

The lower part of the figure shows a cross section of the eastern part of Prowers County that runs horizontally north and south. In that area the relief is smoother and windblown material covers a larger acreage than in the area represented by the upper cross section. Because windblown silt covers most of the eastern part of Prowers County and the underlying geologic formations crop out only in small areas, the soils have developed mainly in windblown silt or sand. The relief in areas where the Richfield and Ulysses soils developed is more nearly level than that in the area where the Baca and Wiley soils developed.

General Nature of the Area

This section of the report tells about the physiography, relief, and drainage of the county and about the climate and water supply. It also describes the social and industrial development and discusses agriculture.

Physiography, Relief, and Drainage

Prowers County lies entirely within the Great Plains physiographic province. Part of it is in the High Plains section, and part is in the Colorado Piedmont section. Most of the county consists of gently rolling to nearly level uplands where the dominant slopes are less than 3 percent. Along the intermittent drainageways, however, are rolling uplands where the slopes are more than 3 percent.

In the northern part of the county is the valley of the Arkansas River, which extends in an east-west direction. This valley consists of areas of alluvial bottom land 1 to 3 miles wide and of terraces that are back from the stream. Along Big Sandy and Two Butte Creeks are other small areas of bottom land, generally no more than a half mile wide. The areas of bottom land and of stream terraces make up about 8 percent of the acreage in the county. In those areas the slopes are less than 2 percent. In the 42 miles from the place where the Arkansas River enters the county to the place where it leaves, there is 300 feet of fall.

Breaks, mainly in the southwestern corner of the county, make up about 10 percent of the acreage. Within the areas of breaks are many vertical cliffs as much as 50 feet high, but the slopes range from 5 to 50 percent. The breaks consist mostly of sandstone and of gravelly material.

An area of sandhills about 4 miles along the south side of the Arkansas River and a narrow strip of sandhills along the east side of the major creeks make up approximately another 10 percent of the county. These areas are nearly level, rolling, or dunelike, and they have no surface drainage.

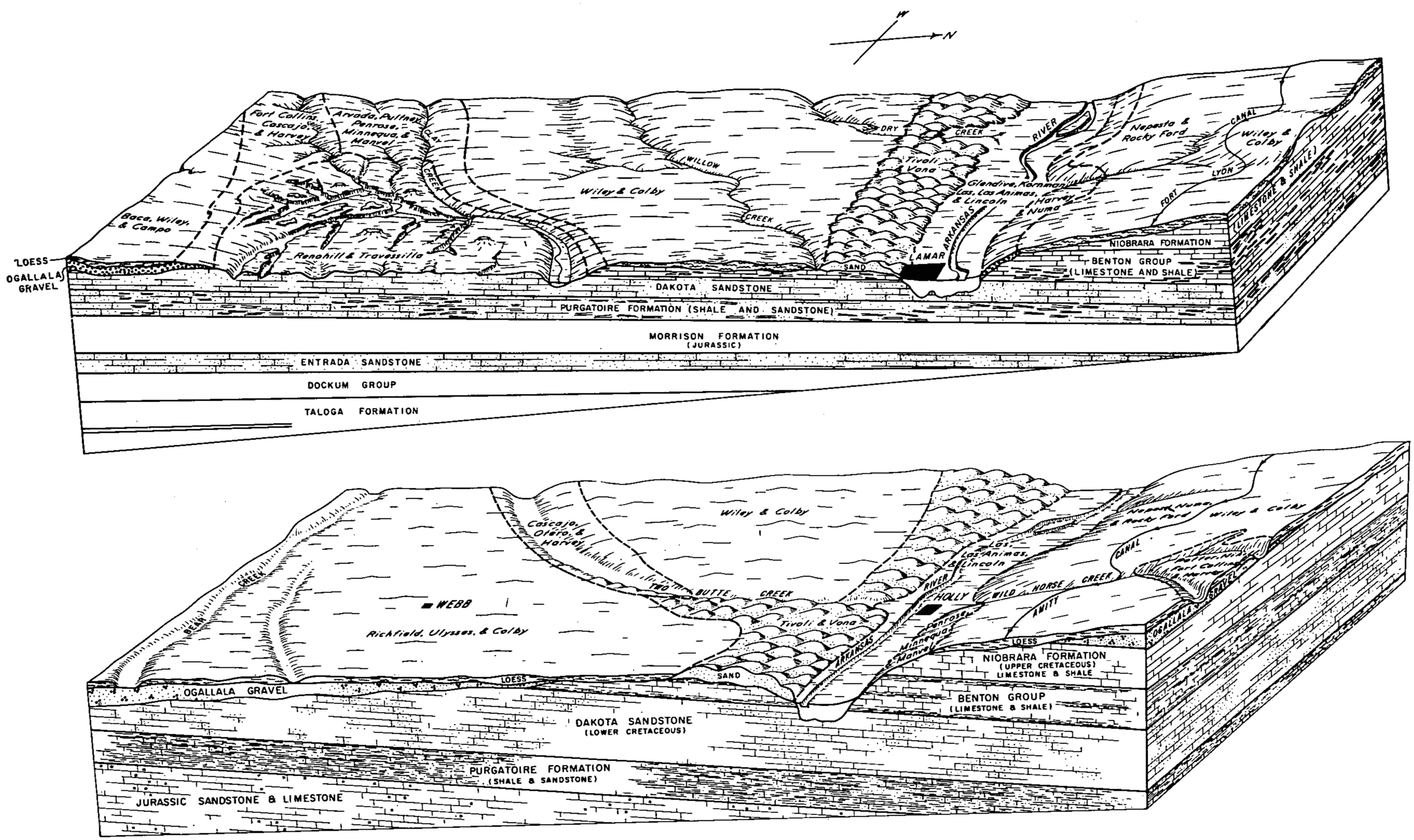

Figure 31.—**Cross sections showing relationships of the soils to the landscape and to the underlying geologic formations in Prowers County. The upper cross section shows relationships in the western part of the county, and the lower shows those in the eastern part of the county.**

In most areas of this county, the elevation is between about 3,400 and 4,200 feet. At the point where the Arkansas River leaves Prowers County, however, the elevation is only 3,350 feet, the lowest point in Colorado, and at Two Buttes Dome, the highest point in the county, it is 4,716 feet. The elevation at Lamar is 3,616 feet.

All drainage from Prowers County is to the Arkansas River. Several intermittent streams and one perennial stream rise in the county or flow through the county and eventually flow into the Arkansas River. The largest of these, and the only perennial stream, is Big Sandy Creek, which drains an area of 3,151 square miles. This stream enters the county from the north and flows southward to the river. The next largest is Two Butte Creek, which drains an area of 818 square miles. It enters the county from the southwest and flows generally northeast to join the Arkansas River at Holly. Some water normally flows in the upper end of this creek, below Two Buttes Reservoir, in Baca County, but the flow soon diminishes and disappears as the water seeps away into the sand. All the other streams in the county are intermittent; they flow only after rains, although many of them have an underground flow. Wild Horse Creek drains approximately 272 square miles, Clay Creek 227, Wolf Creek 127, Dry Creek 80, and Cheyenne Creek 21.

Water for Domestic Use

The water for the farm homes is pumped from deep wells by windmill or electricity. Water for the towns is also obtained from wells and is pumped into large storage tanks. The water supply for the town of Lamar is pumped from shallow wells along Clay Creek. The water from these shallow wells is of good quality and is not alkaline.

In the dryland area some water for livestock is obtained from wells and is brought to the surface by use of a windmill. In some places tanks are used to receive and store runoff water for livestock. Most of the water obtained from these sources is of good quality, but the quality of the water taken from wells depends largely on the formation from which the water was pumped. Ranchers along the Arkansas River, Big Sandy Creek, and the upper part of Two Butte Creek use water from the streams for their livestock.

Climate [5]

The climate of Prowers County is continental, warm, and semiarid. This area is subject to rapid changes in weather, particularly in winter. The winters are short and have extreme variations in temperature; at irregular intervals snowstorms move southward across the plains. The summers are long and have hot days and cool nights.

Table 8 shows temperature and precipitation at three selected stations. From the information in this table the seasonal distribution of rainfall can also be determined. Table 9, p. 144, shows the total yearly rainfall at the same stations from 1940 through 1960. The three selected stations from which these weather records were obtained are Lamar in the western part of the county, Holly in the eastern part, and Two Buttes in Baca County. Lamar and Holly are in the valley of the Arkansas River. Two Buttes is about 5 miles south of the Prowers County line and represents the southern part of the county.

[5] Prepared with the help of J. W. BERRY, State climatologist, U.S. Weather Bureau.

TABLE 8.—*Temperature and precipitation at selected stations*

LAMAR [Elevation, 3,616 feet]

Month	Temperature [1]					Precipitation [2]					
	Average	Maximum		Minimum		Average	Greatest amount received		Driest year (1893)	Wettest year (1946)	Average snowfall
		Absolute	Average	Absolute	Average						
	° F.	° F.	° F.	° F.	° F.	Inches	Inches	Year	Inches	Inches	Inches
December	31.9	79	47.4	−23	16.5	0.55	3.16	1913 [3]	0.52	0.02	4.7
January	30.7	82	47.1	−29	19.3	.31	1.40	1945	(4)	.25	3.3
February	35.0	83	51.8	−30	18.1	.51	2.04	1903	.11	.72	5.5
March	43.5	94	60.5	−26	26.5	.83	4.61	1891	.16	1.40	4.5
April	53.7	95	70.1	8	37.2	1.59	8.34	1900	.23	1.65	2.2
May	62.3	103	77.5	20	47.1	2.24	9.59	1914	.38	5.18	(4)
June	73.3	108	89.2	33	57.3	2.21	7.54	1949	1.40	1.91	(4)
July	78.3	111	94.4	42	62.3	2.51	9.00	1927	2.17	.85	0
August	77.0	110	93.4	41	60.6	2.03	5.35	1923	1.62	4.11	(4)
September	68.8	106	86.1	24	51.3	1.21	4.42	1941	.69	.69	(4)
October	55.7	99	73.9	8	37.6	.96	5.22	1930	.11	2.42	.5
November	41.4	89	58.6	−12	24.2	.49	5.31	1946	(4)	5.31	3.3
Year	54.3	111	70.8	−30	37.8	15.44	24.51	1946 [3]	7.39	24.51	24.0

TABLE 8.—*Temperature and precipitation at selected stations*—Continued

HOLLY [Elevation, 3,385 feet]

Month	Temperature [1]					Precipitation [2]					
	Average	Maximum		Minimum		Average	Greatest amount received		Driest year (1956)	Wettest year (1941)	Average snowfall
		Absolute	Average	Absolute	Average						
	° F.	° F.	° F.	° F.	° F.	Inches	Inches	Year	Inches	Inches	Inches
December	31.6	81	47.4	−23	15.8	0.44	2.80	1913	0.05	0.50	3.0
January	30.6	76	47.0	−28	14.0	.30	1.55	1945	.61	1.11	2.6
February	34.7	83	51.4	−20	18.0	.50	3.91	1913	.19	.09	2.8
March	43.0	96	60.3	−9	25.5	.58	3.47	1924	.15	.61	2.6
April	52.7	95	69.4	7	36.0	1.66	9.00	1900	.35	3.22	1.2
May	62.4	103	77.8	19	47.0	2.11	5.79	1944	.70	4.27	(4)
June	72.5	110	87.7	31	57.2	2.29	6.51	1903	.46	4.52	(4)
July	77.7	109	92.8	40	62.6	2.39	9.64	1927	2.80	3.26	0
August	75.7	106	91.8	38	59.7	2.16	6.33	1915	1.01	3.40	0
September	68.3	104	84.9	28	51.8	1.26	4.43	1941	0	4.43	(4)
October	56.0	97	74.2	2	37.7	.92	6.05	1942	(4)	3.06	.5
November	41.9	90	59.7	−6	24.1	.47	3.16	1899	.73	.32	1.4
Year	53.9	110	70.4	−28	37.5	15.08	28.79	1941	7.05	28.79	14.1

TWO BUTTES [About 5 miles south of the Prowers County line; elevation, 4,075 feet]

Month	Temperature [1]					Precipitation [2]					
	Average	Maximum		Minimum		Average	Greatest amount received		Driest year (1953)	Wettest year (1941)	Average snowfall
		Absolute	Average	Absolute	Average						
	° F.	° F.	° F.	° F.	° F.	Inches	Inches	Year	Inches	Inches	Inches
December	32.7	83	47.7	−23	17.9	0.54	2.31	1891	0.38	0.75	2.8
January	31.4	80	46.8	−25	16.0	.34	1.56	1944	(4)	1.08	2.9
February	33.9	80	49.1	−26	18.5	.55	2.21	1934	.01	.62	4.8
March	42.3	94	58.6	−16	26.0	.80	4.08	1946	.75	1.56	3.5
April	52.0	92	68.0	4	36.0	1.69	7.70	1942	.55	2.02	2.0
May	61.2	100	76.7	14	45.7	2.18	8.18	1951	1.46	4.50	.2
June	71.4	110	86.7	31	56.2	2.19	8.05	1904	.72	3.91	0
July	77.0	111	92.3	40	61.7	2.34	8.56	1895	1.96	3.59	0
August	75.4	111	91.3	39	59.5	1.84	6.63	1916	1.00	4.18	0
September	67.4	105	83.6	27	51.1	1.35	5.42	1941	0	5.42	.3
October	55.3	94	72.2	−2	38.4	.85	4.55	1942	.34	3.43	.3
November	42.3	89	58.9	−8	25.6	.45	1.97	1899	.83	.40	2.0
Year	53.5	111	69.3	−26	37.7	15.12	31.46	1941	8.00	31.46	18.8

[1] *Lamar:* Average temperatures based on a 57-year record, through 1952; absolute maximum and minimum temperatures on a 58-year record, through 1952. *Holly:* Average temperatures based on a 47-year record, through 1952; absolute maximum and minimum temperatures on a 46-year record, through 1952. *Two Buttes:* Average temperatures based on a 50-year record, through 1952; absolute maximum and minimum temperatures on a 52-year record, through 1952.

[2] *Lamar:* Average precipitation and wettest and driest years based on a 68-year record, 1889 through 1957; snowfall based on a 52-year record, through 1952. *Holly:* Average precipitation and wettest and driest years based on a 63-year record, from 1894 through 1957; snowfall based on a 50-year record, through 1952. *Two Buttes:* Average precipitation based on a 70-year record, from 1887 through 1957; snowfall based on a 50-year record, through 1952.

[3] Also in 1891.

[4] An amount too small to measure.

Most of the rainfall is in the form of summer showers, and not uncommonly it is heavy for a short time. The rainfall in a given area is so unreliable that crop production in dry-farmed areas is hazardous. In many instances the total for 1 month exceeds that for some whole years of low rainfall. In some instances the total rainfall during one 24-hour period is the same as that received during an entire year of low rainfall. At Las Animas, 24 miles west of Prowers County, for example, a total of 3.4 inches of rain fell in one 24-hour period, but a total of only 2.79 inches fell during 1 year of low rainfall. These figures for rainfall just outside the county are used because records of hourly or 24-hour precipitation are not available for Prowers County. In May, the month when a large amount of moisture is needed for wheat in dry-farmed areas, 9.59 inches of rain fell at

TABLE 9.—*Total yearly rainfall for selected stations, 1940 through 1960*

[Absence of figure indicates data not available]

Year	Lamar	Holly	Two Buttes
1940	15.04	14.74	15.21
1941	22.07	28.79	31.46
1942	20.88	23.55	24.60
1943	10.09	11.18	11.82
1944	21.94	22.95	
1945	15.69		
1946	24.51		
1947	12.51		
1948	12.48		15.47
1949	21.56		
1950	15.42	10.22	16.66
1951	17.15		16.23
1952	9.51	11.30	
1953	14.01	13.58	8.00
1954	10.23	8.62	10.22
1955	10.09	9.35	9.33
1956	13.99	7.05	8.54
1957	18.12	17.74	12.58
1958	16.30	18.05	15.16
1959	13.38	18.35	11.21
1960	14.06	12.85	12.74

Lamar in 1914, but only 0.25 inch fell during the same month in 1946; total precipitation for the year of least rainfall was only 7.39 inches.

Each year some snow falls in this county; the yearly snowfall averages about 24 inches at Lamar, about 14 inches at Holly, nearly 19 inches at Two Buttes, and about 20 inches at Eads in Kiowa County. Snowstorms normally come from the north and are accompanied by high winds and freezing temperatures. High winds blow the snow into drifts that pile up along fences and in roads and farmyards.

Because the roads are closed by drifting snow in storms of this kind, schools are closed and many parts of the county are cut off from trading centers. These blizzards cause extensive damage and loss of property, and some of them are especially difficult problems to stockmen. Frequently, they are so unexpected and are accompanied by such high winds and low temperatures that stockmen who are unprepared lose hundreds of head of livestock in one storm. An example of the intensity of these storms is a blizzard of 1958, during which a passenger train that stalled just east of the county was almost covered with drifting snow, but at the same time a field nearby was swept bare of snow by the high winds. During some storms the snow falls gently, and it melts in a few days and adds valuable moisture that is stored in the soil for the use of plants during the growing season. Seldom does snow remain on the ground for a month or longer.

The velocity of the wind is greatest in spring and least late in summer and in fall. At times it is as high as 60 to 70 miles per hour. In spring the velocity of the wind is commonly 20 to 30 miles per hour. The wind blows hardest in the afternoon, but dies down at night and in the forenoon. Duststorms are caused by a combination of high wind, prolonged periods of drought, and inadequate ground cover.

Usually, hailstorms cannot be predicted, and they occur only in fairly small areas. In summer they cause a great deal of damage to crops and buildings in Prowers County.

Because rainfall is low and summer temperatures are high, evaporation has an important bearing on crop production. It is measured by using pans that are 3 feet square and are partly submerged. The average evaporation at John Martin Reservoir for each month is as follows:

Month	*Inches*	*Month*	*Inches*
March	5.32	August	11.21
April	7.09	September	8.87
May	8.09	October	5.20
June	[1] 10.72	November	2.50
July	12.23		

[1] 17.98 inches in 1954.

The growing season in Prowers County is long enough for all crops grown in the area. The average date of the last killing frost in spring is April 27 at Lamar and Holly, May 5 at Eads, and May 1 at Two Buttes. The average date of the first killing frost in fall is October 10 at Lamar, October 11 at Holly, October 8 at Eads, and October 16 at Two Buttes. The average length of the growing season is 166 days at Lamar, 167 days at Holly, 155 days at Eads, and 169 days at Two Buttes.

Social and Industrial Development

Before the Civil War, few people lived in the area that is now Prowers County. After the war, thousands of people began to push westward, but they passed through what they called the Great American Desert, of which Prowers County is now a part, and went on to mining areas in the mountains. It was not until after the price of silver had dropped sharply that people began to settle on the Plains. In 1861 the first rancher brought cattle into the valley of the Arkansas River. Shortly afterward, other cattlemen settled along the river, and for many years a half dozen ranchers held all of the deeded land along the river for about 40 miles back from the Kansas State line.

Farming was not extensive in the county before the first railroad was built. Two irrigation ditches were constructed early in the 1870's, however, and irrigated crops were planted. At that time, irrigated crops brought high prices, for the railroad had not yet been built to provide transportation. Dryfarming was attempted but was generally unsuccessful. After a railroad was built, more farmers came into the area, the population increased rapidly, and towns sprang up along the right-of-way. Water decrees were established between 1885 and 1890, and irrigation farming was well underway by 1890. Prowers County was established in 1889, and Lamar was made the county seat.

About 1889 a factory for processing sugar beets was established at Rocky Ford, and in 1905 a second factory was built in Lamar. A flourmill, a plant for condensing milk, and a plant for dehydrating alfalfa were built about 1900, and they helped agriculture in the area. The feeding of lambs for market was begun about 1900 and was extensive until about 1920.

Homesteading was common in the 1920's, and some of the homesteaders attempted dryfarming. They were not successful, except in areas that received the most rainfall. Hundreds of abandoned home sites can still be seen in the areas of low rainfall, where crop failures caused some settlers to leave the area. Most of the land above the irrigation canals remained in grass until the 1940's. Then, rainfall was favorable for several years, modern farm machinery came into use, and economic pressures caused plowing of much of the grassland. Now, nearly 65 percent of the land above the irrigation canals is dry farmed.

Among the major industries in the county at the present time is the alfalfa-dehydrating industry, which has developed rapidly in the past few years. Alfalfa meal and pellets are processed in seven dehydrating plants in the county. When alfalfa is bought for dehydrating, the alfalfa milling companies pay the farmer a set price per ton for the alfalfa and provide the cutters and crews for harvesting the crop. This relieves farmers of the work and responsibility of harvesting the crop in the conventional way and provides a ready market for the alfalfa.

Many grain elevators are located along the railroad, and there is a bakery and a company that manufactures concrete products in Lamar. The concrete products include linings for ditches, irrigation structures, and ready mixed concrete for constructing bridges and other structures.

The quarrying of sand and gravel, the only known minerals in the county, is an important industry. The sand and gravel are used locally for highway construction and for the surfacing of roads, and they are also used in concrete structures. Since World War II, exploration for oil and gas has been extensive, and about 90 percent of the county is now leased to oil and gas companies. Several wells have been drilled, but only one gas-producing well has been successful.

One railroad crosses the county in an east-west direction and runs parallel to the Arkansas River. Branch lines serve the dehydrating plants and the sugar beet dumps. Federal Highways Nos. 50 and 287 pass through the county, and State Highways Nos. 51, 89, and 196 serve various parts of the county. The State highways are mostly graveled, but a few are hard surfaced for a few miles near the towns.

Agriculture [6]

Farming is the principal enterprise in Prowers County. The three types of farming practiced are dryfarming, irrigation farming, and ranching.

Dryfarming is extensive. The principal dry-farmed crops are wheat and sorghum. Some barley, broomcorn, and rye are grown, but no dry-farmed legumes are grown in this county. Dryfarming requires large machinery, and large wheel-type tractors are used for cultivation. Self-propelled combines are used for harvesting the grain, and much of the harvesting is done by custom combining. Planting and tillage are generally done by the farm operator or by local hired help.

In 1959, irrigated cropland amounted to 96,371 acres from which crops were harvested. Irrigation farming is done primarily at lower elevations than the canal systems, but there are some irrigation developments in the uplands where water is pumped from wells. Under the canal systems, water is obtained both from canals and wells. The irrigated areas are farmed intensively. Some stock feeding is done along with the other farming operations. The main crops grown under irrigation are alfalfa, winter wheat, grain sorghum, corn, barley, sugar beets, and corn or sorghum silage, but onions and canteloups are grown to a lesser extent. Various cropping systems are used, but all of the crops, except winter wheat and winter barley, are planted in fall.

On irrigated farms standard equipment is commonly used for cultivating row crops. The alfalfa is generally cut with special cutters, ground into small pieces, and blown into a truck. It is then hauled to local plants, where it is dehydrated. As in the dry-farmed areas, much of the wheat is combined by custom cutters. Planting and tillage are generally done by the farmer or by local hired help, but seasonal laborers are used for thinning the sugar beets.

On most ranches some land is dry farmed or irrigated, and some ranching is done on most dryland and irrigated farms. Cattle are the principal animals raised on the large ranches and on the smaller areas of range throughout the dry-farmed areas. Sheep are raised on irrigated farms, and both sheep and cattle are fattened for market on the irrigated farms. The type of ranching is necessarily flexible, for there is a shortage of grass in many years. In those years it may be necessary to sell calves earlier than in years when the supply of grass is abundant.

Most of the farm population lives on the irrigated farms; dryland farmers live mainly in town. Many farmers, especially dryland farmers, own part of the land they farm and rent part, generally on a sharecrop basis. In general, the number of farms has decreased since 1935, and the size of farms has increased. In 1950 there were 1,126 farms, and the average-sized farm was 888 acres; and in 1959 there were 763 farms, and the average-sized farm was 1,211 acres.

Most of the farms less than 500 acres in size are irrigated farms. Most of the farms more than 500 acres in size are dryland farms and cattle ranches.

The acreage of irrigated land has been fairly constant for more than 50 years, but the acreage under dryland cultivation has increased many times since tractors and combines came into use. In 1920 only 5,483 acres was under dryland cultivation in this county, but by 1957 the area had increased to 430,642 acres. The acreage in wheat and sorghum increased greatly during the same period, and the acreage in rangeland decreased. Table 10 gives the acreage of the principal crops grown in the county for stated years.

Cattle are raised more extensively than other kinds of livestock. Table 11 shows the number of livestock in the county in the specified years, but it does not include animals fed in transit. It shows the number of animals ordinarily kept for stocking purposes; the figures for horses and mules, however, represent all of these animals that are kept for all purposes. In addition to the livestock shown in the table, 28,787 turkeys were raised in the county in 1949.

[6] The statistics used in this section are mainly from statistical records of the State of Colorado.

TABLE 10.—*Acreage of the principal crops grown for all purposes*

Crop	1940	1950	1955	1958
Alfalfa	29,330	27,320	40,100	38,340
Winter wheat	23,155	176,210	185,000	125,600
Grain sorghum	53,534	93,330	174,750	153,630
Corn	4,602	16,730	5,480	8,260
Barley	14,141	14,860	5,020	16,670
Sugar beets	2,431	6,176	1,815	3,254
Broomcorn	3,680	3,080	900	480

TABLE 11.—*Number of livestock on farms*

Livestock	1940	1950	1959
Horses and mules	3,527	2,027	503
Cattle	11,584	28,718	21,750
Milk cows	2,735	2,073	815
Stock sheep	4,139	22,839	11,392
Hogs	3,620	5,614	3,821
Chickens [1] (dozen)	4,823	4,563	2,192

[1] More than 4 months old.

Glossary

Aeration, soil. The exchange of air in a soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkaline soil. Generally, a soil that is alkaline throughout most or all of the parts of it occupied by plant roots; although the term is commonly applied to only a specific layer or horizon of a soil. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. That water held in a soil between field capacity and the wilting point of plants (*18*).

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

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

Clay loam. Soil textural class that contains 27 to 40 percent clay and 20 to 45 percent sand. See also Texture, soil.

Clay skins (clay films). A thin coating of clay on the surface of soil aggregates.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Gravel. Rounded or angular fragments as large as 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Listing. Cultivating so that a small ridge is formed by throwing two furrows together and thus producing alternate beds and furrows.

Loam. A textural class name for soils that contain a moderate amount of sand, silt, and clay. Loam contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. See also Texture, soil.

Loess. Geologic deposit of relatively uniform, fine material, mostly silt, usually transported by wind.

Outwash sediments. Old alluvial sediments, generally now in upland positions, that consist of more or less sorted gravel, sand, silt, or clay.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH. See Reaction, soil.

Pitting. Making shallow pits or basins of suitable capacity and distribution in fallow areas or on rangeland, so that water from rainfall and snowmelt will be retained.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus (*17*):

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Saline soil. A soil that contains soluble salts in amounts large enough to impair the growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having a diameter ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. See also Texture, soil.

Sandy clay loam. Generally, soil material having 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand. See also Texture, soil.

Sandy loam. As used in this report, a soil that contains 50 percent sand and less than 20 percent clay. Also used as a general term for a small group of textural classes of soils, including sandy loam and fine sandy loam. See also Texture, soil.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil material of the silt textural class is 80 percent or more silt and less than 12 percent clay. See also Texture, soil.

Silt loam. Soil material having 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay. See also Texture, soil.

Silty clay. Soil material having 40 percent or more clay and 40 percent or more silt. See also Texture, soil.

Silty clay loam. Soil of this textural class contains 27 to 40 percent clay and less than 20 percent sand. See also Texture, soil.

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

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows (*17*): *Very coarse sand* (2.0 millimeters to 1.0

millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter; and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 millimeters to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); and IV (less than 0.002 millimeter).

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, in most places about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water-holding capacity. See Available water capacity.

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