# SOIL SURVEY OF
# Dawson County, Montana

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

**Major fieldwork for this soil survey was done in the period 1968–70. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service and the Montana Agricultural Experiment Station. It is part of the technical assistance furnished to the Dawson County Soil and Water Conservation District.**

**Copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.**

# HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

## Locating Soils

All the soils of Dawson County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. 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 and a pointer shows where the symbol belongs.

## Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the use of the soils for windbreaks.

*Game managers, sportsmen, and others* can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

*Ranchers and others* can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range and also the names of many of the plants that grow on each range site.

*Community planners and others* can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the section "Use of the Soils for Town and Country Planning."

*Engineers and builders* can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

*Scientists and others* can read about how the soils formed and how they are classified in the section "Formation, Morphology, and Classification of the Soils."

*Newcomers in Dawson County, Montana,* may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

*Cover:* **Aerial view of a farmstead that is protected by a well-planned windbreak. The farmstead is on Farnuf soils and the contours in the background are on Shambo and Lambert soils.**

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# SOIL SURVEY OF DAWSON COUNTY, MONTANA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MONTANA AGRICULTURAL EXPERIMENT STATION

DAWSON COUNTY is mainly on the sedimentary plains in eastern Montana (fig. 1). It has an area of 1,509,120 acres, or 2,358 square miles. Most of the area is drained by the Yellowstone River, which flows in a southwest-to-northeast direction across the southern part of the county. The northwestern corner of the county is drained by the Redwater River.

Elevation ranges from about 2,000 feet on the flood plain of the Yellowstone River at the northern county line to about 3,500 feet in some places along the divide between the drainages of the Yellowstone and Redwater Rivers.

The county is characterized by undulating to rolling uplands, but it has a few large, nearly level benches on the uplands. Areas of greatest relief are along the steep, north- and west-facing, erosional front of the divide between the Yellowstone and Redwater Rivers and in the breaks from the uplands to the Yellowstone Valley. Locally, in these areas and in the Badlands south and east of Glendive, there is a difference in elevation of a few hundred feet.

Cattlemen who brought in large herds in the late 1870's were the first settlers in the county. Later, owners of large herds of sheep and horses made their headquarters here. More than 70 percent of the acreage is still used as range and is grazed by cattle, sheep, and wildlife.

Homesteaders moved into the area in large numbers between 1900 and 1930 and dryfarmed on most of the nearly level benches and in large areas of the undulating to rolling uplands, where they produced grain. About 407,000 acres is in crops, which are grown mainly in a crop-fallow system that includes wheat, barley, and oats. A small acreage is used for mixed grasses and legumes grown for hay.

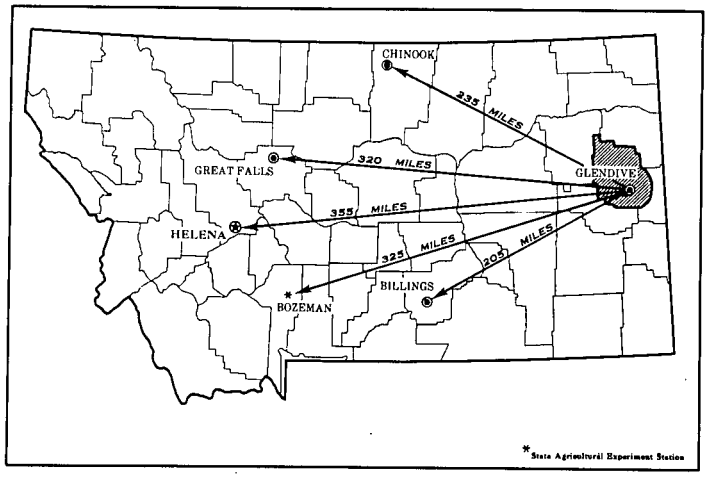


*Figure 1.*—Location of Dawson County in Montana.

Irrigating the meadows of native hay along the Yellowstone River began in the early 1900's. A low dam across the river at Intake diverts water into the Lower Yellowstone Project canal, and this serves a few thousand acres in the northern part of the county. The valley south and west of Glendive is watered from the Buffalo Rapids Project canal. A few privately owned pumping systems furnish water to irrigate several hundred acres. About 20,000 acres of crops and hay in the county are irrigated. The main irrigated crops are sugar beets, alfalfa hay, and corn for silage. A few hundred acres of cereal grains and beans are also irrigated.

Most of Dawson County is privately owned. The Burlington Northern Railroad owns 45,821 acres, most of which is used by farmers and ranchers on a cash-lease basis. In most townships the State of Montana owns sections 16 and 36, called school sections, and leases these to farmers and ranchers. The Federal Government owns about 68,000 acres of grazing land in scattered sections, mainly in the southeastern part of the county. This acreage is used by ranchers who hold grazing permits from the Bureau of Land Management.

In 1970 the population of Dawson County was 11,269; that of Glendive, the county seat, was 6,205; and that of Richey, the only other incorporated town, was 389. Other communities in the county include the small towns of Bloomfield, Hodges, Intake, Lindsay, Marsh, and Stipek. These towns were established during the homesteading period, but their population dwindled in the 1930's.

Among the transportation facilities in the county are airlines, buslines, and railroads. Glendive and Richey are served by a railroad. A limited-access highway, Interstate Highway No. 94, crosses the county from east to southwest and has interchanges at Glendive and at intersections with several county roads.

Industry includes several companies that furnish services in the oilfield in the southeastern part of the county. Large amounts of sand and gravel are shipped from pits near Glendive. Some parts of the county have underground deposits of lignite in sufficient quantity for com-

mercial mining, but in 1970, only one small open-pit mine was in operation.

Water for part of the town of Glendive is pumped from the Yellowstone River, but that for West Glendive, Richey, and most farms and ranches comes from deep wells.

Hunting and fishing are the main kinds of outdoor recreation. Antelope, white-tailed deer, and mule deer are numerous. Sharp-tailed grouse, gray partridge, sage grouse, and rink-necked pheasant are the main game birds. Catfish, pike, and paddlefish are in the Yellowstone River, and some ponds are stocked with bass, northern pike, bluegill, and rainbow trout. The gravelbars along the river contain moss agate. There are picnicking and camping facilities in Makoshika State Park, which is in the scenic Badlands near Glendive.

## How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Dawson County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

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

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Turner fine sandy loam, 1 to 4 percent slopes, is one of several phases within the Turner series.

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 woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. 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 phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Dawson County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Benz-Trembles complex, 2 to 15 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Banks soils is an undifferentiated soil group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Badland is a land type in this county.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for the onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations of houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of that soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential use.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further

study and by consultation with farmers, agronomists, engineers, and others. Then they 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 current methods of use and management.

## General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Dawson County. 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 land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages.

### Soils on Low Stream Terraces and Alluvial Fans

Two soil associations in Dawson County are on stream terraces and alluvial fans. The soils are deep, well-drained, light-colored fine sandy loams, loams, silt loams, and silty clay loams. They are mainly level to gently sloping on the terraces and nearly level to sloping on the fans. The native vegetation consists mainly of grasses and a sparse to dense stand of brush and trees.

#### *1. Trembles-Havrelon association*

*Level to gently sloping, deep fine sandy loams and silt loams underlain by sandy loam and silt loam; on low terraces and flood plains*

This association consists of level to gently sloping soils on narrow, low terraces and flood plains of the Yellowstone and Redwater Rivers and their tributaries.

This association makes up about 7 percent of the county. About 35 percent of it is Trembles soils, and about 30 percent is Havrelon soils. The remaining 35 percent is made up of Banks, Lohler, and Benz soils.

Trembles soils have a surface layer of fine sandy loam or loam and underlying layers of fine sandy loam. Havrelon soils have a surface layer and underlying layers of loam.

A large part of the association is in brushy rangeland. Stands of cottonwood, willow, green ash, rosebush, and silver sagebrush afford excellent cover and browse for white-tailed deer and mule deer. There is abundant food and shelter for ring-necked pheasant and migrating flocks of waterfowl. In some areas the soils are irrigated. The major soils are used for cultivated crops. Minor soils of the Banks and Lohler series are also used for cultivated crops, but the soils of the Benz series are mainly in range or irrigated pasture of salt- and alkali-tolerant grasses.

#### *2. Cherry association*

*Nearly level to sloping, deep soils that are dominantly silty clay loam throughout; on alluvial fans and terraces*

This association is in the valleys of most intermittent streams in the county and on the higher terraces and alluvial fans in the Yellowstone River valley. Areas of this association are extensive and widely distributed.

This association makes up about 9 percent of the county. About 70 percent of it is Cherry soils. The remaining 30 percent is made up of Marias, Vanda, Trembles, and Havrelon soils.

Cherry soils have a surface layer and subsoil of light-colored silty clay loam. The substratum is silty clay loam that has lime accumulations in the upper part. These soils are moderately permeable and well drained.

Marias and Vanda soils are nearly level to gently sloping and are on fans and terraces. They are mainly in two areas; one is immediately west and south of Glendive, and the other is near Stipek. Havrelon and Trembles soils are mainly on low terraces in the valleys of intermittent streams.

Soils in this association in the valley of the Yellowstone River are mainly cultivated. They are irrigated if water is available. In valleys of intermittent streams, some of the soils are dryfarmed and used for grain and hay crops. In some parts of the association, the flow of small streams in spring is diverted into dike systems to provide supplemental irrigation of hay. Part of the association is in range that has a good cover of grass. A moderate to thick stand of trees and brush along the narrow flood plains in some parts of the association provides browse and cover for wildlife.

### Soils on Dissected Sedimentary Plains

Four soil associations in the county are on dissected sedimentary plains. The soils are mainly deep, light-colored, calcareous silt loams and silty clay loams on broken sedimentary plains. They are steep to very steep. Outcrops of the underlying sedimentary beds appear on steep coulee sides and ridges and in some places are dominant on the landscape. In one area in the southeastern part of the county there are steep to very steep, shallow clayey soils underlain by claystone (shale) on uplands and nearly level to strongly sloping, dense clayey soils on fans and terraces. The vegetation consists mainly of grasses and scattered shrubs, but there are brushy areas in some coulees.

#### *3. Lambert-Dimyaw association*

*Steep to very steep, deep silt loams and silty clay loams underlain by silt loam, silty clay loam, or silty clay sedimentary beds; on uplands*

This association consists of steep to very steep soils on uplands that are dissected by many steep-sided coulees.

Numerous outcrops of the soft sedimentary beds that underlie this association are on ridgetops and the steep sides of coulees. Areas of this association are large and widely distributed.

This association makes up about 30 percent of the county. About 65 percent of it is Lambert soils, and about 25 percent is Dimyaw soils. The remaining 10 percent is made up of outcrops of the underlying soft sedimentary beds and small areas of Cherry, Regent, and Ringling soils.

Lambert and Dimyaw soils are light colored and calcareous. Lambert soils have a surface layer of loam or silt loam and underlying layers of silt loam. The soils are deep to soft, silty sedimentary beds. Dimyaw soils have a surface layer of silty clay loam and underlying layers of silty clay.

The soils in this association are used for range. Numerous brushy bottoms in the coulees provide excellent cover for white-tailed deer and mule deer.

### 4. *Norbert-Vanda association*

*Steep to very steep, shallow clays underlain by claystone (shale), and nearly level to strongly sloping, deep, dense clays underlain by stratified clay and silty clay loam; on uplands, fans, and terraces*

This association consists of steep soils on clayey ridges and adjacent sloping to nearly level soils on alluvial fans and terraces in the Cedar Creek drainageway in the southeastern part of the county.

This association makes up about 1 percent of the county. About 70 percent of it is Norbert soils, and about 20 percent is Vanda soils. The remaining 10 percent is made up of Marias soils and small outcrops of claystone.

Norbert soils are shallow. They have a thin surface layer of clay underlain by subsurface layers of clay that rest abruptly on platy, fractured claystone. These soils are on ridges. Vanda soils are on alluvial fans and terraces along Cedar Creek. They are strongly alkaline and have a crusted surface layer of clay underlain by layers of clay and silty clay loam.

Surface runoff is rapid, and the Norbert soils and associated claystone outcrops are highly erodible. Small dams built in this area are filled by sediment in a few years.

This association is in range. The Norbert soils, which are steep, support only a sparse stand of grasses and, in some places, a thin to moderate stand of juniper and scrubby lodgepole pine. Vanda soils, which are on alluvial fans, support a moderate stand of grasses and sagebrush. Among the wildlife commonly found in this area are sage grouse, sharp-tailed grouse, and mule deer.

### 5. *Badland association*

*Steep to very steep, severely eroded land consisting mainly of outcropping silty, sandy, and clayey sedimentary beds; on broken uplands*

This association is characterized by very steep walls of deeply entrenched coulees exposing the multicolored sedimentary beds of soft, sandy, silty, and clayey material that underlie the county. Narrow, winding ridgetops in the association are undulating to rolling and support moderate stands of grass and, in some places, sparse stands of scrubby juniper and pine trees. In the bottoms of some coulees are nearly level to sloping alluvial fans and terraces that support sparse to moderate stands of grass and sagebrush. There are two areas of this association; one is south of and the other is east of Glendive.

This association makes up about 3 percent of the county. About 70 percent of it is Badland. Of the remaining 30 percent, about 20 percent is Benz and Trembles soils and about 10 percent is Dast and Blanchard soils.

Badland consists of the very steep sidewalls, fingering ridges, and isolated buttes formed by downcutting of deep coulees into the soft, brownish-colored sandy beds, buff-colored silty beds, and grayish-colored clayey beds. Many thin seams of coal are exposed, as are some strata of reddish-colored clayey shale. In some parts of the association, exposed sandy beds have hardened to form ledges of soft, crumbly sandstone.

This association is used for wildlife habitat, recreation, and watershed. Accessible ridgetops and most coulee bottoms where Benz, Trembles, Dast, and Blanchard soils occur are in range and grazed by cattle. On the steep Badlands are small patches of grass, forbs, and brush, but these spots are nearly inaccessible to cattle. Mule deer and sharp-tailed grouse are the main wildlife in this area. Makoshika State Park is in this association.

### 6. *Tinsley-Lambert-Lihen association*

*Steep and very steep, deep, gravelly sands and silt loams underlain by thick sand and silt loam sedimentary beds; on uplands*

This association consists of steep and very steep, gravelly soils along bench edges, mainly in areas one-half mile to 3 miles wide and several miles long. It is on the breaks between nearly level high benches and the alluvial fans and terraces in stream valleys. Most areas of the association are along the edges of the valley of the Yellowstone River.

This association makes up about 6 percent of the county. About 55 percent of it is Tinsley soils, about 30 percent is Lambert soils, and about 15 percent is Lihen soils.

Tinsley soils are steep, excessively drained, and gravelly. They are on rounded upper rims and ridges. In most places they have a surface layer of gravelly or very gravelly sand and underlying layers of medium and coarse sand that contains much less gravel. Lambert soils are very steep and are on the lower side slopes of many small coulees. They have a surface layer of light-colored, calcareous gravelly loam and underlying layers of silt loam. Many small outcrops of soft, silty sedimentary beds, in which Lambert soils formed, appear on the sides of coulees. Lihen soils have a thick surface layer of dark-colored loamy sand and underlying layers of light-colored loamy sand. They are sloping to rolling and are in small areas on ridgetops.

This association is in range. Most areas have a good cover of native grasses. Springs are in many coulees, and they furnish water for livestock and wildlife. The brushy bottoms of many coulees provide cover and browse for deer.

## Soils on Sedimentary Plains

Three soil associations in the county are on the undulating to hilly sedimentary plains. The soils are moderately deep to deep, well-drained loams, silt loams, fine sandy

loams, and loamy sands. The dark-colored loams in broad swales and the light-colored silty loams on ridges are underlain by silty sedimentary beds. The moderately deep fine sandy loams and deep loamy sands are underlain by soft sandstone. The vegetation consists mainly of mixed sod-forming and bunch grasses, but there are scattered low shrubs. Large areas of the loams and silt loams are in dryfarmed grain. The one large area of fine sandy loams and loamy sands is in the southeastern part of the county and is used for range.

### 7. *Lambert association*

*Undulating to rolling and hilly, deep silt loams underlain by silt loam sedimentary beds; on uplands*

This association consists of soils that are mainly smooth and undulating to rolling but in places are hilly. These soils are on parts of ridges separating major drainageways. Ridges are low and rounded; swales are broad and smooth and have shallow, meandering drainageways. Surface runoff is medium. Areas of the association are large, generally a few miles wide and several miles long.

This association makes up about 8 percent of the county. About 70 percent of it is Lambert soils. The remaining 30 percent is made up of small areas of Cherry, Dast, Dimyaw, and Shambo soils.

Lambert soils have a surface layer of light-colored silt loam or loam and underlying layers of silt loam.

Some parts of this association are dryfarmed and used for grain crops in an alternating crop-fallow system. Other parts are in large ranches and are used for range (fig. 2). Most areas in range have a good cover of grass, and there are small patches of brush on the bottoms of some swales. The main wildlife species in the association are antelope and sharp-tailed grouse.

### 8. *Shambo-Lambert association*

*Undulating to rolling and hilly, deep loams and silt loams underlain by stratified loam and silt loam alluvium and silt loam sedimentary beds; on uplands*

This association consists of smooth, undulating to rolling soils on low, rounded ridges and in broad swales. Drainageways in swales are shallow and meandering. Areas of the association are large and widely distributed.

This association makes up about 13 percent of the

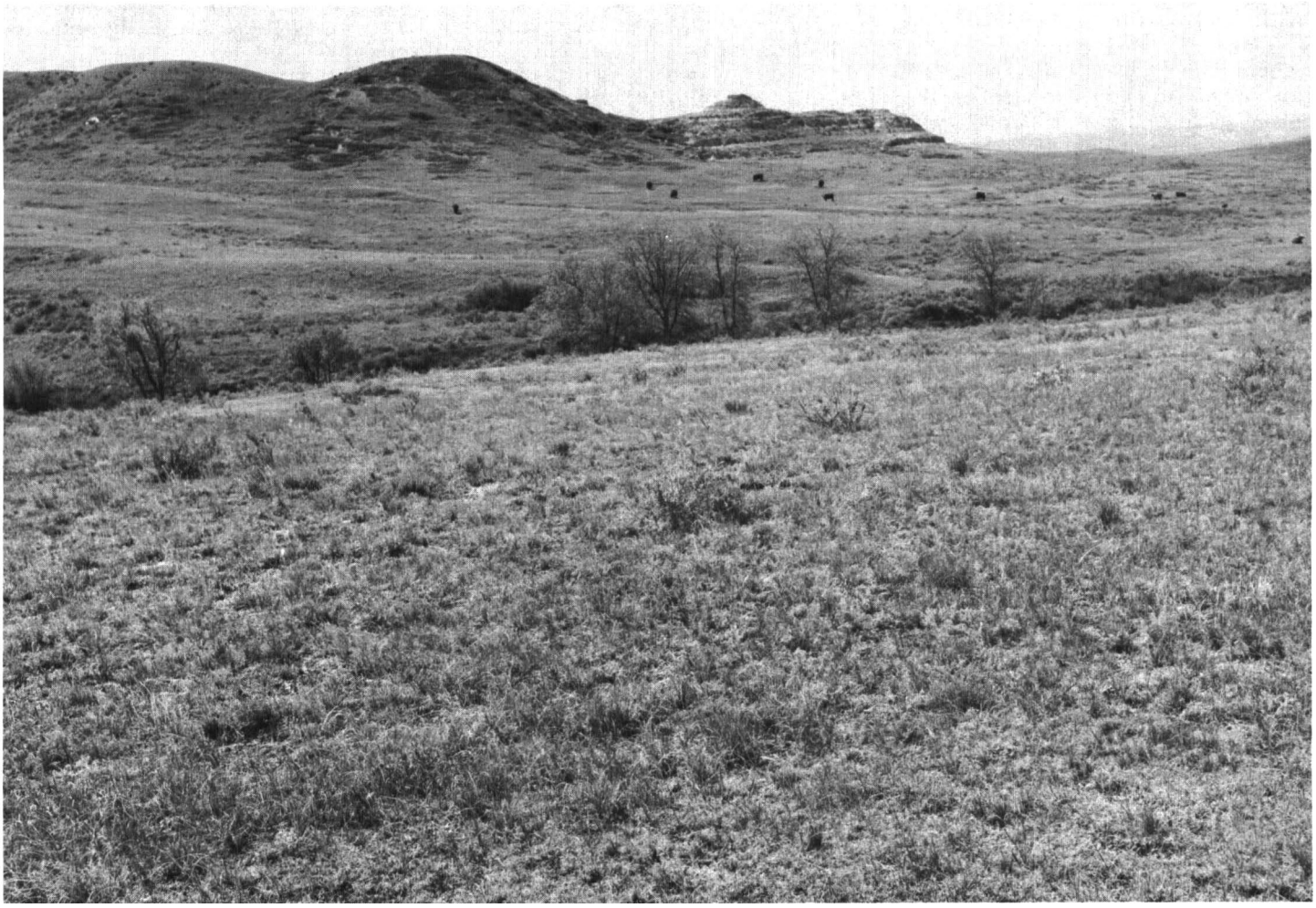

*Figure 2.*—**Typical area used for range in Lambert association. In foreground are Lambert soils, which are in the Silty range site, and in the background are Lambert and Dimyaw soils, which are in the Thin Hilly range site.**

county. About 65 percent of it is Shambo soils, and about 25 percent is Lambert soils. The remaining 10 percent is made up of Cherry and Farnuf soils.

Shambo soils have a surface layer of dark grayish-brown loam, a subsoil of loam, and a substratum of calcareous loam or silt loam. Lambert soils are mainly on the ridgetops. They are light-colored, calcareous silt loam throughout.

Nearly all of this association is dryfarmed and used for grain in an alternating crop-fallow system. The few areas in range have a good cover of grasses. Antelope, sharp-tailed grouse, and gray partridge are the main wildlife species in this association.

### 9. Dast-Blanchard association

*Undulating to rolling and hilly, moderately deep and deep fine sandy loams and loamy sands underlain by soft sandstone; on uplands*

This association consists of undulating to hilly soils on the divide between the drainageways of Cedar Creek and Glendive Creek in the southeastern part of the county. Large areas of low, undulating ridges and swales are between steep, hilly ridges. On some of the steep ridges, there are ledges and boulders formed by outcrops of the soft, sandy sedimentary beds that underlie the area.

This association makes up about 2 percent of the county. About 85 percent of it is Dast and Blanchard soils, which are about equal in extent. The remaining 15 percent is made up of Dimyaw, Shambo, and Tally soils.

Dast soils have a surface layer and subsoil of brown fine sandy loam. They are moderately deep to weakly consolidated, sandy sedimentary beds. Blanchard soils are loamy fine sand throughout. Material weathered from the weakly consolidated sandstone underlying both Dast and Blanchard soils ranges from loamy fine sand to fine sand in texture. The outcrops of this sandstone are consolidated to soft.

This association is in range. It has a good cover of grasses and widely scattered patches of brushy plants. Water for livestock comes mainly from wells. Wildlife prevalent in the area are white-tailed deer, mule deer, sage grouse, sharp-tailed grouse, and gray partridge.

## Soils on High Terraces

Two soil associations are on high terraces. On remnants of old high river terraces of the uplands, the soils are mainly nearly level to rolling but in some parts of old broad valleys, they are nearly level to sloping. The soils are well drained. They have a surface layer of dark-colored loam and a subsoil of clay loam, and they are underlain by loam to silty clay loam or by sand or sand and gravel. The vegetation consists mainly of mixed sod-forming and bunch grasses. Most areas are farmed.

### 10. Farnuf association

*Nearly level to rolling, deep soils that have a loam surface layer and a clay loam subsoil, underlain by loam to silty clay loam alluvium; on uplands*

This association consists of nearly level to gently rolling soils on broad high benches. Slopes are mostly less than 4 percent, but on the few low ridges, they are as much as about 8 percent. Areas of the association are mainly north and west of the Yellowstone River.

This association makes up about 8 percent of the county. About 75 percent of it is Farnuf soils. About 10 percent is made up of Shambo soils, and the remaining 15 percent is made up of Turner and Beaverton soils.

Farnuf soils have a surface layer of dark grayish-brown loam, a subsoil of clay loam, and a substratum of silt loam to silty clay loam.

This association is dryfarmed for wheat, barley, and oats. Some areas are used for range.

### 11. Turner-Beaverton association

*Nearly level to sloping, deep soils that have a loam or clay loam surface layer and a clay loam, gravelly clay loam, or sandy clay loam subsoil, underlain by sands or sands and gravel; on uplands*

This association consists of nearly level to sloping soils on broad high benches, bench edges, and bottoms of drainageways that dissect the benches. Areas of the association are mainly north and west of the Yellowstone River.

This association makes up about 6 percent of the county. About 65 percent of it is Turner soils, and about 25 percent is Beaverton soils. Of the rest 5 percent is Tally soils, and 5 percent is Farnuf soils.

Turner soils have a surface layer of dark grayish-brown loam or fine sandy loam and a subsoil of clay loam or sandy clay loam that abruptly overlies a substratum of sand or sand and gravel at a depth of 20 to 40 inches. Beaverton soils have a surface layer of brown clay loam, a subsoil of gravelly clay loam, and a substratum of sand or sand and gravel at a depth of 10 to 20 inches.

Most areas of the association are in parts of the county where irrigation water is not available. Most of the association is dryfarmed and used for wheat, barley, and oats in a crop-fallow system. A small dryfarmed acreage is used for corn and hay crops. Antelope range over most areas of this association. Numerous coveys of sharp-tailed grouse and gray partridge are hatched in the fence rows and feed in the grain fields.

## Soils on Glaciated Plains

Two soil associations are on the glaciated plains. One consists of deep, nearly level to hilly, well-drained soils that have a surface layer of dark-colored loam to clay loam and a subsoil of clay loam. They are underlain by friable clay loam glacial till. The other consists of steep to very steep soils at the contact between the glaciated plains and the sedimentary plains. Soils on the upper sides and crests of ridges have a thin surface layer of dark-colored loam underlain by clay loam glacial till. They are very shallow to the glacial till. Soils on lower slopes are light-colored silt loams underlain by silt loam sedimentary beds. The vegetation consists mainly of mixed sod-forming and bunch grasses, but there are also widely scattered low shrubs. Most areas of the deep, nearly level to hilly soils are dryfarmed and used for grain. The steep and very steep soils of this association are in range.

### 12. Vida-Williams association

*Gently undulating to rolling and hilly, deep soils that have a loam to clay loam surface layer and a clay loam subsoil, underlain by friable clay loam glacial till; on uplands*

This association consists of broad areas of gently undulating to rolling and hilly soils underlain by friable clay loam glacial till. This is the only part of the county where granitic rocks are predominant. These rocks are mainly pebbles, but there are a few cobblestones and boulders. Only in a few small areas of the association are there enough of these rocks to hinder cultivation. The four areas of the association are all in the northwestern corner of the county.

This association makes up about 4 percent of the county. About 60 percent of it is Vida soils, and about 25 percent is Williams soils. The remaining 15 percent is made up of Zahill soils.

All of these soils have a surface layer of dark grayish-brown loam where they are under a cover of grass. In cultivated areas the plow layer of Vida and Zahill soils is clay loam. Vida and Williams soils have a subsoil of clay loam and a substratum of clay loam. Lime has been leached to a depth of 8 to 10 inches in the Vida soils and to a depth of more than 10 inches, generally 12 to 16 inches, in the Williams soils. Williams soils are mainly in the more nearly level parts of the association, generally on small flats and in swales. They have slopes of less than 4 percent. Vida soils generally have slopes of about 2 to 10 percent.

More than half of this association is dryfarmed and used for wheat, barley, and oats. Areas used for range generally are steeper or are in large ranches where the soils are not cultivated. Wildlife common in these areas are antelope, sharp-tailed grouse, and gray partridge.

### 13. Zahill-Lambert association

*Steep and very steep loams that are underlain by friable clay loam glacial till, and silt loams that are underlain by silt loam sedimentary beds; on uplands*

This association consists of steep soils on narrow ridges and in the intervening valleys along the edges of the glaciated uplands. The ridges are capped by a mantle of glacial till. The till contains granitic rocks, mainly pebbles but some boulders. On the lower side slopes of the ridges and in the bottoms of the narrow valleys there are soft, silty sedimentary beds. Areas of this association are mainly in the northwestern corner of the county.

This association makes up about 3 percent of the county. About 40 percent of it is Zahill soils, and about 40 percent is Lambert soils. Of the rest, about 15 percent is Shambo soils, and about 5 percent is Vida soils.

Zahill soils have a thin surface layer of dark grayish-brown loam underlain by calcareous clay loam glacial till. These soils are on the crests and upper side slopes of ridges. Lambert soils have a surface layer of grayish-brown, calcareous silt loam and underlying layers of silt loam over soft, silty sedimentary beds. Lambert soils are on the lower side slopes of ridges and swales.

Areas of the association are used for range and, in most places, have a good cover of mixed sod grasses and bunch grasses. Silver sagebrush and buckbrush are the main brushy plants that furnish browse for white-tailed deer, mule deer, and antelope. Sharp-tailed grouse and gray partridge are common in this association.

## Descriptions of the Soils

This section describes the soil series and mapping units in Dawson County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series is true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative of mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil, unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badland, for example, does not belong to a soil series, but nevertheless is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page for the description of each capability unit and range site is listed in the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of the soils are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (5).[1]

### Absher Series

The Absher series consists of deep, well-drained, nearly level to sloping soils on alluvial fans. These soils formed in alluvium that had been affected by salts and alkali and residuum that had weathered from sedimentary beds.

In a representative profile the surface layer, about 4 inches thick, is dark grayish-brown loam over grayish-brown silt loam. The subsoil is strongly alkaline, grayish-brown silty clay about 14 inches thick. The substratum is olive-gray silty clay and silty clay loam and has common seams of lime and gypsum.

Permeability is very slow, and the available water capacity is high.

[1] Italic numbers in parentheses refer to Literature Cited, p. 70.

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

| Soil | Area | Extent |
|---|---|---|
| Absher loam, 0 to 8 percent slopes | 4, 085 | 0. 3 |
| Badland | 48, 790 | 3. 2 |
| Banks soils | 7, 461 | . 5 |
| Beaverton complex, 4 to 15 percent slopes | 9, 274 | . 6 |
| Benz loam, 0 to 4 percent slopes | 2, 572 | . 2 |
| Benz-Trembles complex, 2 to 15 percent slopes | 31, 480 | 2. 1 |
| Blanchard-Dimyaw complex, 8 to 80 percent slopes | 6, 879 | . 5 |
| Cherry silty clay loam, 0 to 2 percent slopes | 41, 001 | 2. 7 |
| Cherry silty clay loam, 2 to 4 percent slopes | 68, 643 | 4. 6 |
| Cherry silty clay loam, 4 to 8 percent slopes | 31, 367 | 2. 1 |
| Cherry-Lambert complex, 4 to 25 percent slopes | 34, 078 | 2. 3 |
| Cherry, Havrelon, and Trembles soils, occasionally flooded | 60, 577 | 4. 0 |
| Dast fine sandy loam, 2 to 8 percent slopes | 4, 660 | . 3 |
| Dast-Blanchard complex, 2 to 8 percent slopes | 6, 409 | . 4 |
| Dast-Blanchard complex, 8 to 25 percent slopes | 20, 078 | 1. 3 |
| Dimyaw silty clay loam, 8 to 25 percent slopes | 7, 895 | . 5 |
| Farnuf loam, 0 to 4 percent slopes | 32, 095 | 2. 1 |
| Farnuf loam, 4 to 8 percent slopes | 6, 964 | . 5 |
| Farnuf-Shambo loams, 0 to 4 percent slopes | 17, 963 | 1. 2 |
| Farnuf-Shambo loams, 4 to 8 percent slopes | 19, 092 | 1. 3 |
| Havrelon silt loam, 0 to 2 percent slopes | 9, 759 | . 7 |
| Havrelon silt loam, 2 to 4 percent slopes | 4, 028 | . 3 |
| Lambert gravelly loam, 20 to 40 percent slopes | 37, 761 | 2. 5 |
| Lambert silt loam, 2 to 8 percent slopes | 115, 498 | 7. 7 |
| Lambert silt loam, 8 to 15 percent slopes | 124, 338 | 8. 2 |
| Lambert-Badland complex | 101, 684 | 6. 7 |
| Lambert-Blanchard complex, 15 to 65 percent slopes | 17, 353 | 1. 1 |
| Lambert-Dimyaw complex, 15 to 65 percent slopes | 108, 824 | 7. 2 |
| Lambert-Ringling complex, 15 to 65 percent slopes | 24, 198 | 1. 6 |
| Lihen loamy sand, 4 to 20 percent slopes | 10, 241 | . 7 |
| Lohler silty clay loam | 4, 657 | . 3 |
| Marias silty clay, 0 to 2 percent slopes | 5, 478 | . 4 |
| Marias silty clay, 2 to 4 percent slopes | 785 | (1) |
| Marias silty clay, 4 to 8 percent slopes | 1, 117 | . 1 |
| Norbert clay, 8 to 65 percent slopes | 13, 492 | . 9 |
| Regent silty clay loam, 1 to 4 percent slopes | 1, 449 | 0. 1 |
| Regent silty clay loam, 4 to 8 percent slopes | 1, 643 | . 1 |
| Regent-Dimyaw complex, 4 to 8 percent slopes | 3, 990 | . 3 |
| Regent-Dimyaw complex, 8 to 15 percent slopes | 6, 344 | . 4 |
| Riverwash | 2, 205 | . 2 |
| Saline land | 6, 159 | . 4 |
| Savage silty clay loam, 0 to 2 percent slopes | 470 | (1) |
| Savage silty clay loam, 2 to 4 percent slopes | 331 | (1) |
| Shambo loam 0 to 2 percent slopes | 18, 567 | 1. 2 |
| Shambo loam, 2 to 4 percent slopes | 15, 312 | 1. 0 |
| Shambo loam, 4 to 8 percent slopes | 15, 565 | 1. 0 |
| Shambo-Lambert complex, 4 to 8 percent slopes | 88, 973 | 5. 9 |
| Shambo-Lambert complex, 8 to 15 percent slopes | 24, 991 | 1. 7 |
| Tally fine sandy loam, 0 to 4 percent slopes | 3, 719 | . 3 |
| Tally fine sandy loam, 4 to 8 percent slopes | 5, 764 | . 4 |
| Tally fine sandy loam, 8 to 15 percent slopes | 4, 084 | . 3 |
| Terrace escarpments | 5, 026 | . 3 |
| Tinsley-Lambert complex, 15 to 65 percent slopes | 68, 054 | 4. 5 |
| Tinsley soils, 15 to 65 percent slopes | 12, 598 | . 8 |
| Trembles fine sandy loam | 14, 128 | . 9 |
| Trembles loam | 4, 573 | . 3 |
| Turner fine sandy loam, 1 to 4 percent slopes | 5, 646 | . 4 |
| Turner loam, 0 to 2 percent slopes | 12, 080 | . 8 |
| Turner loam, 2 to 4 percent slopes | 12, 883 | . 9 |
| Turner loam, 4 to 8 percent slopes | 2, 839 | . 2 |
| Turner-Beaverton loams, 0 to 2 percent slopes | 7, 453 | . 5 |
| Turner-Beaverton loams, 2 to 4 percent slopes | 14, 097 | . 9 |
| Turner-Beaverton loams, 4 to 8 percent slopes | 10, 890 | . 7 |
| Vanda clay, 0 to 8 percent slopes | 4, 853 | . 3 |
| Vida clay loam, gently undulating | 9, 823 | . 7 |
| Vida clay loam, undulating | 13, 968 | . 9 |
| Vida-Zahill complex, undulating | 10, 167 | . 7 |
| Vida-Zahill complex, rolling | 12, 485 | . 8 |
| Williams loam, gently undulating | 4, 861 | . 3 |
| Williams-Vida complex, gently undulating | 1, 349 | (1) |
| Williams-Vida complex, undulating | 943 | (1) |
| Zahill loam, 15 to 65 percent slopes | 17, 540 | 1. 2 |
| Zahill-Lambert complex, 15 to 65 percent slopes | 22, 722 | 1. 5 |
| Total | 1, 509, 120 | 100. 0 |

[1] Less than 0.1 percent.

These soils are used for range. The vegetation is mainly alkali-tolerant grasses, forbs, and shrubs.

Absher soils are associated with Regent, Savage, and Vanda soils.

Representative profile of Absher loam, 0 to 8 percent slopes, in grass, 200 feet east and 200 feet south of the west quarter corner of sec. 8, T. 14 N., R. 58 E.:

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; soft, very friable, slightly sticky and nonplastic; many fine and medium roots; neutral; clear boundary.

A2—2 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, medium, structure; slightly hard, very friable, nonsticky and nonplastic; many fine and medium roots; neutral; abrupt boundary.

B21t—4 to 10 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, columnar structure; very hard, firm, sticky and plastic; common fine roots and pores; thick continuous clay films on vertical ped faces; strongly alkaline; clear boundary.

B22t—10 to 13 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure; extremely hard, firm, sticky and plastic; few fine and medium roots; medium continuous clay films on vertical ped faces; strongly alkaline; gradual boundary.

B3cs—13 to 18 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to blocky; extremely hard, firm, sticky and plastic; few fine roots; few thin clay films; few fine seams of gypsum; weakly calcareous; very strongly alkaline; clear boundary.

C1cacs—18 to 26 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) moist; massive; very hard, firm, sticky and plastic; few fine roots; common seams of lime and gypsum; strongly calcareous; very strongly alkaline; clear boundary.

C2cs—26 to 60 inches, olive-gray (5Y 5/2) silty clay loam, olive gray (5Y 4/2) moist; massive; hard, firm, sticky and plastic; common seams of lime and gypsum; strongly calcareous; very strongly alkaline.

The A horizon ranges from 1.5 to 4 inches in thickness and from fine sandy loam to silty clay loam in texture. The B horizon ranges from heavy silty clay loam to light clay. The C horizon is strongly alkaline or very strongly alkaline.

**Absher loam, 0 to 8 percent slopes** (Ab).—This soil is in swales on uplands and on alluvial fans in small intermittent stream valleys, mainly in the eastern part of the county. Typical areas of this soil are marked by numerous panspots or microdepressions and have an appearance of scabland because the soil has a very thin, light-colored surface layer. Included in mapping are small areas of Regent and Dimyaw soils.

Surface runoff is slow to medium, and the hazard of erosion is moderate to high.

This soil is used for range. Capability unit VIe–1, dryland; Panspots range site.

## Badland

Badland (Ba) consists mainly of very steep, nearly barren areas. Areas of this land type are characterized by nearly vertical escarpments, narrow ridges, isolated buttes, and deeply entrenched coulees. These areas were formed by the active geologic erosion of soft, multicolored sedimentary beds of loamy sand, sandy loam, silt loam, clay loam, and silty clay. Slopes range from 15 to more than 100 percent. Barren to nearly barren sedimentary beds make up about 75 percent of this mapping unit. Included in mapping are areas of Benz and Trembles soils in the coulee bottoms and Blanchard, Dast, Dimyaw, and Lambert soils on ridges and buttes.

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

Most of this unit is used for recreation, wildlife habitat, and watershed. Makoshika State Park, which is east and south of Glendive, consists mainly of Badland. The included soils support grasses, forbs, and shrubs and, in accessible areas, have limited use as range. Grazing management is difficult to implement on these soils because of the limited acreage, remoteness from one area to another, and accessibility. Extreme care must be used to prevent overgrazing and subsequent erosion that could destroy the limited range resource. Capability unit VIIIe–1, dryland; not in a range site.

## Banks Series

The Banks series consists of deep, somewhat excessively drained, nearly level to gently sloping soils on low terraces and flood plains. These soils formed in recent alluvium along the major streams.

In a representative profile the surface layer is brown loamy fine sand about 10 inches thick. It is underlain by light brownish-gray layers of loamy fine sand and fine sand.

Permeability is rapid, and the available water capacity is moderate.

These soils are used for range and irrigated crops. The vegetation consists of grasses, forbs, shrubs, and trees.

Banks soils are associated with Havrelon and Trembles soils.

Representative profile of Banks loamy fine sand, in an area of Banks soils, in a cultivated field, 1,320 feet west and 600 feet north of the southeast corner of sec. 33, T. 14 N., R. 54 E.:

Ap—0 to 10 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak, fine, granular structure; soft, very friable; common fine roots; weakly calcareous; mildly alkaline; clear, smooth boundary.

C—10 to 60 inches, light brownish-gray (2.5Y 6/2) stratified loamy fine sand and fine sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose dry and moist; few fine roots; strongly calcareous; moderately alkaline.

The A horizon ranges from fine sandy loam to fine sand in texture and from brown to light brownish gray in color. The C horizon is dominantly loamy fine sand, but thin strata of both finer and coarser material are common in most profiles.

**Banks soils** (Bk).—This mapping unit is made up of nearly level to gently sloping soils on low terraces and flood plains along the major streams in the county. Small areas are occasionally flooded during unseasonably warm months in winter when ice jams form on the major streams. This unit consists of Banks loamy fine sand, Banks fine sandy loam, and Banks fine sand. Banks loamy fine sand, the dominant soil in the unit, has the profile described as representative for the series. The other two soils have profiles similar to the one described as representative for the series, but the surface layer ranges from 4 to 10 inches in thickness and is fine sandy loam or fine sand. Included in mapping are small areas of Havrelon and Trembles soils and Riverwash.

Surface runoff is very slow, and the hazard of soil blowing is very high.

These soils are used for range and irrigated crops. Capability unit IVe–4, dryland; capability unit IVe–1, irrigated; Sands range site.

## Beaverton Series

The Beaverton series consists of well-drained, nearly level and gently undulating to rolling soils on terraces and uplands. These soils formed in loam and clay loam alluvium underlain, at a depth of 10 to 20 inches, by sand and gravel.

In a representative profile the surface layer is brown clay loam about 8 inches thick. The subsoil is brown clay loam about 5 inches thick. The substratum is light-gray gravelly clay loam underlain by loose very gravelly loamy sand.

Permeability is moderate, and the available water capacity is low.

These soils are used for dryfarming, irrigated crops, and range. The vegetation consists of grasses, forbs, and shrubs.

Beaverton soils are associated with Lambert, Zahill, Tinsley, and Turner soils.

Representative profile of Beaverton clay loam, in an area of Turner-Beaverton loams, 0 to 2 percent slopes, in a cultivated field, 1,200 feet east and 250 feet north of the southwest corner of sec. 4, T. 20 N., R. 53 E.:

Ap—0 to 8 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate, fine and very fine, granular structure; hard, friable, slightly sticky and slightly plastic; common roots; 10 percent pebbles; neutral; abrupt boundary.

B2t—8 to 10 inches, brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; hard, friable, sticky and slightly plastic; common roots; thick continuous clay films

on vertical ped faces; 10 percent pebbles; neutral; gradual boundary.

B3ca—10 to 13 inches, brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; hard, very friable, slightly sticky and slightly plastic; common roots; thin patchy clay films on vertical ped faces; 15 percent pebbles; weakly calcareous, and pendant lime on pebbles; moderately alkaline; clear, wavy boundary.

C1ca—13 to 17 inches, light-gray (10YR 7/2) gravelly clay loam, grayish brown (10YR 5/2) moist; weak, coarse, prismatic structure; hard, very friable, slightly sticky and nonplastic; few to common roots; about 20 percent pebbles; strongly calcareous; pebbles completely coated with distinct accumulations of lime; moderately alkaline; clear, wavy boundary.

IIC2ca—17 to 60 inches, light-gray (10YR 7/2) very gravelly loamy sand, light brownish gray (10YR 6/2) moist; about 50 percent pebbles; strongly calcareous; pebbles and coarse sand completely coated with lime; moderately alkaline.

The Ap horizon ranges from dark grayish brown to brown in color and from loam to clay loam in texture. The B horizon ranges from dark grayish brown to brown. The upper part of the C horizon ranges from white to light gray and from clay loam to sandy clay loam. The IIC horizon begins at a depth of 10 to 20 inches and is sand to loamy sand. It is 40 to 70 percent gravel. Most areas have 10 to 30 percent gravel in the A and B horizons, but some have as much as 35 percent.

**Beaverton complex, 4 to 15 percent slopes** (Bm).—The soils of this complex are on undulating to rolling ridges on uplands and sloping terrace edges. Beaverton loam and Beaverton gravelly loam make up 65 to 75 percent of the complex. The rest consists of areas of Turner and Tinsley soils that are too small to be mapped separately. These Beaverton soils have a profile similar to the one described as representative of the series, but in most areas, the surface layer is gravelly.

Included with this complex in mapping are small areas of Lambert soils.

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

Most areas of this complex are used for dryfarmed crops. Some areas are used for range. Capability unit IVe–3, dryland; Shallow to Gravel range site.

## Benz Series

The Benz series consists of deep, well-drained, nearly level to moderately steep soils on fans and low terraces. These soils formed in stratified alluvium that was affected by alkali.

In a representative profile the surface layer, about 8 inches thick, is light brownish-gray loam that is very strongly alkaline. It is underlain by layers of stratified light brownish-gray clay loam, silty clay, and fine sand that are strongly alkaline.

Permeability is slow, and the available water capacity is moderate.

These soils are used mostly for range. The vegetation is dominantly alkali-tolerant grasses, forbs, and shrubs.

Benz soils are associated with Havrelon, Trembles, and Vanda soils.

Representative profile of Benz loam, 0 to 4 percent slopes, in a cultivated field, 900 feet east and 1,320 feet south of the north quarter corner of sec. 24, T. 14 N., R. 54 E.:

Ap—0 to 8 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; first 0.25 to 1 inch is crusted; weak, fine, granular structure below the crusted surface; hard, friable, slightly sticky and slightly plastic; few fine roots; very strongly alkaline; abrupt boundary.

C1—8 to 44 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak, medium, platy structure; hard, friable, slightly sticky and slightly plastic; few fine roots and pores; several strata of silty clay loam and fine sandy loam 1 to 3 inches thick; strongly alkaline; clear boundary.

IIC2—44 to 51 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; many, medium, faint, gray and yellowish-brown mottles; weak, medium, platy structure; very hard, firm, sticky and plastic; strongly alkaline; clear boundary.

IIIC3—51 to 65 inches, light brownish-gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; single grain; loose dry and moist; strongly alkaline.

The A horizon is light brownish gray to grayish brown and ranges from silty clay loam to fine sandy loam in texture. The C horizon has an average texture of silt loam to loam. It commonly has thin strata of silty clay loam, fine sandy loam, and fine sand. Reaction is strongly alkaline to very strongly alkaline throughout.

**Benz loam, 0 to 4 percent slopes** (Bn).—This soil is on alluvial fans and stream terraces. Small areas are occasionally flooded during unseasonably warm winter months when ice jams form on the major streams of the county. This soil has the profile described as representative for the series. In areas used for range, this soil has weak granular structure throughout the surface layer. In cultivated areas or where the soil has been trampled by livestock, a thin crust forms on the surface. Included in mapping are small areas of Trembles, Havrelon, and Vanda soils.

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

Most areas of this soil are in range. Capability unit VIe–1, dryland; Saline Upland range site.

**Benz-Trembles complex, 2 to 15 percent slopes** (Bt).—The soils in this complex are on dissected terraces and fans, mainly in narrow, deep-cut coulees that drain steep broken uplands and badlands. The Benz soils in this complex have a profile similar to the one described as representative of the Benz series, but the surface layer is only 4 to 6 inches thick and does not crust on drying. Benz soils make up 40 to 50 percent of the complex, and Trembles soils 30 to 40 percent.

Included with the complex in mapping and making up about 10 to 25 percent of the unit are eroded ridges and knobs of exposed sedimentary beds and sharply meandering, deep-cut flood channels that are subject to overflow in spring and summer. Also included in mapping are small areas of Havrelon and Banks soils.

Surface runoff is slow to medium, and the hazard of erosion is very high.

These soils are used for range. Capability unit VIe–1, dryland; Benz soil in Saline Upland range site; Trembles soil in Sandy range site.

## Blanchard Series

The Blanchard series consists of deep, somewhat excessively drained, gently undulating to hilly and steep to very steep soils on the side slopes of sedimentary plains. These soils formed in material weathered from sandy sedimentary beds.

In a representative profile the surface layer is brown

loamy fine sand about 3 inches thick. It is underlain by light brownish-gray loamy fine sand.

Permeability is rapid, and the available water capacity is moderate.

These soils are used mainly for range, but a few areas are used for crops. The vegetation consists of grasses, forbs, and, in a few places, scattered pine trees.

Blanchard soils are associated with Dast, Tally, Dimyaw, and Lambert soils.

Representative profile of Blanchard loamy fine sand, in an area of Blanchard-Dimyaw complex, 8 to 80 percent slopes, in grass, 3,000 feet east and 600 feet north of the west quarter corner of sec. 6, T. 14 N., R. 56 E.:

A1—0 to 3 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak, fine, granular structure; soft, very friable; many fine roots; neutral; clear, wavy boundary.

C1—3 to 16 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; weak, very coarse, prismatic structure; soft, very friable; common fine roots; neutral; gradual, smooth boundary.

C2—16 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; single grain; loose, dry and moist; few large roots; mildly alkaline.

The A horizon is grayish brown to brown and is loamy sand to loamy fine sand. The C horizon ranges from loamy fine sand to fine sand. The entire profile is calcareous in some places. Depth to unconsolidated sandstone ranges from 54 to more than 60 inches.

**Blanchard-Dimyaw complex, 8 to 80 percent slopes** (By).—The soils of this complex are on strongly dissected uplands. In a typical area, the Blanchard soil is on the hilltops and upper parts of the steep to very steep side slopes, and the Dimyaw soil is on the lower part of the steep to very steep side slopes. These soils are rolling to very steep. Slopes are mainly 15 to 45 percent but range from 8 to 80 percent. The Blanchard soil has the profile described as representative of the Blanchard series. The Blanchard soil makes up 40 to 50 percent of this complex, and the Dimyaw soil 30 to 40 percent.

Included in mapping are small areas of sandstone outcrop and exposed silty clay loam and silty clay sedimentary beds. Also included are small areas of Dast, Lambert, Regent, and Norbert soils.

Surface runoff is slow to medium on the Blanchard soil and rapid on the Dimyaw soil. The hazard of water erosion is slight to moderate on the Blanchard soil and high on the Dimyaw soil. The hazard of soil blowing is high on the Blanchard soil.

This complex is used for range. Scattered pine trees grow on the Blanchard soil. Capability unit VIe–2, dryland; Blanchard soil in Sands range site; Dimyaw soil in Thin Hilly range site.

## Cherry Series

The Cherry series consists of deep, well-drained, nearly level to sloping and undulating to hilly soils on fans and terraces along streams throughout the county. These soils formed in alluvium.

In a representative profile the surface layer is grayish-brown silty clay loam about 5 inches thick. The subsoil is grayish-brown silty clay loam about 13 inches thick. The substratum is light brownish-gray and pale-brown silty clay loam.

Permeability is moderately slow, and the available water capacity is high.

These soils are used for dryfarmed and irrigated crops and for range. The vegetation is grasses, shrubs, and trees.

Cherry soils are associated with Havrelon, Lohler, Marias, and Lambert soils.

Representative profile of Cherry silty clay loam, 0 to 2 percent slopes, in a cultivated field, 100 feet west and 50 feet north of the southeast corner of the northeast quarter of sec. 4, T. 18 N., R. 53 E.:

Ap—0 to 5 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, fine and very fine, granular structure; slightly hard, friable, sticky and plastic; common fine roots; moderately alkaline; abrupt, smooth boundary.

B21—5 to 13 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and coarse, prismatic structure; hard, friable, sticky and plastic; common fine roots; moderately alkaline; gradual, smooth boundary.

B22—13 to 18 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure; hard, very friable, sticky and slightly plastic; common fine roots; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—18 to 23 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; common fine roots; strongly calcareous; few, fine, indistinct threads of lime; moderately alkaline; diffuse, smooth boundary.

C2—23 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak, thin, platy structure; hard, friable, sticky and plastic; few medium and fine roots; strongly calcareous; moderately alkaline.

The A horizon is light brownish gray to grayish brown and ranges from silt loam to silty clay loam in texture. The B horizon is light olive-brown to grayish-brown silty clay loam. The C horizon ranges from silt loam to silty clay loam. The A and B horizons are calcareous in some places.

**Cherry silty clay loam, 0 to 2 percent slopes** (Cc).—This soil is on fans and terraces along drainageways and streams. It has the profile described as representative of the series. Included in mapping are small areas of Havrelon, Lohler, and Marias soils.

Surface runoff is slow, and the hazard of erosion is none to slight.

This soil is used for irrigated and dryfarmed crops and for range. Capability unit IIIc–1, dryland; capability unit IIc–1, irrigated; Silty range site.

**Cherry silty clay loam, 2 to 4 percent slopes** (Cd).—This soil is on fans and terraces along drainageways and streams. Included in mapping are small areas of Marias, Savage, and Shambo soils.

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

This soil is used for irrigated and dryfarmed crops and for range. Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Silty range site.

**Cherry silty clay loam, 4 to 8 percent slopes** (Ce).—This soil is on alluvial fans along drainageways and near streams. Included in mapping are small areas of Lambert, Marias, and Shambo soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used for irrigated and dryfarmed crops and for range. Capability unit IIIe–2, dryland; capability unit IIIe–1, irrigated; Silty range site.

**Cherry-Lambert complex, 4 to 25 percent slopes** (Cm).—The soils in this complex are on dissected sedimentary plains. A typical area consists of deeply dissected alluvial fans and terraces and hilly to steep areas on uplands that have a few outcrops of soft sedimentary beds. The Cherry soils are on alluvial fans, and the Lambert soils are on the ridges and upper parts of side slopes. These soils are undulating to hilly. Cherry soils make up 50 to 70 percent of this complex, and Lambert soils 30 to 50 percent. Included in mapping are small areas of Dast, Dimyaw, and Shambo soils and Rock outcrops.

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

This complex is used for dryfarmed crops and for range. Capability unit VIe–3, dryland; Silty range site.

**Cherry, Havrelon, and Trembles soils, occasionally flooded** (Ct).—This mapping unit consists of Cherry silty clay loam, Havrelon silt loam, and Trembles fine sandy loam. These nearly level to gently sloping soils are on low terraces and flood plains in narrow valleys of intermittent streams and are subject to periodic damaging overflow. In a few places these soils have a water table that rises to a depth of less than 3 feet. Slopes are commonly less than 4 percent, but they are steep on short terrace breaks and along meandering stream channels. Cherry, Havrelon, and Trembles soils occur together in about 60 to 70 percent of the areas, but any one of these soils may be dominant in any one area. Included in mapping are Shambo, Banks, and Farnuf soils.

Surface runoff is slow. The hazard of erosion is high.

These soils are used for range. Capability unit VIw–1, dryland; Overflow range site.

## Dast Series

The Dast series consists of moderately deep, well-drained, undulating to hilly soils on sedimentary plains. These soils formed in material weathered from soft sandstone.

In a representative profile the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is grayish-brown fine sandy loam about 13 inches thick. The substratum is grayish-brown very fine sandy loam underlain by soft sandstone beds that weather to a texture of fine sandy loam, loamy fine sand, and fine sand.

Permeability is moderately rapid, and the available water capacity is low.

These soils are used for crops and range. The vegetation is mainly drought-resistant grasses, forbs, and shrubs.

Dast soils are associated with Blanchard, Lambert, Tally, and Shambo soils.

Representative profile of Dast fine sandy loam, 2 to 8 percent slopes, in grass, 2,000 feet west and 600 feet north of the southeast corner of sec. 12, T. 13 N., R. 56 E.:

A1—0 to 5 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak, very fine, granular structure; slightly hard, very friable, slightly sticky and nonplastic; many fine roots; moderately alkaline; clear, smooth boundary.

B2—5 to 18 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; common fine and medium roots; moderately alkaline; clear, wavy boundary.

C1ca—18 to 23 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine roots; strongly calcareous; common soft masses of lime; moderately alkaline; abrupt, smooth boundary.

C2—23 to 31 inches, light yellowish-brown (2.5Y 6/4) fine sandy loam, light olive brown (2.5Y 5/4) moist; weak, thick and medium, platy structure; slightly hard, very friable, slightly sticky and nonplastic; common fine roots; strongly calcareous; moderately alkaline; clear, smooth boundary.

C3—31 to 60 inches, light-gray (2.5Y 7/2) stratified soft standstone, loamy fine sand, and fine sand, light brownish gray (2.5Y 6/2) moist; massive; hard; few medium roots along cleavage planes; strongly calcareous; moderately alkaline.

The A horizon is brown to grayish brown. The upper part of the C horizon is loam, fine sandy loam, or very fine sandy loam and has prominent lime accumulations. The substratum ranges from noncalcareous to calcareous. Depth to soft standstone ranges from 20 to 40 inches.

**Dast fine sandy loam, 2 to 8 percent slopes** (Da).—This soil is on the sedimentary plains. It has the profile described as representative of the series. Included in mapping are small areas of Blanchard, Tally, and Lambert soils.

Surface runoff is slow to medium, and the hazard of erosion is moderate to high.

Most areas of this soil are used for range. A few areas are used for dryfarmed crops. Capability unit IVe–2, dryland; Sandy range site.

**Dast-Blanchard complex, 2 to 8 percent slopes** (Db).—The soils of this complex are on sedimentary plains. They are undulating to sloping. Dast soils make up about 60 percent of the complex, and Blanchard soils about 35 percent.

Included in mapping are small areas of Tally, Shambo, and Lambert soils. Also included are blowout spots and low dunes.

Surface runoff is slow to medium, and the hazard of soil blowing is high.

This complex is used mainly for range. Small areas are used for dryfarmed crops. Capability unit IVe–2, dryland; Dast soil in Sandy range site; Blanchard soil in Sands range site.

**Dast-Blanchard complex, 8 to 25 percent slopes** (Dc).—The soils in this complex are on sedimentary plains. They are rolling to hilly. Dast soils make up 60 percent of the complex, and Blanchard soils about 35 percent.

Included in mapping are small areas of Tally, Shambo, and Lambert soils. Also included are areas of blowouts, low dunes, and sandstone outcrops.

Surface runoff is slow to medium. The hazard of erosion is high.

This complex is used for range, and native vegetation is mainly grasses and shrubs. Capability unit VIe–2, dryland; Dast soil in Sandy range site; Blanchard soil in Sands range site.

## Dimyaw Series

The Dimyaw series consists of deep, well-drained, rolling to very steep soils on uplands. These soils formed in sedimentary beds of silty clay loam to silty clay.

In a representative profile the surface layer is light brownish-gray silty clay loam about 1 inch thick. The underlying layers are olive-gray and pale-olive silty clay.

Permeability is slow, and the available water capacity is high.

These soils are used mainly for range, but small areas are used for crops. The vegetation is grasses, forbs, and shrubs.

Dimyaw soils are associated with Blanchard, Lambert, Norbert, and Regent soils.

Representative profile of Dimyaw silty clay loam, 8 to 25 percent slopes, in grass, 2,100 feet west and 1,100 feet south of the northeast corner of sec. 23, T. 16 N., R. 57 E.:

A1—0 to 1 inch, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; strong, fine, granular structure; hard, firm, sticky and plastic; few fine roots and pores; mildly alkaline; clear, smooth boundary.

C1—1 to 8 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) moist; weak, medium and fine, prismatic structure parting to weak, fine, blocky; very hard, firm, sticky and plastic; common fine roots and pores; moderately alkaline; clear, smooth boundary.

C2ca—8 to 14 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 5/3) moist; weak, very thin, platy structure; very hard, firm, sticky and plastic; common fine roots and pores; many threads and nodules of lime; calcareous; gradual, smooth boundary.

C3—14 to 60 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 5/3) moist; weak platy structure; very hard, very firm, sticky and plastic; few fine roots and pores; common threads of lime; calcareous.

The A horizon is light brownish gray to grayish brown and ranges from silty clay to silty clay loam in texture. The C horizon, below a depth of 40 inches, consists of sedimentary beds of silty clay and silty clay loam. This material is light brownish gray, olive gray, light olive gray, and pale olive gray. In many places it contains thin strata of siltstone, claystone, and soft lignite.

**Dimyaw silty clay loam, 8 to 25 percent slopes** (Dm).—This is a rolling to steep soil on knobs and ridges in the uplands. A typical area has many spots and knobs of exposed sedimentary beds. Included in mapping are small areas of Lambert, Norbert, and Regent soils.

Surface runoff is rapid on this soil. The hazard of erosion is high.

This soil is used for range. Capability unit VIe–3, dryland; Thin Hilly range site.

## Farnuf Series

The Farnuf series consists of deep, well-drained, nearly level to sloping soils on fans and terraces and in upland swales. These soils formed in old alluvium.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil is dark grayish-brown and brown clay loam about 14 inches thick. The substratum is calcareous, light brownish-gray silty clay loam and light-gray gravelly loam.

Permeability is moderate, and the available water capacity is high.

These soils are used for crops and range. A small part of the cropland is irrigated. The vegetation is grasses, forbs, and shrubs.

Farnuf soils are associated with Shambo and Turner soils.

Representative profile of Farnuf loam, 0 to 4 percent slopes, in a cultivated field, 1,200 feet east and 200 feet south of the northwest corner of sec. 36, T. 19 N., R. 53 E.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; mildly alkaline; abrupt, smooth boundary.

B21t—6 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; hard, very friable, sticky and plastic; common fine roots; clay films on some ped faces; mildly alkaline; diffuse, smooth boundary.

B22t—14 to 18 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure; hard, very friable, sticky and plastic; common fine roots; thin clay films on some vertical ped faces; mildly alkaline; gradual, wavy boundary.

B3ca—18 to 20 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure; hard, friable, sticky and slightly plastic; common fine roots; weakly calcareous; few, medium, distinct lime nodules; mildly alkaline; gradual, wavy boundary.

C1ca—20 to 32 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; common fine roots; strongly calcareous; common, fine, prominent threads and seams of lime; moderately alkaline; gradual boundary.

C2—32 to 60 inches, light-gray (10YR 7/2) gravelly loam, grayish brown (10YR 5/2) moist; massive; hard, friable, slightly sticky and slightly plastic; approximately 30 percent gravel; strongly calcareous; pendants of lime on pebbles; moderately alkaline.

The A horizon ranges from loam to clay loam in texture. The B2t horizons range from clay loam to silty clay loam. The upper part of the C horizon ranges from silt loam to silty clay loam. Gravel occurs in the lower part of the C horizon in most places. Sedimentary beds of sand and gravel occur at a depth of more than 40 inches.

**Farnuf loam, 0 to 4 percent slopes** (Fa).—This soil is on fans and terraces. It has the profile described as representative of the series. Included in mapping are small areas of Shambo and Turner soils.

Surface runoff is slow to medium on this soil, and there is little or no hazard of erosion.

Most areas of this soil are used for crops. A part of the cropland is irrigated. Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Silty range site.

**Farnuf loam, 4 to 8 percent slopes** (Fb).—This soil is on fans and terraces on uplands. Included in mapping are small areas of Lambert, Shambo, Tally, and Turner soils.

Surface runoff is medium on this soil. The hazard of erosion is slight to moderate.

This soil is used mainly for dryfarmed crops. A few areas are used for range. Capability unit IIIe–2, dryland; Silty range site.

**Farnuf-Shambo loams, 0 to 4 percent slopes** (Ff).—The soils of this complex are on fans and terraces on uplands. The Farnuf soil makes up 50 to 70 percent of this complex, and the Shambo soil 30 to 50 percent. Included in mapping are small areas of Beaverton, Lambert, and Turner soils.

Surface runoff is slow to medium on these soils, and there is little or no hazard of erosion.

Areas of this complex are used mainly for dryfarmed crops. Capability unit IIIe–1, dryland; Silty range site.

**Farnuf-Shambo loams, 4 to 8 percent slopes** (Fh).—The soils of this complex are on alluvial fans and terraces and on high benches. The Farnuf soil makes up 50 to 60 percent of this complex, and the Shambo soil 40 to 50 percent. Included in mapping are small areas of Beaverton, Lambert, and Turner soils.

Surface runoff is medium on these soils. The hazard of erosion is moderate.

These soils are used for dryfarmed crops and range. Capability unit IIIe–2, dryland; Silty range site.

## Havrelon Series

The Havrelon series consists of deep, well-drained, nearly level to gently sloping soils on low terraces and flood plains along the streams in the county. These soils formed in stratified alluvium.

In a representative profile the surface layer is grayish-brown silt loam about 8 inches thick. It is underlain by light brownish-gray, stratified silt loam, fine sandy loam, and silty clay loam.

Permeability is moderate, and the available water capacity is high.

These soils are used for irrigated and dryfarmed crops and range. The vegetation is grasses, forbs, shrubs, and trees. Havrelon soils are associated with Cherry, Lohler, and Trembles soils.

Representative profile of Havrelon silt loam, 0 to 2 percent slopes, in a cultivated field, 1,320 feet west and 1,000 feet north of the southeast corner of sec. 17, T. 18 N., R. 57 E.:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, fine, granular structure; hard, friable, slightly sticky and slightly plastic; many medium and fine roots; calcareous; moderately alkaline; abrupt boundary.

C—8 to 60 inches, light brownish-gray (2.5Y 6/2) stratified silt loam, fine sandy loam, and silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, thick and medium, platy structure; hard, friable, slightly sticky and slightly plastic; common fine and medium roots and pores; calcareous; moderately alkaline.

The Ap horizon is light brownish gray to grayish brown and ranges from loam to silty clay loam in texture. The C horizon is stratified and has an average texture of silt loam or loam.

**Havrelon silt loam, 0 to 2 percent slopes** (Ha).—This soil is on low terraces and flood plains. Small areas are occasionally flooded during unseasonably warm winter months when ice jams form on the major streams of the county. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Cherry, Lohler, and Trembles soils. Also included are small areas of soils that have a surface layer of fine sandy loam and silty clay loam.

Surface runoff is very slow to slow, and there is little or no hazard of erosion.

This soil is used for irrigated and dryfarmed crops and for range. Capability unit IIIc–1, dryland; capability unit IIc–1, irrigated; Silty range site.

**Havrelon silt loam, 2 to 4 percent slopes** (Hb).—This soil is on terraces and flood plains. Included in mapping are small areas of Cherry, Lohler, and Trembles soils.

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

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Silty range site.

## Lambert Series

The Lambert series consists of deep, well-drained, gently sloping to very steep soils on upland sedimentary plains. These soils formed in sedimentary beds of soft loam and silt loam.

In a representative profile the surface layer is grayish-brown silt loam about 4 inches thick. It is underlain by brown, light yellowish-brown, and light-gray calcareous silt loam.

Permeability is moderately slow, and the available water capacity is high.

These soils are used for dryfarmed crops and for range. The vegetation is grasses, forbs, and shrubs.

Lambert soils are associated with Blanchard, Cherry, Dimyaw, Dast, Regent, Shambo, Tinsley, Ringling and Zahill soils.

Representative profile of Lambert silt loam, 2 to 8 percent slopes, in grass, 250 feet east and 1,200 feet north of the southwest corner of sec. 29, T. 20 N., R. 50 E.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, very fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; weakly calcareous; moderately alkaline; gradual, wavy boundary.

C1—4 to 10 inches, brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; slightly hard, very friable; slightly sticky and slightly plastic; many fine roots; weakly calcareous; moderately alkaline; gradual, wavy boundary.

C2ca—10 to 23 inches, light-gray (2.5Y 7/2) silt loam, light brownish gray (2.5Y 6/2) moist; moderate, medium, blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; strongly calcareous; many indistinct threads and nodules of lime; moderately alkaline; clear, wavy boundary.

C3—23 to 60 inches, light yellowish-brown (2.5Y 6/3) stratified silt loam and loam, light olive brown (2.5Y 5/3) moist; moderate, medium and thin, platy structure; very hard, friable, slightly sticky and nonplastic; few fine roots and pores; strongly calcareous; moderately alkaline.

The Ap horizon is light brownish gray to grayish brown and is loam to silt loam. The A horizon is gravelly loam in places. The C horizon is made up of stratified sedimentary beds that are calcareous and soft to friable. This horizon ranges mainly from very fine sandy loam to silty clay loam, but in places it also has strata of fine sandy loam that have a cumulative thickness of less than 6 inches. This horizon is brown, light gray, light brownish gray, light yellowish brown, pale yellow, pale olive, and white.

**Lambert gravelly loam, 20 to 40 percent slopes** (La).—This soil is on hills and ridges on sedimentary upland plains. It has a profile similar to the one described as representative of the series, but it has a 2- to 4-inch mantle of gravelly loam on the surface.

Included with this soil in mapping are small areas of Dimyaw, Shambo, Tinsley, and Zahill soils. Also included are areas that have slopes of less than 20 percent or more than 40 percent.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

This soil is used for range. Capability unit VIe–3, dryland; Thin Hilly range site.

**Lambert silt loam, 2 to 8 percent slopes** (Lb).—This soil is on long side slopes and low knobs on the sedimentary plains. It has the profile described as representative of the

series. In places the soil is severely eroded. Included in mapping are small areas of Cherry, Dast, and Shambo soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

**Lambert silt loam, 8 to 15 percent slopes** (Lc).—This is a moderately steep to rolling soil on crests and side slopes of hills and ridges on the sedimentary plains. Severely eroded areas are common. Included in mapping are small areas of Dast, Dimyaw, and Shambo soils.

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

This soil is used mainly for range. Capability unit IVe–1, dryland; Silty range site.

**Lambert-Badland complex** (Ld).—The steep to very steep soils in this complex are on broken upland sedimentary plains. The Lambert soils are steep, have short slopes, and are on ridgetops, which are divided by very steep areas of Badland where deep gullies and outcrops of sedimentary beds are common (fig. 3). The Lambert soils have slopes of 20 to 40 percent, and Badland has slopes of 40 percent to nearly vertical. Lambert soils make up 50 to 60 percent of this complex, and Badland 30 to 50 percent. Included in mapping are small areas of Blanchard, Dast, Dimyaw, Regent, Ringling, Tinsley, and Zahill soils.

Surface runoff is very rapid, and the hazard of erosion is high to very high.

This complex is used for range. Capability unit VIe–3, dryland; Lambert soils in Thin Hilly range site.

***Figure 3.*—Area of Lambert-Badland complex that is used for range. It also provides excellent cover and browse for deer.**

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**Lambert-Blanchard complex, 15 to 65 percent slopes** (Le).—In this complex are hilly to very steep soils on uplands. Lambert soils make up 40 to 60 percent of this complex, and Blanchard soils 30 to 50 percent.

Included with this complex in mapping are small areas of Dast, Dimyaw, Tally, and Shambo soils. Also included are some areas that have slopes of less than 15 percent. In most areas some sandstone outcrops are included.

Surface runoff is slow to very rapid, and the hazard of erosion is high.

This complex is used for range. Capability unit VIe–3, dryland; Lambert soils in Thin Hilly range site; Blanchard soils in Sands range site.

**Lambert-Dimyaw complex, 15 to 65 percent slopes** (Lm).—In this complex are hilly to very steep soils on dissected sedimentary plains. Lambert soils make up 45 to 60 percent of the complex, and Dimyaw soils 30 to 45 percent. Severely eroded areas are common. Included in mapping are small areas of Blanchard, Dast, Regent, and Ringling soils.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

This complex is used for range. Capability unit VIe–3, dryland; Thin Hilly range site.

**Lambert-Ringling complex, 15 to 65 percent slopes** (Lr).—This complex consists of hilly to very steep soils on uplands. Lambert soils make up 40 to 60 percent of the complex, and Ringling soils 30 to 50 percent. In a typical area, Lambert soils occupy the lower side slopes and Ringling soils the upper side slopes and ridgetops. The areas generally have many outcrops of reddish-brown scoria.

Included with this complex in mapping are small areas of Cherry, Dimyaw, and Shambo soils. Also included are areas that have slopes of more than 65 percent.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

These soils are used for range. Ringling soils are also used as a source of surface material for some county roads. Capability unit VIe–3, dryland; Lambert soils in Thin Hilly range site; Ringling soils in Very Shallow range site.

## Lihen Series

The Lihen series consists of deep, somewhat excessively drained, sloping to rolling soils on upland terraces and ridges. These soils formed in old sandy alluvium.

In a representative profile the surface layer is dark grayish-brown loamy sand about 23 inches thick. It is underlain by grayish-brown loamy sand.

Permeability is rapid, and the available water capacity is moderate.

These soils are used mainly for range. The vegetation is grasses and shrubs.

Lihen soils are associated with Tinsley, Tally, Turner, and Beaverton soils.

Representative profile of Lihen loamy sand, 4 to 20 percent slopes, in grass, 600 feet east and 200 feet south of the northwest corner of sec. 11, T. 16 N., R. 56 E.:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; soft, very friable; many fine roots; neutral; clear, wavy boundary.

A12—4 to 23 inches, dark grayish-brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; mildly alkaline; clear, wavy boundary.

C—23 to 60 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; single grain; loose, dry and moist; common to few medium and fine roots; mildly alkaline.

The A horizon is more than 20 inches thick and ranges from loamy sand to sandy loam in texture. The C horizon is loamy sand to loamy fine sand.

**Lihen loamy sand, 4 to 20 percent slopes** (ls).—This soil is on old stream terraces. Included in mapping are areas of Tinsley, Tally, Turner, and Beaverton soils.

Surface runoff is slow to medium. The hazard of soil blowing is high, but the hazard of erosion is only slight to moderate.

This soil is used mainly for range. Capability unit VIe–2, dryland; Sands range site.

## Lohler Series

The Lohler series consists of deep, moderately well drained, nearly level soils on low terraces and flood plains along the streams in the county. These soils formed in stratified alluvium.

In a representative profile the surface layer is grayish-brown silty clay loam about 10 inches thick. The underlying layer is grayish-brown and light brownish-gray silty clay loam.

Permeability is moderately slow, and the available water capacity is high.

These soils are used for irrigated crops and for range. The vegetation is grasses, forbs, shrubs, and trees.

Lohler soils are associated with Cherry, Havrelon, Marias, and Trembles soils.

Representative profile of Lohler silty clay loam, in a cultivated field, 1,500 feet south and 1,320 feet east of the northwest corner of sec. 20, T. 18 N., R. 57 E.:

Ap—0 to 10 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, fine, granular structure; hard, firm, sticky and plastic; many worm holes and casts; strongly calcareous; moderately alkaline; clear, smooth boundary.

C1—10 to 39 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, thin, platy structure parting to weak, fine, subangular blocky; hard, firm, sticky and plastic; common fine roots and pores; few, thin (less than 1 inch) strata of silt loam; strongly calcareous; moderately alkaline; clear, smooth boundary.

C2—39 to 60 inches, light brownish-gray (2.5Y 6/2) light silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, thin, platy structure; hard, friable, slightly sticky and slightly plastic; strongly calcareous; moderately alkaline.

The A horizon in cultivated areas is light brownish gray to grayish brown and ranges from silty clay loam to silty clay in texture. The C horizon has an average texture of silty clay loam. Thin strata of fine sandy loam to silty clay are common.

**Lohler silty clay loam** (lt).—This soil is on low terraces and flood plains. Small areas are occasionally flooded during unseasonably warm winter months when ice jams form on the major streams of the county. Slopes range from 0 to 2 percent. In some places the surface layer is silty clay. Included in mapping are small areas of Cherry, Havrelon, Marias, and Trembles soils.

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

This soil is used for irrigated and dryfarmed crops and

for range. Capability unit IIIs–1, dryland; capability unit IIs–1, irrigated; Clayey range site.

## Marias Series

The Marias series consists of deep, well-drained, nearly level to sloping soils on fans and terraces. The soils formed in clayey alluvium.

In a representative profile the surface layer is grayish-brown silty clay about 5 inches thick. The underlying layer is grayish-brown and light olive-gray silty clay. These soils crack deeply as they dry.

Permeability is slow, and the available water capacity is high.

These soils are used for dryfarmed and irrigated crops and for range. The vegetation is grasses, forbs, and shrubs.

Marias soils are associated with Cherry, Lohler, Savage, and Vanda soils.

Representative profile of Marias silty clay, 0 to 2 percent slopes, in a cultivated field, 700 feet east and 150 feet south of the northwest corner of sec. 24, T. 17 N., R. 55 E.:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) moist; moderate, fine and very fine, granular structure; hard, friable, sticky and plastic; moderately alkaline; abrupt, smooth boundary.

C1—5 to 8 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure; hard, firm, sticky and plastic; common fine and medium roots and pores; moderately alkaline; clear, wavy boundary.

C2—8 to 25 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, fine, angular blocky; extremely hard, very firm, sticky and plastic; common, small, distinct slickensides; strongly calcareous; strongly alkaline; clear, wavy boundary.

C3ca—25 to 42 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, blocky structure; extremely hard, very firm, sticky and plastic; many, large, distinct slickensides; strongly calcareous; common threads of lime; strongly alkaline; clear, wavy boundary.

C4ca—42 to 60 inches, light olive-gray (5Y 6/2) light silty clay, olive gray (5Y 4/2) moist; massive; hard, firm, sticky and plastic; strongly calcareous; many threads of lime; very strongly alkaline.

The A horizon is grayish brown to light brownish gray. The C horizon is light gray or light olive gray to grayish brown. Silty clay is the dominant texture, but strata of silty clay loam and silt loam are below a depth of 40 inches in some profiles. Seams of gypsum are below a depth of 25 inches in some places.

**Marias silty clay, 0 to 2 percent slopes** (Ma).—This soil is on fans and terraces. It has the profile described as representative for the series. Included in mapping are small areas of Cherry, Lohler, Savage, and Vanda soils.

Surface runoff is slow, and the hazard of erosion is slight.

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIs–1, dryland; capability unit IIs–1, irrigated; Clayey range site.

**Marias silty clay, 2 to 4 percent slopes** (Mb).—This soil is on fans and terraces. Included in mapping are spots and areas of Cherry, Savage, and Vanda soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIe–4, dryland; capability unit IIe–2, irrigated; Clayey range site.

**Marias silty clay, 4 to 8 percent slopes** (Mc).—This soil is on alluvial fans. Included in mapping are small areas of Cherry and Vanda soils.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–5, dryland; Clayey range site.

## Norbert Series

The Norbert series consists of shallow, well-drained, rolling to very steep soils on broken and dissected uplands and sedimentary plains. These soils formed in material weathered from clay shale.

In a representative profile the surface layer is grayish-brown clay about 2 inches thick. It is underlain by grayish-brown clay about 11 inches thick. The substratum grades to gray clay shale and fractured clay shale at a depth of about 13 inches.

Permeability is slow, and the available water capacity is low.

These soils are used for range. The vegetation consists of grasses, forbs, shrubs, juniper, and scrub pine trees.

Norbert soils are associated with Dimyaw, Marias, and Vanda soils.

Representative profile of Norbert clay, 8 to 65 percent slopes, in grass, 850 feet east and 400 feet south of the north quarter corner of sec. 7, T. 13 N., R. 56 E.:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong, fine and medium, granular structure; very hard, firm, very sticky and very plastic; moderately alkaline; clear, wavy boundary.

C1—2 to 13 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, coarse, blocky structure; extremely hard, very firm, very sticky and very plastic; common fine and very fine roots and pores; few fine gypsum crystals; moderately alkaline; clear, wavy boundary.

C2—13 to 25 inches, gray (2.5Y 5/1) clay shale, very dark gray (2.5Y 3/1) moist; few fine roots along fractures and between plates; few gypsum crystals; gradual, wavy boundary.

C3—25 to 60 inches, gray (2.5Y 5/1), fractured clay shale; few seams of gypsum crystals between plates and in fractures.

The A horizon ranges from silty clay to clay in texture. Shaly clay or fractured, platy shale is at a depth of 10 to 20 inches. The A and C1 horizons are more than 50 percent clay.

**Norbert clay, 8 to 65 percent slopes** (No).—This is a rolling to very steep soil on broken and dissected uplands. A typical area has common outcrops of clay shale. Included in mapping are areas that are steeper than 65 percent. Also included are areas of Dimyaw, Marias, and Vanda soils.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

This soil is used for range. Capability unit VIe–3, dryland; Shallow Clay range site.

## Regent Series

The Regent series consists of moderately deep, well-drained, nearly level to sloping or rolling soils on sedimentary plains. These soils formed in material weathered from sedimentary beds of silty clay loam and silty clay.

In a representative profile the surface layer is grayish-

brown silty clay loam about 3 inches thick. The subsoil is grayish-brown and light brownish-gray silty clay about 20 inches thick. The substratum consists of calcareous, brown silty clay, about 14 inches thick, underlain by very dark brown soft clay shale at a depth of about 37 inches.

Permeability is slow, and the available water capacity is moderate.

These soils are used for crops and for range. The vegetation is grasses, forbs, and shrubs.

Regent soils are associated with Dast, Dimyaw, Lambert, Norbert, and Shambo soils.

Representative profile of Regent silty clay loam, 1 to 4 percent slopes, in grass, 1,600 feet west and 1,300 feet south of the northeast corner of sec. 23, T. 16 N., R. 57 E.:

A1—0 to 3 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, sticky and plastic; many roots, moderately alkaline; clear, wavy boundary.

B2t—3 to 12 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong, medium, prismatic structure; hard, friable, sticky and plastic; common fine and medium roots; clay films on some ped faces; moderately alkaline; gradual, wavy boundary.

B3ca—12 to 23 inches, light brownish-gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure; very hard, soft, sticky and plastic; common fine roots; strongly calcareous; distinct nodules of lime; moderately alkaline; diffuse, smooth boundary.

C1ca—23 to 37 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; massive; hard, friable, sticky and plastic; few roots; few fine coal chips in lower part; strongly calcareous; moderately alkaline; diffuse, smooth boundary.

IIC2—37 to 60 inches, very dark-brown (10YR 2/2) soft shale that has the texture of silty clay, very dark brown (10YR 2/2) moist; massive; sticky and slightly plastic; few roots along bedding planes; strongly calcareous; lime coatings along bedding planes; moderately alkaline.

The A horizon ranges from silty clay loam to silty clay in texture. The B2t horizon is dark grayish brown to grayish brown and ranges from silty clay to heavy silty clay loam. The lower part of the C horizon is silty clay and silty clay loam, and in some places there are lignite beds below a depth of 40 inches. Depth to soft shale ranges from 20 to 40 inches.

**Regent silty clay loam, 1 to 4 percent slopes** (Rc).—This soil is on sedimentary plains. It has the profile described as representative of the series. Included in mapping are small areas of Dimyaw and Lambert soils and Regent silty clay.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–4, dryland; Clayey range site.

**Regent silty clay loam, 4 to 8 percent slopes** (Rd).—This soil is on sedimentary plains. Included in mapping are small areas of Dimyaw, Lambert, and Shambo soils and of Regent silty clay.

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

This soil is used for range and for dryfarmed crops. Capability unit IIIe–5, dryland; Clayey range site.

**Regent-Dimyaw complex, 4 to 8 percent slopes** (Re).—The soils in this complex are on sedimentary plains. Regent soils make up 50 to 60 percent of this complex, and Dimyaw soils, 30 to 40 percent. Included in mapping are small areas of Dast, Lambert, and Shambo soils.

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

This complex is used for range and for dryfarmed crops. Capability unit IIIe–5, dryland; Clayey range site.

**Regent-Dimyaw complex, 8 to 15 percent slopes** (Rg).—In this complex are rolling soils on sedimentary plains. Regent and Dimyaw soils each make up about equal parts of the complex. Included in mapping are small areas of Absher, Dast, Lambert, and Norbert soils.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

This complex is used for dryfarmed crops and for range. Capability unit IVe–1, dryland; Clayey range site.

## Ringling Series

The Ringling series consists of deep, well-drained, hilly to very steep soils on ridges of the sedimentary plains. These soils formed in material weathered from reddish-brown shale.

In a representative profile the surface layer is brown gravelly loam about 11 inches thick. It is underlain by fractured, light reddish-brown shale. Content of angular, gravel-size fragments increases with depth.

Permeability is moderate, and the available water capacity is low.

These soils are used mainly for range, but in small areas where they are associated with deeper soils, they are used for crops. The vegetation is grasses, forbs, and shrubs.

Ringling soils are associated with Cherry, Dimyaw, Lambert, and Shambo soils.

Representative profile of Ringling gravelly loam in an area of Lambert-Ringling complex, 15 to 65 percent slopes, in grass, 100 feet southwest of the northeast corner of sec. 36, T. 20 N., R. 53 E.:

A11—0 to 6 inches, brown (7.5YR 4/2) gravelly loam, dark brown (7.5YR 3/2) moist; moderate, very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots; 20 percent hard angular shale fragments; weakly calcareous; moderately alkaline; clear boundary.

A12—6 to 11 inches, brown (7.5YR 4/2) gravelly loam, dark brown (7.5YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; 35 percent hard angular shale fragments; weakly calcareous; moderately alkaline; gradual boundary.

IIC—11 to 60 inches, light reddish-brown (2.5YR 6/4) mass of cobblestones and gravel and less than 5 percent fine earth that has the texture of loam, reddish brown (2.5YR 4/4) moist; common to few roots in cracks; few to many, medium to coarse, open pores; weakly calcareous; lime coatings on lower side of some fragments; moderately alkaline.

The A horizon ranges from brown to reddish brown in color and from gravelly silty clay loam to gravelly loam in texture. Content of angular rock fragments increases from about 15 percent at the surface to 100 percent in the lower part of the profile. Depth to cobblestones and the gravelly IIC horizon ranges from 10 to 20 inches. The IIC horizon is light reddish brown, brown, reddish yellow, and red.

These soils are mapped only in a complex with Lambert soils.

## Riverwash

Riverwash (Rw) consists of nearly level areas on flood plains along the rivers and in dry stream channels. These areas are subject to annual flooding. A typical area consists of barren or nearly barren bars of gravel and sand. Some of these areas have been partly stabilized by willows and other brushy vegetation.

Riverwash is used for wildlife habitat. It is also a source of sand and gravel for roadbuilding. Capability unit VIIIw–1, dryland; not in a range site.

## Saline Land

Saline land (Sa) consists of nearly level areas of poorly drained, stratified, loamy soil material that contains such large quantities of soluble salts and alkali that only the most salt-tolerant native plants can grow. Most areas have crusts of white salt on the surface and many seams of salt crystals throughout. The material ranges from sandy loam to clay in texture, but it is dominantly loam or clay loam. Most areas have a water table at or within a few inches of the surface during most of the growing season in most years. Capability unit VIw–2, dryland; Saline Lowland range site.

## Savage Series

The Savage series consists of deep, well-drained, level to gently sloping soils on alluvial fans and terraces along the Yellowstone River. These soils formed in alluvium.

In a representative profile the surface layer is dark grayish-brown silty clay loam about 4 inches thick. The subsoil is dark grayish-brown and grayish-brown silty clay and silty clay loam about 16 inches thick. The substratum is light brownish-gray and grayish-brown silty clay loam.

Permeability is moderately slow, and the available water capacity is high.

These soils are used mainly for dryfarmed and irrigated crops, but small areas are used for range. The vegetation is grasses, forbs, and shrubs.

Savage soils are associated with Cherry, Marias, and Farnuf soils.

Representative profile of Savage silty clay loam, 0 to 2 percent slopes, in a cultivated field, 75 feet south and 2,100 feet east of the northeast corner of sec. 1, T. 16 N., R. 55 E.:

Ap—0 to 4 inches, dark grayish-brown (2.5YR 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, fine, granular structure; slightly hard, friable, sticky and plastic; common fine roots; mildly alkaline; abrupt, smooth boundary.

B2t—4 to 13 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, friable, sticky and plastic; common fine roots; clay films on some ped faces; mildly alkaline; clear, smooth boundary.

B3ca—13 to 20 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; hard, friable, sticky and plastic; few roots; moderately calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—20 to 34 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; weak, coarse, blocky structure; hard, friable, sticky and slightly plastic; few roots; strongly calcareous; many, fine, soft masses of lime; moderately alkaline; gradual, smooth boundary.

C2—34 to 60 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, sticky and plastic; few roots; strongly calcareous; moderately alkaline.

In cultivated areas the A horizon ranges from silty clay loam to silty clay in texture. The C horizon ranges from silty clay loam to silty clay.

**Savage silty clay loam, 0 to 2 percent slopes** (Sc).—This soil is on fans and terraces. It has the profile described as representative for the series. Included in mapping are small areas of Cherry, Farnuf, and Marias soils.

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

This soil is used for irrigated and dryfarmed crops. Capability unit IIIc–1, dryland; Silty range site.

**Savage silty clay loam, 2 to 4 percent slopes** (Sd).—This soil is on fans and terraces. Included in mapping are small areas of Cherry and Marias soils.

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

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIe–1, dryland; Silty range site.

## Shambo Series

The Shambo series consists of deep, well-drained, nearly level to sloping and undulating to rolling soils on terrace side slopes, swales, fans, and terraces throughout the county. These soils formed in alluvium and material weathered from sedimentary beds.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The upper part of the subsoil is dark grayish-brown loam about 9 inches thick, and the lower part is brown, calcareous loam about 11 inches thick. The substratum is pale-brown loam.

Permeability is moderate, and the available water capacity is high.

These soils are used for dryfarmed and irrigated crops and for range. The vegetation is grasses, forbs, and shrubs.

Shambo soils are associated with Cherry, Farnuf, Lambert, and Tally soils.

Representative profile of Shambo loam, 0 to 2 percent slopes, in a cultivated field, 50 feet north and 1,250 feet west of the southeast corner of sec. 29, T. 19 N., R. 53 E.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and nonplastic; mildly alkaline; clear, smooth boundary.

B2—5 to 14 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; common fine and medium roots and pores; mildly alkaline; clear, wavy boundary,

B3ca—14 to 25 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure; hard, very friable, slightly sticky and nonplastic; common fine roots and pores; strongly calcareous; few fine threads of lime; moderately alkaline; clear, smooth boundary.

C—25 to 60 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; massive; hard, friable, slightly sticky and nonplastic; strongly calcareous; few fine threads of lime; moderately alkaline.

The A and B horizons are loam to silt loam. The C horizon is material weathered from sedimentary beds of loam or silt loam to clay loam. The beds begin at a depth of 25 to 60 inches.

**Shambo loam, 0 to 2 percent slopes** (Se).—This soil is on fans and terraces. It has the profile described as representative for the series. Included in mapping are small areas of Cherry, Farnuf, and Turner soils.

Surface runoff is slow, and the hazard of erosion is slight.

This soil is used for dryfarmed crops and for range. Capability unit IIIc–1, dryland; Silty range site.

**Shambo loam, 2 to 4 percent slopes** (Sf).—This soil is on fans and terraces on sedimentary plains. Included in mapping are small areas of Cherry, Lambert, and Farnuf soils.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–1, dryland; Silty range site.

**Shambo loam, 4 to 8 percent slopes** (Sg).—This soil is on side slopes of hills and ridges of the sedimentary plains. Included in mapping are areas of Lambert and Cherry soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

**Shambo-Lambert complex, 4 to 8 percent slopes** (Sh).—This complex consists of undulating soils on sedimentary plains. Shambo soils make up 50 to 70 percent of this complex, and Lambert soils 25 to 45 percent. Shambo soils are on side slopes and fans, and Lambert soils are on the crests of ridges (fig. 4). Included in mapping are areas of Dast, Farnuf, and Tally soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This complex is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

**Shambo-Lambert complex, 8 to 15 percent slopes** (Sm).—In this complex are rolling soils on sedimentary plains. Shambo soils make up 50 to 70 percent of this

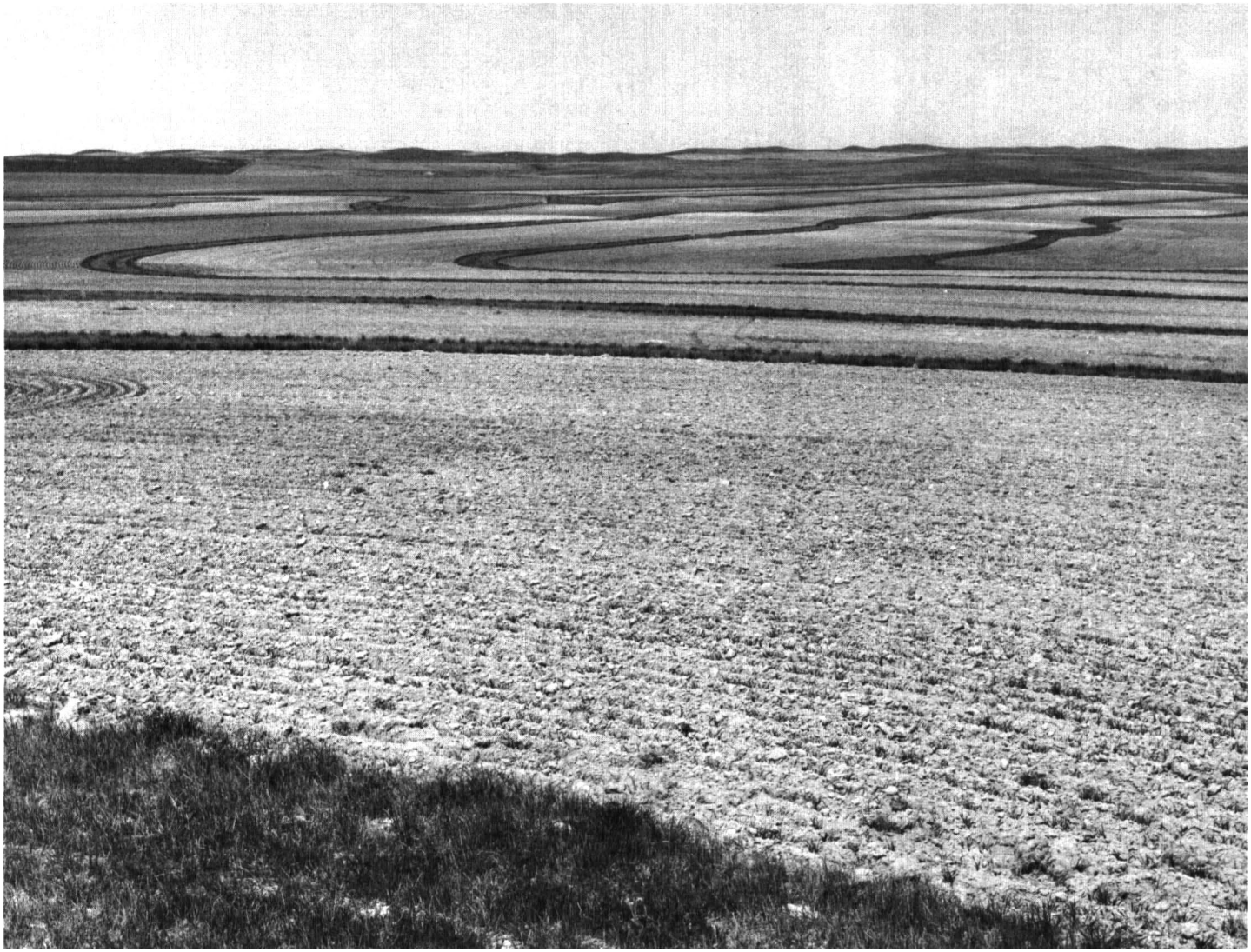

*Figure 4.*—**Typical field of dryfarmed crops in an area of Shambo-Lambert complex, 4 to 8 percent slopes.**

complex, and Lambert soils 25 to 45 percent. In a typical area, Shambo soils are on the side slopes and Lambert soils are on the crests of hills and ridges. Included in mapping are areas of Dast, Regent, and Tally soils.

Surface runoff is rapid, and the hazard of erosion is moderate to high.

This complex is used for range and for dryfarmed crops. Capability unit IVe-1, dryland; Silty range site.

## Tally Series

The Tally series consists of deep, well-drained, nearly level to moderately steep soils on hills, ridges, and side slopes of the uplands. These soils formed in material weathered from sandy sedimentary beds and alluvium.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 7 inches thick. The subsoil is dark grayish brown fine sandy loam about 9 inches thick. The substratum is grayish-brown fine sandy loam.

Permeability is moderately rapid, and the available water capacity is high.

These soils are used for dryfarmed crops and for range. The vegetation is dominantly grasses and shrubs.

Tally soils are associated with Blanchard, Dast, Farnuf, and Shambo soils.

Representative profile of Tally fine sandy loam, 8 to 15 percent slopes, in grass, 1,720 feet west and 5 feet south of the northeast corner of sec. 35, T. 16 N., R. 57 E.:

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and nonplastic; many fine and medium roots; neutral; clear, wavy boundary.

B2—7 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; slightly hard, friable, slightly sticky and nonplastic; common fine and medium roots and pores; neutral; gradual, smooth boundary.

C—16 to 60 inches +, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure; soft, very friable, nonsticky and nonplastic; common medium roots to a depth of 42 inches, few roots below this depth; mildly alkaline.

The A horizon is fine sandy loam to sandy loam. The B horizon is brown to dark grayish brown and ranges from fine sandy loam to sandy loam. In most places the C horizon ranges from light brownish gray to grayish brown and is fine sandy loam to sandy loam, but in places it is loamy fine sand at a depth of more than 30 inches. Some profiles have silt loam sedimentary beds or clay loam glacial till at a depth of 40 to 60 inches. Some profiles have a calcareous and moderately alkaline C horizon.

**Tally fine sandy loam, 0 to 4 percent slopes** (Ta).—This soil is in swales of the sedimentary plains. In some cultivated areas, soil blowing has built up ridges along the leeward edge of the fallow strips. Included in mapping are small areas of Shambo and Turner soils.

Surface runoff is slow. The hazard of water erosion is moderate, and the hazard of soil blowing is moderate to high.

This soil is used for dryfarmed crops and for range. Capability unit IIIe-3, dryland; Sandy range site.

**Tally fine sandy loam, 4 to 8 percent slopes** (Tb).—This soil is on sedimentary plains. In some cultivated areas soil blowing has built up low ridges along the leeward edges of fallow strips. Included in mapping are small areas of Dast, Farnuf, and Shambo soils.

Surface runoff is slow to medium, and the hazard of erosion is moderate to high.

This soil is used for dryfarmed crops and for range. Capability unit IIIe-3, dryland; Sandy range site.

**Tally fine sandy loam, 8 to 15 percent slopes** (Tc).—This soil is on hills and ridges of the sedimentary plains. A typical area has a few outcrops of hard sandstone. This soil has the profile described as representative of the series. Included in mapping are small areas of Blanchard, Dast, Lambert, Farnuf, and Shambo soils.

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

This soil is used mainly for range, but a few areas are used for dryfarmed crops. Capability unit IVe-2, dryland; Sandy range site.

## Terrace Escarpments

Terrace escarpments (Te) consist of the steep to very steep fronts of low terraces. They are composed mainly of gravelly and very gravelly loam material that has little or no horizon development. Some areas are severely eroded and contain little or no gravel. Slopes range from 15 percent to nearly vertical. Mapped areas range from 150 to 600 feet in width.

Surface runoff is rapid to very rapid, and the hazard of erosion is very high.

This mapping unit is used for range. The vegetation is mainly grasses. Capability unit VIe-3, dryland; Thin Hilly range site.

## Tinsley Series

The Tinsley series consists of deep, excessively drained, steep to very steep soils on the side slopes of high terraces in upland areas. These soils formed in gravelly and sandy material.

In a representative profile the surface layer is dark grayish-brown gravelly sandy loam about 4 inches thick. It is underlain by pale-brown very gravelly sand.

Permeability is very rapid, and the available water capacity is very low.

These soils are used for range. They are also used as a source of sand and gravel. The vegetation is mainly drought-resistant grasses.

Tinsley soils are associated with Beaverton, Farnuf, Lambert, Lihen, and Turner soils.

Representative profile of Tinsley gravelly sandy loam, in an area of Tinsley soils, 15 to 65 percent slopes, in grass, 1,100 feet south and 600 feet west of the northeast corner of sec. 11, T. 16 N., R. 56 E.:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; strong, fine, granular structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; 15 percent gravel; mildly alkaline; clear boundary.

C—4 to 60 inches, pale-brown (10YR 6/3) very gravelly sand, brown (10YR 5/3) moist; single grain; loose, dry and moist; few fine and very fine roots; 60 percent gravel; weakly effervescent; thin lime crusts on undersides of some pebbles; moderately alkaline.

The A horizon ranges from light brownish gray to dark grayish brown in color and from gravelly sandy loam to

gravelly loamy sand in texture. The C horizon is gravelly to very gravelly sand. Gravel content ranges from 35 to 60 percent. The entire profile is calcareous in some places.

**Tinsley-Lambert complex, 15 to 65 percent slopes** (Tg).—The soils of this complex are on the edges and side slopes of terraces on the uplands. In a typical area, Tinsley soils are on the upper side slopes and rounded edges of the terraces and Lambert soils are on the lower side slopes and foot slopes. Tinsley soils make up 50 to 70 percent of this complex, and Lambert soils 25 to 45 percent. The Lambert soils have a profile similar to the one described as representative for the series, except that they have a surface layer of gravelly loam, 2 to 4 inches thick. Included in mapping are small areas of Beaverton, Lihen, and Turner soils.

Surface runoff is slow to very slow on Tinsley soils and rapid on Lambert soils. The hazard of erosion, mainly soil blowing, is very high on these soils.

This complex is used for range. Capability unit VIIs–1, dryland; Tinsley soils in Gravel range site; Lambert soils in Thin Hilly range site.

**Tinsley soils, 15 to 65 percent slopes** (Tm).—This mapping unit consists of Tinsley gravelly sandy loam and Tinsley gravelly loamy sand. Individual areas may be all Tinsley gravelly sandy loam, all Tinsley gravelly loamy sand, or some of both soils. Tinsley gravelly sandy loam has the profile described as representative for the series. Tinsley gravelly loamy sand has a profile similar to the one described as representative of the series, except for the texture of the upper 3 to 6 inches. Included in mapping are small areas of Beaverton, Lambert, Lihen, Farnuf, and Turner soils.

Surface runoff is slow to very slow, and the hazard of soil blowing is very high.

These soils are used for range. The vegetation is grasses and forbs. Capability unit VIIs–1, dryland; Gravel range site.

## Trembles Series

The Trembles series consists of deep, well-drained, nearly level to gently sloping soils on low terraces and flood plains along the streams of the county. These soils formed in stratified alluvium.

In a representative profile the surface layer is grayish-brown fine sandy loam about 8 inches thick. This is underlain by light brownish-gray fine sandy loam. The profile is calcareous throughout.

Permeability is moderately rapid, and the available water capacity is high.

These soils are used for irrigated crops and for range. The vegetation is grasses, forbs, shrubs, and trees.

Trembles soils are associated with Banks, Cherry, Havrelon, and Lohler soils.

Representative profile of Trembles fine sandy loam, in a cultivated field, 500 feet west and 500 feet north of the southeast corner of sec. 18, T. 18 N., R. 57 E.:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; calcareous; moderately alkaline; abrupt, smooth boundary.

C1—8 to 20 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure; soft, very friable, nonsticky and nonplastic; calcareous; moderately alkaline; clear, smooth boundary.

C2—20 to 60 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; calcareous; moderately alkaline.

The A horizon is light brownish gray to grayish brown and ranges from loam to fine sandy loam in texture. The C horizon has an average texture of fine sandy loam. It commonly has thin strata ranging from clay loam to loamy sand.

**Trembles fine sandy loam** (Tn).—This nearly level to gently sloping soil is on low terraces and flood plains. In places it is subject to occasional nondetrimental flooding when ice jams form during unseasonably warm winter months. It has the profile described as representative for the series. Slopes are dominantly less than 2 percent, but they range from 0 to 4 percent. Included in mapping are small areas of Banks, Havrelon, Cherry, and Lohler soils.

Surface runoff is very slow to slow. The hazard of water erosion is only moderate, but the hazard of soil blowing is high.

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIe–3, dryland; capability unit IIIe–2, irrigated; Sandy range site.

**Trembles loam** (To).—This soil is on terraces and flood plains. Small areas are occasionally flooded during unseasonably warm winter months when ice jams form on the major streams of the county. Slopes range from 0 to 2 percent. The profile is similar to the one described as representative of the series, except that the surface layer is loam about 4 to 8 inches thick and, in places, is silty clay loam.

Included with this soil in mapping are small areas of Havrelon, Lohler, and Cherry soils. Also included are small areas of Trembles fine sandy loam.

Surface runoff is slow, and the hazard of erosion is slight.

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIc–1, dryland; capability unit IIc–1, irrigated; Silty range site.

## Turner Series

The Turner series consists of deep, well-drained, nearly level to sloping or gently undulating to undulating soils on terraces. These soils formed in old alluvium underlain by sand and gravel at a depth of 20 to 40 inches.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The subsoil is grayish-brown clay loam about 15 inches thick. The upper part of the substratum is calcareous, light-gray clay loam about 8 inches thick. The lower part is grayish-brown, stratified sand and gravel.

Permeability and the available water capacity are moderate.

These soils are used for dryfarmed and irrigated crops and for range. The vegetation is grasses, forbs, and shrubs.

Turner soils are associated with Beaverton, Farnuf, Shambo, and Tinsley soils.

Representative profile of Turner loam, 0 to 2 percent slopes, in a cultivated field, 800 feet west and 50 feet south of the northeast corner of sec. 2, T. 16 N., R. 56 E.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium

roots and pores; mildly alkaline; abrupt, smooth boundary.

B2t—5 to 16 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots and pores; common thin clay films; mildly alkaline; clear, wavy boundary.

B3ca—16 to 20 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine roots and pores; few thin clay films; strongly calcareous; few threads of lime; moderately alkaline; clear, wavy boundary.

C1ca—20 to 28 inches, light-gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; weak, medium, prismatic structure; hard, friable, slightly sticky and slightly plastic; few fine roots and pores; 5 percent gravel; strongly calcareous; many threads of lime; moderately alkaline; abrupt, smooth boundary.

IIC2—28 to 60 inches +, grayish-brown (10YR 5/2) stratified sand and gravel, dark grayish brown (10YR 4/2) moist; single grain; loose, dry and moist; strongly calcareous; moderately alkaline.

In cultivated areas the A horizon ranges from fine sandy loam to clay loam. The B horizon ranges from dark grayish brown or brown to grayish brown and from sandy clay loam to clay loam. The B3 horizon is calcareous in most places. The C horizon, if present, is calcareous clay loam to sandy clay loam. Depth to the IIC horizon of sand and gravel is 20 to 40 inches.

**Turner fine sandy loam, 1 to 4 percent slopes** (Tr).—This soil is on terraces on uplands. It has a profile similar to the one described as representative of the series, but it has a surface layer of fine sandy loam. Included in mapping are areas of Turner loam and Beaverton and Tinsley soils.

Surface runoff is slow. The hazard of water erosion is only moderate, but the hazard of soil blowing is high.

This soil is used for dryfarmed crops and for range. Capability unit IIIe–3, dryland; Sandy range site.

**Turner loam, 0 to 2 percent slopes** (Ts).—This soil is on stream terraces. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Beaverton, Farnuf, Shambo, and Tinsley soils. Also included are small areas of Turner fine sandy loam.

Surface runoff is slow, and the hazard of erosion is slight.

This soil is used for dryfarmed crops and for range. Capability unit IIIc–1, dryland; capability unit IIs–2, irrigated; Silty range site.

**Turner loam, 2 to 4 percent slopes** (Tt).—This soil is on stream terraces. Included in mapping are small areas of Beaverton, Farnuf, and Tinsley soils.

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

This soil is used for dryfarmed and irrigated crops and for range. Capability unit IIIe–1, dryland; capability unit IIe–3, irrigated; Silty range site.

**Turner loam, 4 to 8 percent slopes** (Tu).—This soil is on stream terraces. Included in mapping are small areas of Beaverton and Tinsley soils.

Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used for range and for dryfarmed crops. Capability unit IIIe–2, dryland; Silty range site.

**Turner-Beaverton loams, 0 to 2 percent slopes** (Tv).—The soils of this complex are on terraces. The Turner soil makes up 50 to 70 percent of this complex, and the Beaverton soil 20 to 40 percent. The Beaverton soil has the profile described as representative for the Beaverton series. Included in mapping are small areas of Farnuf and Shambo soils and of Turner fine sandy loam.

Surface runoff is slow, and the hazard of erosion is slight.

These soils are used for dryfarmed and irrigated crops and for range. Capability unit IVs–1, dryland; capability unit IVs–1, irrigated; Turner soil in Silty range site; Beaverton soil in Shallow to Gravel range site.

**Turner-Beaverton loams, 2 to 4 percent slopes** (Tw).—The soils of this complex are gently undulating and are on terraces. The Turner soil makes up 45 to 70 percent of this complex, and the Beaverton soil 25 to 50 percent. Included in mapping are small areas of Farnuf, Shambo, and Tinsley soils.

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

These soils are used for dryfarmed and irrigated crops and for range. Capability unit IVs–1, dryland; capability unit IVe–2, irrigated; Turner soil in Silty range site; Beaverton soil in Shallow to Gravel range site.

**Turner-Beaverton loams, 4 to 8 percent slopes** (Ty).—The soils of this complex are undulating and are on terraces. Turner and Beaverton soils each make up about 45 percent of the complex. Included in mapping are small areas of Lihen, Farnuf, and Tinsley soils.

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

These soils are used for dryfarmed crops and for range. Capability unit IVe–3, dryland; Turner soil in Silty range site; Beaverton soil in Shallow to Gravel range site.

## Vanda Series

The Vanda series consists of deep, well-drained, nearly level to sloping soils on fans and terraces. These soils formed in clayey alluvium.

In a representative profile the surface layer is light-gray silty clay loam about 1 inch thick. The underlying layers are dense, olive-gray and grayish-brown clay and silty clay loam.

Permeability is very slow, and the available water capacity is moderate.

These soils are used mainly for range. The vegetation is alkali-tolerant grasses, forbs, and shrubs.

Vanda soils are associated with Absher, Marias, Norbert, and Savage soils.

Representative profile of Vanda clay, 0 to 8 percent slopes, in grass, 1,050 feet north and 1,050 feet east of the west quarter corner of sec. 2, T. 14 N., R. 55 E.:

A1—0 to 1 inch, light olive-gray (5Y 6/2) silty clay loam, olive gray (5Y 4/2) moist; massive; very hard, friable, slightly sticky and plastic; few fine and very fine roots and tubular pores; many fine to medium vesicular pores; moderately alkaline; abrupt, smooth boundary.

C1—1 to 8 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; weak, fine, blocky structure; extremely hard, very firm, very sticky and plastic; few fine and very fine roots and pores; moderately alkaline; gradual, smooth boundary.

C2—8 to 28 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; weak, fine, blocky structure; extremely hard, very firm, very sticky and plastic; few fine and

very fine roots and pores; weakly calcareous; few fine threads of gypsum and lime; strongly alkaline; clear, smooth boundary.

C3csca—28 to 36 inches, olive-gray (5Y 5/2) clay; olive gray (5Y 4/2) moist; massive; extremely hard, very firm, very sticky and plastic; moderately calcareous; common fine threads of gypsum and lime; strongly alkaline; clear, smooth boundary.

C4—36 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, platy structure; very hard, firm, sticky and plastic; moderately calcareous; few very fine threads of lime; strongly alkaline.

The crusted A horizon ranges from light gray to light brownish gray in color and from silt loam to silty clay loam in texture. The C horizon ranges from clay to silty clay loam, but it averages more than 35 percent clay. Reaction is moderately alkaline to strongly alkaline in the A horizon and ranges from moderately alkaline to very strongly alkaline in the C horizon. Few to many threads of gypsum and lime are in the C horizon.

**Vanda clay, 0 to 8 percent slopes** (Va).—This soil is on fans and terraces. Slopes generally are between 2 and 6 percent. Included in mapping are small areas of Absher, Marias, and Savage soils.

Surface runoff is very slow to medium, and the hazard of erosion is moderate to high.

This soil is used mainly for range. Capability unit VIe–1, dryland; Dense Clay range site.

## Vida Series

The Vida series consists of deep, well-drained, gently undulating to rolling soils on uplands that have been glaciated. These soils formed in calcareous clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown clay loam about 5 inches thick. The subsoil is brown and light brownish-gray clay loam about 17 inches thick. The lower part of the subsoil is calcareous. The substratum is light-gray clay loam glacial till.

Permeability is moderately slow, and the available water capacity is high.

These soils are used for dryfarmed crops and for range. The vegetation is grasses, shrubs, and forbs.

Vida soils are associated with Williams and Zahill soils.

Representative profile of Vida clay loam, gently undulating, in a cultivated field, 1,050 feet south of the northwest corner of sec. 20, T. 23 N., R. 50 E.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; 5 percent gravel; moderately alkaline; clear, smooth boundary.

B2t—5 to 9 inches, brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to moderate, medium, subangular blocky; hard, firm, sticky and plastic; common fine and medium roots and pores; common thin clay films; 10 percent gravel; moderately alkaline; clear, wavy boundary.

B3ca—9 to 22 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate, coarse, prismatic structure; hard, firm, sticky and plastic; common fine and few medium roots and pores; thin patchy clay films; 10 percent gravel and lignite chips; strongly calcareous; many fine threads of lime; moderately alkaline; gradual, wavy boundary.

C—22 to 60 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; few fine and medium roots; 15 percent gravel and many coal chips; strongly calcareous; strongly alkaline.

The A horizon ranges from loam to clay loam in texture. The thickness of the combined noncalcareous A and B horizons ranges from 6 to 10 inches. The B3ca horizon is light brownish-gray to brown clay loam. The C horizon is light brownish-gray to light-gray clay loam glacial till. The average content of coarse fragments ranges from 10 to 25 percent throughout the profile. These fragments are mostly gravel, but in places some are cobblestones.

**Vida clay loam, gently undulating** (Vc).—This soil has complex slopes of 1 to 4 percent and is on uplands that have been glaciated. It has the profile described as representative of the series. A few stones are scattered on the surface. Included in mapping are small areas of Williams and Zahill soils.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–1, dryland; Silty range site.

**Vida clay loam, undulating** (Vd).—This soil has complex slopes of 4 to 8 percent and is on long side slopes of uplands that have been glaciated. A few stones are scattered on the surface. Included in mapping are small areas of Williams and Zahill soils.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

**Vida-Zahill complex, undulating** (Vh).—The soils in this mapping unit have complex slopes of 4 to 8 percent and are on uplands that have been glaciated. Vida soils are on the smoother, least sloping parts of the landscape, and Zahill soils are on the ridges. Vida soils make up 60 to 70 percent of this complex, and Zahill soils 25 to 35 percent. A few cobblestones and stones are scattered on the surface. Included in mapping are small areas of Williams soils in swales.

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

This complex is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

**Vida-Zahill complex, rolling** (Vk).—The soils in this mapping unit have complex slopes of 8 to 15 percent and are on glaciated uplands. Vida soils are on the lower part of side slopes, and Zahill soils are on the crests of ridges and hills. Vida soils make up 45 to 60 percent of this complex, and Zahill soils 35 to 50 percent. Included in mapping are small areas of Williams soils.

Surface runoff is rapid, and the hazard of erosion is high.

This complex is used mainly for range. Capability unit IVe–1, dryland; Silty range site.

## Williams Series

The Williams series consists of deep, well-drained, gently undulating to undulating soils on uplands that have been glaciated. These soils formed in calcareous clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The subsoil is dark grayish-brown, grayish-brown, and light brownish-gray clay loam about 21 inches thick. The lower part of the

subsoil is calcareous. The substratum is light-gray clay loam glacial till.

Permeability is moderately slow, and the available water capacity is high.

These soils are used mainly for dryfarmed crops. A small acreage is used for range, where the vegetation is grasses, forbs, and shrubs.

Williams soils are associated with Vida and Zahill soils.

Representative profile of Williams loam, gently undulating, in a cultivated field, 300 feet south and 100 feet east of the northwest corner of sec. 17, T. 23 N., R. 50 E.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; abrupt, smooth boundary.

B21t—5 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky; hard, friable, sticky and slightly plastic; common fine and medium roots and pores; mildly alkaline; clear, smooth boundary.

B22t—10 to 14 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; hard, firm, sticky and plastic; common fine and medium roots and pores; common thin clay films on vertical ped faces, but few on horizontal faces; mildly alkaline; clear, wavy boundary.

B3ca—14 to 26 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, firm, sticky and plastic; common fine and medium roots; calcareous; many threads and soft nodules of lime; strongly alkaline; gradual, wavy boundary.

C—26 to 60 inches +, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure parting to moderate, fine, angular blocky; hard, firm, sticky and plastic; calcareous; common threads and soft nodules of lime; strongly alkaline.

In cultivated areas the A horizon ranges from loam to clay loam in texture. A light brownish-gray or grayish-brown B3ca horizon is in most profiles.

**Williams loam, gently undulating** (Wm).—This soil is on the smoothest part of uplands that have been glaciated. It has the profile described as representative of the series. Slopes range from 1 to 4 percent. Included in mapping are small areas of Vida and Zahill soils.

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

This soil is used for dryfarmed crops and for range. Capability unit IIIe–1, dryland; Silty range site.

**Williams-Vida complex, gently undulating** (Wn).—The soils in this mapping unit have complex slopes of 1 to 4 percent and are on glaciated uplands. Williams soils make up 50 to 65 percent of this complex, and Vida soils 35 to 50 percent. Included in mapping are spots of Zahill soils.

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

This complex is used mainly for dryfarmed crops, but a small acreage is in range. Capability unit IIIe–1, dryland; Silty range site.

**Williams-Vida complex, undulating** (Wv).—The soils in this mapping unit have complex slopes of 4 to 8 percent and are on uplands that have been glaciated. In a typical area, Williams soils are in the shallow swales, and Vida soils are on the low ridges. Williams and Vida soils each make up about equal parts of this complex. Included in mapping are small areas of Zahill soils on ridge crests.

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

This complex is used for dryfarmed crops and for range. Capability unit IIIe–2, dryland; Silty range site.

## Zahill Series

The Zahill series consists of deep, well-drained soils. These soils are moderately steep to very steep and rolling and are on hills, ridges, and knolls on uplands that have been glaciated. They formed in calcareous clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown loam about 3 inches thick. It is underlain by layers of grayish-brown and olive-colored clay.

Permeability is moderately slow, and the available water capacity is high.

These soils are used for dryfarmed crops and for range. The vegetation is grasses, forbs, and shrubs.

Zahill soils are associated with Lambert, Vida, and Williams soils.

Representative profile of Zahill loam, 15 to 65 percent slopes, in grass, 300 feet east and 250 feet north of the southwest corner of sec. 26, T. 23 N., R. 50 E.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; strong, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; 15 percent pebbles; strongly calcareous; moderately alkaline; clear, wavy boundary.

C1ca—3 to 9 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure parting to strong, fine, granular; slightly hard, firm, sticky and plastic; many fine and medium roots and pores; 15 percent pebbles; strongly calcareous; common threads of lime and lime casts on pebbles; moderately alkaline; diffuse, smooth boundary.

C2—9 to 60 inches +, olive (5Y 5/3) clay loam, olive (5Y 4/3) moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; few fine and medium roots and pores; 15 percent pebbles; strongly calcareous; common threads of lime and lime casts on pebbles; strongly alkaline.

The A horizon ranges from light brownish gray to dark grayish brown in color and from loam to clay loam in texture. The profile ranges from 15 to 30 percent gravel, cobblestones, and stone-size fragments throughout.

**Zahill loam, 15 to 65 percent slopes** (Zh).—This soil is on the dissected edges of uplands that have been glaciated. It has the profile described as representative of the series. Included in mapping are small areas of Lambert, Vida, and Williams soils.

Surface runoff is rapid, and the hazard of erosion is high.

This soil is used for range. Capability unit VIe–3, dryland; Thin Hilly range site.

**Zahill-Lambert complex, 15 to 65 percent slopes** (Zm).—The soils in this complex are on dissected edges of uplands that have been glaciated. Zahill soils are on the upper side slopes and crests of hills and ridges, and Lambert soils are on the lower side slopes. Zahill and Lambert soils each make up 40 to 45 percent of this complex. Included in mapping are small areas of Shambo, Vida, and Williams soils.

Surface runoff is rapid to very rapid, and the hazard of erosion is high.

This complex is used for range. Capability unit VIe–3, dryland; Thin Hilly range site.

# Use and Management of the Soils

This section discusses the management of the soils for crops and pasture, explains the system of capability grouping used by the Soil Conservation Service, and discusses the management of the soils in Dawson County by capability units, both dryland and irrigated. Estimated yields of the principal crops are given. Also discussed are the management of soils for range, for wildlife, and for windbreaks. The soil properties and features that affect engineering practices and the limitations that affect town and country development are listed mainly in tables.

## Use of the Soils for Cultivated Crops

Most of the acreage in Dawson County is dryfarmed. Among the crops grown in these areas are wheat, barley, and oats and a small acreage of corn, sorghum for forage, potatoes, and flax. A small part of the acreage is used for hay and pasture crops, grasses, and grass and legume mixtures. Among the management needs are conserving moisture and controlling soil blowing, runoff, and water erosion.

About 20,000 acres in the county is used for irrigated crops. The main crops are sugar beets, alfalfa for hay, corn for silage, and beans for drying, but a small acreage is used for barley and oats. Among the management needs are maintaining irrigation efficiency, choosing a proper irrigation system, and controlling soil blowing on bare fields in fall and winter.

In recent years the use of fertilizer has increased steadily, but the rate of application is still low. In dryfarmed areas small amounts of nitrogen and phosphorus are drilled into the soil as small grain is seeded. A typical application is 5 to 10 pounds of nitrogen and 20 to 30 pounds of phosphorus. Research in other areas, where the soils and the climate are similar to those in Dawson County, indicates that a good response could be expected from the application of a much larger amount of fertilizer. Locally, the topdressing of winter wheat using additional nitrogen is being researched. Wheat, barley, and oats respond well to applications of nitrogen and phosphorus in dryfarmed areas if the soils are moist to a depth of 30 inches or more at seeding time.

The use of fertilizer and the rate of application vary more in irrigated areas than in dryfarmed areas. The fertilizer should be applied according to the results of soil tests and the needs of the crop to be grown. Soil tests provide information that helps to avoid the costly errors of either applying a fertilizer that is not needed or applying an insufficient amount of one that is needed. Experience on a few farms, as well as research, indicate that a good response could be expected from a much larger amount of fertilizer than is generally applied. Some crops on some soils need other fertilizer in addition to nitrogen and phosphorus.

### *Capability grouping*

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for windbreaks, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in Dawson County.)

Class II soils have moderate limitations that reduce the choice of plans or that require moderate conservation practices.

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in Dawson County.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or to esthetic purposes.

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* shows 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 limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are 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 the management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIe–2 or VIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

### *Management by capability units, dryland*

Most of the cropland in Dawson County is dryfarmed. A crop-fallow system is used that includes mainly wheat, barley, and oats. A small acreage is used for corn, sorghum for forage, potatoes, flax, hay and pasture crops, grasses, and grass and legume mixtures. The frost-free season in Dawson County ranges from 110 to 135 days.

The crop-fallow system was initiated in the mid 1930's as a means of reducing crop failure caused by drought. The main benefit of fallowing has been weed control. Soil moisture research indicates that a small amount of additional moisture is made available to crops as a result of fallowing. Improved tillage equipment and chemicals have largely eliminated the need to fallow for weed control. It is also indicated that if practices designed to conserve moisture, such as stubble-mulch tillage, contour farming, terracing, and stripcropping, are used in conjunction with adequate fertilization, some soils could be cropped more frequently than they can in an alternate crop-fallow system. This applies particularly to the level to gently undulating, deep, well-drained soils that have moderate to moderately slow permeability and high available water capacity.

Soil blowing is a hazard on all soils that are cropped in the county. Some soils are more susceptible to soil blowing than others, but all of them will blow at times if they are left bare. Wind stripcropping, leaving crop residue on the surface, using stubble-mulch tillage, and providing field windbreaks are practices that are used to control soil blowing in places. On some soils one of these practices is effective, but on others a combination of practices is needed. Tillage operations that leave the surface of the soil ridged or rough also help to reduce soil blowing.

Surface runoff causes considerable erosion on much of the cropland. This is perhaps most apparent on the steeper soils, but the most damage is probably done on the gently sloping to strongly sloping soils where the slopes are long. Some nearly level soils are severely damaged by scouring flows in meandering water courses fed by runoff from nearby steeper areas.

The use of contour strips, terraces, and grassed waterways greatly reduces damage caused by runoff. Leaving crop residue on the surface also reduces damage from runoff.

The capability units, dryland, in Dawson County are described, and suggestions for use and management of the soils in each unit are given in the following pages. The names of the soil series represented are mentioned in the descriptions of each unit, but this does not mean that all the soils in a given series are in the unit. The capability classification of each soil is given in the "Guide to Mapping Units."

#### CAPABILITY UNIT IIIe–1, DRYLAND

This unit consists of the deep, well-drained, nearly level to sloping and gently undulating Cherry, Farnuf, Havrelon, Savage, Shambo, Turner, Vida, and Williams soils. These soils are on terraces, fans, and uplands. Slopes are dominantly 2 to 4 percent, but they range from 0 to 4 percent. The soils have a surface layer of loam to silty clay loam and a subsoil or underlying layers of moderately to moderately slowly permeable loam to silty clay loam. The Turner soil has stratified sand and gravel at a depth of 20 to 40 inches. The available water capacity generally is moderate to high, but the Turner soil has moderate available water capacity. Surface runoff is slow to medium. The hazards of soil blowing and water erosion are slight to moderate.

These soils are suited to wheat, barley, oats, corn, and hay crops that are dryfarmed in a crop-fallow system. Their suitability is restricted because precipitation is limited.

Stripcropping, stubble-mulch tillage, and field windbreaks are effective in reducing excessive soil loss from blowing. In addition, because these measures trap blowing snow, they add to the limited moisture available for crops. Contour farming and terracing help to reduce soil loss caused by runoff. They can be used by themselves or in combination and still be effective because of the gentle slope. Grassed waterways also help to reduce soil loss caused by runoff.

#### CAPABILITY UNIT IIIe–2, DRYLAND

This unit consists of deep, well-drained, gently sloping to sloping or undulating Cherry, Farnuf, Lambert, Shambo, Turner, Vida, Williams, and Zahill soils on alluvial fans and uplands. Slopes are dominantly 4 to 8 percent, but they range from 2 to 8 percent. These soils have a surface layer of loam to silty clay loam and a subsoil or underlying layers of loam to silty clay loam. Permeability is moderate to moderately slow. The available water capacity is moderate in the Turner soil but high in the other soils. Surface runoff is medium to rapid. The hazard of erosion is slight to high. Soil blowing is also a hazard if the surface of the soil is left bare.

These soils are suited to and used mainly for dryfarmed wheat, barley, oats, and hay in a crop-fallow system. Their suitability is restricted because precipitation is limited.

Contour farming, stripcropping, leaving crop residue on the surface, and using grassed waterways help to reduce erosion and conserve moisture. These measures should be used in combination to afford maximum protection because of the slope and the hazard of runoff. Field windbreaks also can be used to control soil blowing.

#### CAPABILITY UNIT IIIe–3, DRYLAND

This unit consists of deep, well-drained, nearly level to sloping or undulating Tally and Turner soils on uplands and a Trembles soil on low stream terraces. Slopes are dominantly 2 to 4 percent but range from 0 to 8 percent.

The Tally soils are fine sandy loam to a depth of more than 60 inches in most places, but they have clay loam layers below a depth of 40 inches in some places. The Turner soil has a surface layer of fine sandy loam, a subsoil of clay loam, and stratified sand and gravel at a depth of 20 to 40 inches. The Trembles soil has a surface layer and underlying layer of fine sandy loam that reach to a depth of 40 inches or more. Permeability is moderate to moderately rapid, and the available water capacity is moderate to high. Surface runoff is very slow to medium. The hazard of soil blowing is high, and the hazard of water erosion is moderate to high.

These soils are suited to wheat, barley, oats, and hay crops that are dryfarmed in a crop-fallow system. Their suitability is restricted because precipitation is limited.

Stripcropping and leaving crop residue on the surface of fallowed strips are needed to reduce excessive loss from soil blowing. Deep tillage that leaves the surface rough should be utilized to help control blowing when the surface of the soil is bare. Field windbreaks can also be used effectively to help control soil blowing and to help conserve moisture by trapping snow. Contour farming, terracing, and using grassed waterways can reduce surface runoff and minimize soil losses. These measures should be used in combination for effective results because the hazard of water erosion is moderate to high.

#### CAPABILITY UNIT IIIe–4, DRYLAND

This unit consists of deep to moderately deep, well-drained, gently sloping to nearly level Regent and Marias soils on terraces, fans, and uplands. The Regent soil has a surface layer of silty clay loam and a subsoil of silty clay. The Marias soil is silty clay throughout. These soils have a moderately alkaline surface layer and a moderately alkaline to strongly alkaline subsoil or underlying layer. Permeability is slow, and the available water capacity is high to moderate. Surface runoff is slow to medium. The hazards of water erosion and soil blowing are slight to moderate.

These soils are suited to wheat, barley, oats, and hay crops that are dryfarmed in a crop-fallow system. The suitability of these soils is restricted because precipitation is limited.

Stripcropping and stubble-mulch tillage help to reduce soil blowing. Field windbreaks can also be used. Terraces and contour farming help to control runoff and conserve moisture. Either one of these practices, or both, can be used effectively to reduce soil losses from erosion. Grassed waterways can also be used to control gullying in shallow drainageways. The cost for the power used to till these soils is high.

#### CAPABILITY UNIT IIIe–5, DRYLAND

This unit consists of deep and moderately deep, well-drained, sloping Marias, Regent, and Dimyaw soils on alluvial fans and uplands. Slopes are 4 to 8 percent. The Marias soil is silty clay throughout. Regent and Dimyaw soils have a surface layer and subsoil or underlying layers of silty clay loam to silty clay. Regent soils have soft shale at a depth of 20 to 40 inches. In all the soils, permeability is slow and the available water capacity is high to moderate. Surface runoff is medium to rapid. The hazards of water erosion and soil blowing are moderate to high.

These soils are suited to wheat, barley, oats, and hay that are dryfarmed in a crop-fallow system.

Contour stripcropping, leaving crop residue on the surface, and using grassed waterways help to control erosion and conserve moisture. These measures have to be used in combination for effective results because of the moderate to high hazard of erosion. Emergency tillage that roughens the surface helps to control soil blowing if the soil surface is left bare for long periods of time.

#### CAPABILITY UNIT IIIs–1, DRYLAND

This unit consists of deep, moderately well drained and well-drained, nearly level Lohler and Marias soils on stream terraces and alluvial fans. These soils have a surface layer and underlying layers of silty clay loam and silty clay. Permeability is moderately slow or slow, and the available water capacity is high. Surface runoff is very slow or slow. The hazard of erosion is slight.

These soils are suited to dryfarmed wheat, barley, oats, and corn in a crop-fallow system. Their suitability is restricted because precipitation is limited.

Contour farming, stripcropping, and leaving crop residue on the surface help to conserve moisture, control soil blowing, and trap drifting snow, thus adding to the limited moisture supply.

#### CAPABILITY UNIT IIIc–1, DRYLAND

This unit consists of deep, well-drained, nearly level Cherry, Havrelon, Savage, Shambo, Trembles, and Turner soils on stream terraces. Slopes are 0 to 2 percent. These soils have a surface layer of loam to silty clay loam and a subsoil or underlying material of fine sandy loam to silty clay loam. The Turner soil has stratified sand and gravel at a depth of 20 to 40 inches. Permeability is moderately rapid to moderately slow. The available water capacity is moderate in the Turner soil but high in the other soils. Surface runoff is very slow or slow, and there is little or no hazard of erosion. Soil blowing is a hazard if fields are left bare for long periods of time.

These soils are suited to wheat, barley, oats, corn, and hay crops that are dryfarmed in a crop-fallow system. Their suitability is restricted because precipitation is limited. If additional moisture were available, these soils could be cropped each year.

The main limitation to the use of these soils is the limited precipitation. Stripcropping, leaving crop residue on the surface, and planting field windbreaks help to control soil blowing, conserve moisture, and trap drifting snow, thus adding to the limited moisture supply.

#### CAPABILITY UNIT IVe–1, DRYLAND

This unit consists mainly of deep and moderately deep, well-drained, moderately steep to rolling Dimyaw, Lambert, Regent, Shambo, Vida, and Zahill soils on the uplands. Slopes range from 8 to 15 percent. Some areas are moderately to severely eroded. These soils have a surface layer of loam to silty clay and a subsoil or underlying layers of loam to silty clay. Permeability is moderate to slow. The available water capacity is moderate to high. Surface runoff is rapid.

If erosion is controlled, these soils are suited to wheat, barley, oats, and hay that are dryfarmed in a crop-fallow system.

Contour stripcropping, leaving crop residue on the surface, and using grassed waterways are essential if the soils are used for small grain. Well-managed hay or pasture

crops that form a sod can adequately reduce surface runoff and protect the soil from excessive erosion. Applications of barnyard manure, nitrogen, and phosphorus help in getting stands of hay and pasture crops started and in maintaining their vigor.

#### CAPABILITY UNIT IVe-2, DRYLAND

This unit consists mainly of moderately deep to deep, well-drained and somewhat excessively drained, undulating to moderately steep Dast, Blanchard, and Tally soils on uplands. Some areas are moderately to severely eroded. These soils have a surface layer and underlying layers of fine sandy loam or loamy fine sand. The Dast soils are underlain by soft sandstone at a depth of 20 to 40 inches. Permeability is moderately rapid and rapid. The available water capacity is low to moderate in most of the soils but is high in the Tally soil. Plant roots penetrate to a depth of 5 feet or more in most of the soils, but they are restricted by the soft sandstone in the Dast soils. Surface runoff is slow to rapid. The hazard of water erosion is moderate to high. The hazard of soil blowing is high in cultivated areas.

These soils are suited to wheat, barley, and oats that are dryfarmed in a crop-fallow system.

A combination of stripcropping or field windbreaks and leaving large amounts of crop residue on the surface is needed to control soil blowing. Permanent hay or pasture crops that provide a continuous cover afford the best protection and result in a minimum loss of soil from water erosion or soil blowing. Contour farming, terraces, and grassed waterways should be used to reduce surface runoff and minimize soil losses from water on these sloping soils. Some areas that were cropped have been seeded to native grass and are used for range.

#### CAPABILITY UNIT IVe-3, DRYLAND

This unit consists of undulating to rolling Beaverton and Turner soils on terraces and uplands. These soils have a surface layer of loam to gravelly loam and a subsoil of moderately permeable clay loam to gravelly clay loam. Stratified layers of sand and gravel are at a depth of 20 to 40 inches in the Turner soil and 10 to 20 inches in Beaverton soils. Few plant roots penetrate these layers. The available water capacity is moderate in the Turner soil and low in Beaverton soils. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high.

These soils are suited to wheat, barley, oats, and hay that are dryfarmed in a crop-fallow system. Limited moisture supply affects crops grown on the Beaverton soil in most years, and crops are likely to fail if precipitation is much below average.

Excessive losses of soil through erosion should be kept to a minimum so that the available water capacity is maintained. If significant losses of soil are allowed, the suitability of these soils for crop production is reduced to a point where it is not economically feasible to farm them. Contour farming, stripcropping, leaving crop residue on the surface, and using grassed waterways help to reduce losses of soil through erosion and to conserve moisture.

#### CAPABILITY UNIT IVe-4, DRYLAND

This unit consists only of Banks soils, which are deep, somewhat excessively drained, level to gently sloping soils on low stream terraces. Loamy fine sand is the dominant texture, but some areas have a surface layer of sandy loam to loam as much as 4 inches thick. Permeability is rapid, and the available water capacity is moderate. Surface runoff is very slow.

Because the hazard of soil blowing is high, these soils are poorly suited to small grain and to row crops that are dryfarmed in a crop-fallow system.

High soil losses can be expected if these soils are left bare for long periods of time. A permanent cover of grasses or legumes used for hay or pasture is a suitable cropping system. Contour farming, stripcropping, and leaving crop residue on the surface are needed if small grain or row crops are grown. These practices minimize losses from soil blowing and help to conserve moisture. Field windbreaks can also be effectively used. Crop damage can be expected in spring if the soils in adjacent fields are left bare.

#### CAPABILITY UNIT IVs-1, DRYLAND

This unit consists of nearly level to gently undulating Turner and Beaverton soils. These soils have a surface layer of loam to clay loam and a subsoil of clay loam to gravelly clay loam. Layers of sand or sand and gravel are at a depth of 20 to 40 inches in Turner soils and 10 to 20 inches in Beaverton soils. Permeability is moderate. The available water capacity is moderate in Turner soils and low in Beaverton soils. Surface runoff is slow to medium. The hazard of erosion is slight to moderate.

These soils are suited to wheat, barley, oats, and hay that are dryfarmed in a crop-fallow system. The shallow Beaverton soils are droughty, and crops are likely to fail on these soils if precipitation is much below average.

Stripcropping, contour farming, and leaving crop residue on the surface help to conserve moisture and control soil blowing. Care must be taken to insure that losses of soil through erosion are not excessive, despite the slight to moderate hazard of erosion. Excessive soil losses could reduce the available water capacity and make these soils unsuitable for crops.

#### CAPABILITY UNIT VIe-1, DRYLAND

This unit consists mainly of deep, nearly level to sloping Absher, Benz, and Vanda soils. Also in this unit is a Trembles soil which occurs with Benz soils. These soils have strongly alkaline to very strongly alkaline layers at the surface, or they are very shallow to these layers. Generally, the soils have a surface layer and subsoil or underlying layers of loam to clay, but the Trembles soil is fine sandy loam throughout. Surface runoff is slow to medium, and the hazard of erosion is moderate to very high. Permeability generally is slow to very slow but is moderately rapid in the Trembles soil. The available water capacity generally is high but is moderate in the Benz soils.

#### CAPABILITY UNIT VIe-2, DRYLAND

This unit consists mainly of deep, somewhat excessively drained, sloping to very steep and rolling to hilly Blanchard, Dast, Dimyaw, and Lihen soils on uplands. These soils are loamy sand to loamy fine sand to a depth of 60 inches or more. Permeability is rapid, and the available water capacity is moderate. Surface runoff is slow to medium. The hazard of water erosion is only slight to moderate, but the hazard of soil blowing is high.

These soils are unsuitable for crops because of their slope and the high hazard of soil blowing.

#### CAPABILITY UNIT VIe-3, DRYLAND

This unit consists mainly of Cherry, Dimyaw, Lambert, Norbert, and Zahill soils on uplands. Most areas of these soils are dissected by many drainageways and are characterized by narrow ridges and steep-walled coulees. They are marked by small, moderately eroded to severely eroded spots. Also in this unit are Blanchard and Ringling soils and Badland and Terrace escarpments. Except for Terrace escarpments, all of these soils occur with Lambert soils. All the soils in this unit are mainly steep to very steep.

Generally, these soils have a surface layer and subsoil or underlying layer of loam to silty clay loam. Blanchard soils, however, are loamy fine sand throughout the profile; and Ringling soils, to a depth of 10 to 20 inches, are gravelly loam and, below that depth, mainly cobblestones and gravel. Badland consists of soft sedimentary beds having a texture of loamy sand, sandy loam, silt loam, clay loam, and silty clay. Terrace escarpments are mainly gravelly and very gravelly loam.

Surface runoff is medium to very rapid, and the hazard of erosion is high or very high. Permeability is rapid in Blanchard soils, moderate in Ringling soils, and moderate to slow in the other soils. The available water capacity is moderate in Blanchard soils, low in Norbert and Ringling soils, and generally high in the other soils.

Because of the slope and the hazard of erosion, these soils are suitable only for range.

#### CAPABILITY UNIT VIw-1, DRYLAND

This unit consists only of Cherry, Havrelon, and Trembles soils, occasionally flooded. These soils are deep, well drained, and nearly level to undulating. They are on narrow terraces that are dissected by sharply meandering flood channels on the flood plains of intermittent streams. The soils are subject to periodic damaging overflow. The surface layer and subsoil or underlying layers range from fine sandy loam to silty clay loam in texture. Permeability is moderately slow to moderately rapid, and the available water capacity is high. The hazard of erosion is high.

Because of the erosion hazard caused by frequent flooding, these soils are unsuitable for cultivated crops. They are well suited to range. Native grass is harvested for hay in some areas. Applications of nitrogen and phosphorus fertilizers help in getting grasses started and in maintaining their vigor.

#### CAPABILITY UNIT VIw-2, DRYLAND

This unit consists of the Saline land. This land type is made up of stratified, loamy soil material that is very strongly affected by salts and alkali. It is on low stream terraces and in upland swales. It ranges from sandy loam to clay in the surface layer and underlying layers. Drainage is poor, and the water table is within a few inches of the surface during most of the growing season. Surface runoff is slow to very slow.

These soils are not suited to cultivated crops, hay, or pasture because of the salts and the alkali and a high water table. Reclamation would require extensive drainage, leveling, and leaching of salts and alkali. The soils are well suited to range.

#### CAPABILITY UNIT VIIs-1, DRYLAND

This unit consists mainly of steep to very steep, excessively drained Lambert and Tinsley soils. These soils have a surface layer of gravelly sandy loam underlain by gravelly sand. Permeability is very rapid, and the available water capacity is low. Surface runoff is slow to very slow. The hazard of erosion is very high, especially from soil blowing.

These soils are too steep and too droughty for dryfarming. They have limited use as range. The hazard of soil blowing is very high if the native grass cover is destroyed.

#### CAPABILITY UNIT VIIIe-1, DRYLAND

This unit consists of Badland. This land type is steep to very steep, is severely eroded, and has broken slopes formed by downcutting into the soft, sandy, silty, and clayey sedimentary beds. It is used as wildlife habitat and is important for its scenic value.

#### CAPABILITY UNIT VIIIw-1, DRYLAND

This unit consists of Riverwash. This land type is made up of sand and gravel bars along streams that are subject to annual flooding. Some areas support a moderate stand of bushy vegetation, mainly willows. These areas provide some browse and cover for wildlife, but they have no practical grazing value for cattle.

### *Management by capability units, irrigated*

Irrigated crops are grown on about 20,000 acres in Dawson County. Sugar beets, alfalfa for hay, corn for silage, and dry beans are the main crops, but a small acreage of barley and oats is also irrigated. There are 110 to 135 frost-free days.

Water is pumped and diverted from the Yellowstone River and delivered by a system of canals and ditches. It is then applied to crops by either the border or the furrow method.

Irrigation efficiency is generally low but could be improved by lining canals and ditches, by installing adequate control structures, by land leveling, and by properly using furrows, borders, contour levees, and contour ditches. Some of the soils could be irrigated more efficiently with a sprinkler system.

Soil blowing is a hazard on most soils used for irrigated crops if fields are left bare in fall and winter. Leaving crop residue on the surface and leaving the surface rough when fields are plowed in fall help to control soil blowing. Field windbreaks are also effective.

In the following pages each of the capability units, irrigated, in Dawson County is described, and suggestions for use and management of the soils in each unit are given. The names of the soil series represented are mentioned in the descriptions of each unit, but this does not mean that all the soils in a given series are in this unit. The capability classification of each soil is given in the "Guide to Mapping Units."

#### CAPABILITY UNIT IIe-1, IRRIGATED

This unit consists of the deep, well-drained, nearly level to gently sloping and undulating Cherry, Farnuf, and Havrelon soils on terraces, fans, and uplands. Slopes are dominantly 2 to 4 percent but range from 0 to 4 percent. The soils have a surface layer and subsoil or underlying layer of loam to silty clay loam. Permeability is moderate

or moderately slow. The available water capacity is high. Surface runoff is slow to medium. Soil blowing is a hazard if fields are left bare.

These soils are used for sugar beets, alfalfa, beans for drying, corn, barley, and oats.

Leaving crop residue on the surface or using field windbreaks effectively controls soil blowing. Irrigation water is applied by furrow and border methods. Contour farming of row crops is necessary to control water erosion. Distribution of water can be improved by land smoothing. Bench leveling can be done in most places without permanently damaging the soils by deep cutting. Field leveling of large areas is not a suitable practice because it would require deep cutting and would expose a strongly alkaline, strongly saline, or very sandy layer in some places. Large applications of barnyard manure, nitrogen, and phosphorus are beneficial in the places where a limy substratum is exposed in leveling.

#### CAPABILITY UNIT IIe-2, IRRIGATED

This unit consists only of Marias silty clay, 2 to 4 percent slopes, which is a deep, well-drained soil on terraces and fans. This soil is silty clay throughout the profile. The surface layer is mildly alkaline to moderately alkaline, and the subsoil is moderately alkaline to strongly alkaline. Permeability is slow, and the available water capacity is high. Surface runoff is slow to medium. The intake of water is slow.

This soil is used for sugar beets, alfalfa, and corn.

Contour farming of row crops improves distribution of water and reduces the possibility of soil losses. Leveling improves distribution of water where the surface of the soil is uneven, but deep cuts can expose a strongly alkaline layer that, in places, forms a crust that further reduces the intake of water. The irrigation ditches that run downslope should have sufficient drop structures to control ditch erosion. Heavy applications of barnyard manure, nitrogen, and phosphorus help in getting crops started and increase plant vigor, especially in cut areas.

#### CAPABILITY UNIT IIe-3, IRRIGATED

Turner loam, 2 to 4 percent slopes, is the only soil in this unit. This soil has a surface layer of loam, a subsoil of clay loam, and a substratum of sand or sand and gravel at a depth of 20 to 40 inches. Permeability is moderate, and the available water capacity is moderate. Few roots penetrate the sandy substratum. Surface runoff is medium.

This soil is used for alfalfa, sugar beets, corn, beans for drying, barley, and oats.

Contour farming of row crops helps to improve distribution of water. Leveling helps to improve distribution of water, but cuts of more than 1 foot should be avoided if possible. Moderate cuts reduce the available water capacity, and deep cuts expose the sandy substratum. Water loss is high if ditch bottoms are cut into the sandy layers, but this can be controlled by lining the ditches with concrete. Excessive ditch cutting can be avoided by installing sufficient drop structures to maintain a nonerosive flow of water.

#### CAPABILITY UNIT IIs-1, IRRIGATED

This unit consists of deep, well-drained, level to nearly level Lohler and Marias soils on stream terraces and alluvial fans. These soils have a surface layer and underlying material of silty clay loam to silty clay. The effective rooting depth is 5 feet or more. Permeability is moderately slow to slow, and the available water capacity is high. Surface runoff is slow, and the hazard of erosion is slight.

These soils are used for alfalfa, sugar beets, corn, wheat, barley, and oats.

These soils are difficult to irrigate because intake of water is slow. Distribution of water can be improved by leveling where the surface is uneven, but deep cuts can expose a strongly alkaline layer that forms a crust in places and further reduces intake of water. Applications of barnyard manure, nitrogen, and phosphorus help in getting crops started and increase plant vigor, especially in cut areas.

#### CAPABILITY UNIT IIs-2, IRRIGATED

Turner loam, 0 to 2 percent slopes, is the only soil in this unit. It is level to nearly level and is on stream terraces and uplands. The soil has a surface layer of loam and a subsoil of clay loam. A substratum of sand or sand and gravel is at a depth of 20 to 40 inches. Few plant roots penetrate this layer. Permeability is moderate, and the available water capacity is moderate. Surface runoff is slow. The hazard of erosion is slight.

This soil is used for alfalfa, corn, sugar beets, dry beans, barley, and oats.

Leveling can improve distribution of water where the surface is uneven, but deep cuts reduce the available water capacity and can expose a sandy substratum in places. Cuts should be kept to a depth of less than 1 foot if at all possible. Water loss is high if ditches are cut into the sandy substratum, but this can be controlled by lining the ditches with concrete.

#### CAPABILITY UNIT IIc-1, IRRIGATED

This unit consists of deep, well-drained, nearly level Cherry, Havrelon, and Trembles soils on stream terraces. Slopes range from 0 to 2 percent. These soils have a surface layer of silty clay loam, silt loam, or loam and a subsoil or underlying layers of silty clay loam. Permeability is moderatey slow, and the available water capacity is high. Surface runoff is slow, and there is little or no hazard of erosion.

These soils are suited to alfalfa, corn, beans for drying, sugar beets, barley, and oats. The crops that can be grown are restricted to those that are frost tolerant or to hybrids that can mature within a short growing season.

The relatively short growing season of 110 to 135 days is the only limitation to the use of these soils. Water is applied to row crops by the furrow method and to small grain and hay crops by the border method. Distribution of water can be improved by leveling where the surface of the soil is uneven. These soils are not permanently damaged by deep cutting. Large amounts of barnyard manure, nitrogen, and phosphorus help in getting crops started and increase plant vigor, especially where leveling has exposed a limy subsurface layer.

#### CAPABILITY UNIT IIIe-1, IRRIGATED

This unit consists only of Cherry silty clay loam, 4 to 8 percent slopes, a moderately deep to deep, well-drained, sloping soil on alluvial fans and uplands. This soil has a surface layer of silty clay loam and a subsoil and substratum of silty clay loam. Permeability is moderate. Available water capacity is high, and the rooting zone is

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5 feet or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly for alfalfa, small grain, and pasture, but it can be used for sugar beets.

Application of irrigation water without causing erosion is difficult. Only a few areas are irrigated. Row irrigation can be done safely only if rows are contoured and small streams are used. Hay crops can be irrigated safely from contour ditches if borders are narrow and runs are short. Corrugations within the borders can be used to establish crops. Leveling should not be considered, but irrigation is easier if some smoothing is done in places where there are high and low spots.

#### CAPABILITY UNIT IIIe–2, IRRIGATED

This units consists only of Trembles fine sandy loam, a deep, well-drained, level to gently sloping soil on low stream terraces. This soil is fine sandy loam in texture to a depth of 40 inches or more. In places, strata of loamy fine sand are at a depth of 40 inches or more. Slopes are 0 to 4 percent. Permeability is moderately rapid, and the available water capacity is high. Plant roots easily penetrate to a depth of 5 feet or more. Surface runoff is slow to very slow. The hazard of soil blowing is high.

These soils are suited to alfalfa, corn, sugar beets, beans for drying, barley, and oats.

Using field windbreaks, leaving crop residue on the surface, and leaving the surface roughened by tillage are effective ways to control soil blowing. Deep cuts from leveling do not permanently damage these soils, but applications of barnyard manure, nitrogen, and phosphorus are beneficial where leveling has been done. Deep percolation results in water loss if irrigation runs are long. Lining ditches with concrete helps to reduce seepage and makes the ditches easier to maintain. These soils can be watered more efficiently with a sprinkler system, but border and furrow irrigation systems can also be used. In the steeper areas furrows should be placed on the contour.

#### CAPABILITY UNIT IVe–1, IRRIGATED

Banks soils are the only soils in this unit. They are deep, somewhat excessively drained, and level to gently sloping. They are on low stream terraces. Slopes range from 0 to 4 percent. Loamy fine sand is the dominant texture, but in some areas the surface layer is fine sandy loam or fine sand as much as 4 inches thick. Permeability is rapid, and the available water capacity is moderate. Surface runoff is very slow. The hazard of soil blowing is very high. In places these soils are subject to occasional flooding in winter.

These soils are used for alfalfa, sugar beets, corn, barley, and oats.

These soils should not be left bare for prolonged periods, because of the hazard of soil blowing. Soil blowing can be controlled by leaving large amounts of crop residue on the surface and by planting field windbreaks. Some crop damage can be expected in spring when seedlings are emerging, unless the fields are protected from soil blowing. Proper irrigation of this soil with a gravity system is difficult because of the rapid permeability. Short runs are necessary to avoid excessive loss of water because of the deep percolation. Loss of water from unlined field ditches is high. More even distribution of water could be obtained by using a sprinkler system.

#### CAPABILITY UNIT IVe–2, IRRIGATED

This unit consists of Turner-Beaverton loams, 2 to 4 percent slopes, on terraces and uplands. These soils are gently undulating. They have a surface layer of loam to gravelly loam and a subsoil of moderately permeable clay loam to gravelly clay loam. Layers of sand or sand and gravel are at a depth of 20 to 40 inches in Turner soils and at a depth of 10 to 20 inches in Beaverton soils. Few plant roots penetrate these layers. The available water capacity is moderate in Turner soils and low in Beaverton soils. Surface runoff is medium.

These soils are used for alfalfa, corn, sugar beets, beans for drying, barley, and oats.

These soils are difficult to irrigate properly because they take in water at different rates and because they vary considerably in the amount of water they hold. Leveling to improve the distribution of water is hazardous, because the cuts required in leveling expose the sandy or gravelly substratum of the Beaverton soil in many places. This practice not only makes these areas more difficult to irrigate, but it also creates a soil-blowing hazard in places. Careful design of the irrigation system is needed to prevent excessive losses of water and to control erosion. In areas where, because of the slope, cutting in conveyance and field ditches is excessive and exposes the underlying layer of sandland gravel, the loss of water is great. Lining the ditches with concrete prevents much of this loss. In most areas irrigation water can be applied more efficiently with a sprinkler system.

#### CAPABILITY UNIT IVs–1, IRRIGATED

This unit consists of Turner-Beaverton loams, 0 to 2 percent slopes, on terraces and uplands. These soils have a surface layer of loam to gravelly loam and a subsoil of moderately permeable clay loam to gravelly clay loam. Layers of sand or sand and gravel are at a depth of 20 to 40 inches in Turner soils and 10 to 20 inches in Beaverton soils. Few plant roots penetrate these layers. The available water capacity is moderate in Turner soils and low in Beaverton soils. Surface runoff is slow.

These soils are used for alfalfa, corn, sugar beets, beans for drying, barley, and oats.

Proper irrigation of these soils is difficult because they take in water at different rates and because they vary considerably in available water capacity. Leveling to improve the distribution of water in areas irrigated by a gravity system is hazardous. Even moderate cutting of the Beaverton soil drastically reduces the available water capacity and in places exposes the sandy or gravelly substratum that takes in water very rapidly. Water loss in unlined field ditches is generally high on these soils. Irrigation efficiency could be improved by using a sprinkler system.

## Estimated Yields

Table 2 lists estimated yields of principal crops on the soils that are farmed. Estimates are not listed if the soil is not ordinarily used for a crop or is not suited to it. The yields listed are not presumed to be the highest obtainable but are near the average of those that can be expected from a high level of management. Estimates are based on field observations and records of actual yields.

Management required to obtain these yields includes selection of adapted crop varieties, good control of weeds

and insects, and timeliness in seeding and harvesting operations.

Increased yields of most crops on most of the soils can be expected by strict application of moisture-conserving practices, erosion control practices, improved irrigation water management, and the use of much larger amounts of fertilizer.

## Use of the Soils for Range [2]

Range is land on which the climax (natural potential) plant community is mainly grasses, grass-like plants, and shrubs that are valuable for grazing and that grow in sufficient quantity to justify grazing use. In Dawson County vegetation having the potential for range grows on about 1,084,000 acres, or about 72 percent of the total acreage. The raising of cattle and sheep is the main livestock enterprise.

From early settlement of the county to about 1950, the range was heavily grazed. Since then, most of the range in Dawson County has been gradually improving, and at present about 60 percent of it is in good or excellent condition.

The average annual precipitation in the county ranges from 10 to 14 inches.

### *Range condition*

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site.

Heavy use over a long period reduces the vigor of plants and may kill them. Grazing animals are selective and grazing pressure is heaviest on the most palatable plants. These plants are eventually grazed out if overuse of a range area is prolonged.

Before domestic grazing animals began using the range in this county, the plants that grew on each soil made up the potential or climax vegetation. These climax plants are called decreasers or increasers, depending on their response to grazing pressure. The decreasers are generally the tallest growing, most productive plants, and generally are dominant in the climax plant cover. The increasers are present in smaller amounts and are generally lower growing plants that fill in as the more desirable plants decline. They, in turn, are weakened by continued close grazing and also begin to decline. Invaders are weedy plants that are not in the climax composition. They are generally less palatable and fill the voids that develop as the decreasers and increasers are weakened or killed.

Continuous overgrazing of any range site causes the composition of the plant cover to change from that of the original or climax cover. The degree of these changes is reflected in the range condition class. The range condition of a site is determined by comparing the kinds and amounts of the present plant cover with the kinds and amounts of plants in the climax or potential plant cover. The climax plant community of a range site can be determined by study of relict areas and undisturbed areas or areas where grazing animals have been excluded. The range condition is excellent if more than 75 percent of the present composition is made up of original, or climax, plants. It is good if the percentage of climax plants is 50 to 75 percent, fair if the percent is 25 to 50, and poor if less than 25 percent. Range condition is determined to provide an estimate of the deviation from climax on a range site and serves as a basis for planning the management needed to improve or maintain the plant community for the uses planned.

### *Management of range*

A management program on range includes three groups of conservation practices. They are forage management practices, animal control practices, and special improvement practices.

Forage management practices are the most important in any range conservation program. Proper grazing use, deferred grazing, and planned grazing systems are the major practices. Proper grazing use includes a safe degree of use, proper season of use, and range readiness. As a general rule, at least 50 percent of each year's growth should be left by grazing animals to maintain the vigor and production of the better grasses. Forage management should be applied on all range sites. Good forage management is essential to maintain the range condition on sites in good or excellent condition or to improve the range condition on sites in poor or fair condition.

Animal control practices include fencing, salting, and use of mineral supplements, water developments, riding or herding, and livestock pest control. One or more of these practices is generally needed to obtain optimum uniformity in distribution of grazing use over a range area. In effect, they are essential means of achieving a good forage management program.

Special improvement practices are needed in places where other management practices do not achieve the desired results or where recovery is too slow from forage management alone. They include range seeding, fertilization, range pitting, contour furrowing, shallow chiseling, waterspreading, and brush control.

Where feasible, the mechanical treatment practices of pitting, contour furrowing, and shallow chiseling can speed recovery of a range area in two ways. They increase the rate and amount of moisture taken in by the soil and reduce the amount of the less desirable plants in the area. These practices must be followed by deferred grazing to allow the more desirable plants to improve or reestablish themselves. If there are not enough of the better grasses to accomplish this recovery, a seedbed should be prepared, the range should be seeded, and then grazing should be deferred.

A water supply is necessary in every range area for the health and growth of livestock. Properly planned water developments help to achieve uniform distribution of animals.

The range condition on all of the range sites in Dawson County can be maintained or improved by practicing proper grazing use and by using an appropriate grazing system.

### *Descriptions of range sites*

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. It is a product of all environmental factors responsible for its development. In the absence of abnormal disturbances and physical deterioration, the site supports a plant community characterized by an association of spe-

[2] FRANK W. KIRSCHTEN, range conservationist, Soil Conservation Service, Glendive, Montana, helped prepare this section.

TABLE 2.—*Estimated average acre*

[Absence of yield figure indicates that the crop is not suited

| Soil | Winter wheat, dryland | Spring wheat, dryland | Barley | |
|---|---|---|---|---|
| | | | Dryland | Irrigated |
| | *Bu.* | *Bu.* | *Bu.* | *Bu.* |
| Banks soils | | | | 45 |
| Beaverton complex, 4 to 15 percent slopes | 18 | 15 | 22 | |
| Cherry silty clay loam, 0 to 2 percent slopes | 28 | 22 | 38 | 75 |
| Cherry silty clay loam, 2 to 4 percent slopes | 28 | 22 | 38 | 60 |
| Cherry silty clay loam, 4 to 8 percent slopes | 26 | 20 | 30 | |
| Dast fine sandy loam, 2 to 8 percent slopes | 22 | 18 | 30 | |
| Dast-Blanchard complex, 2 to 8 percent slopes | 12 | 10 | 18 | |
| Dast-Blanchard complex, 8 to 25 percent slopes | 10 | 8 | 16 | |
| Farnuf loam, 0 to 4 percent slopes | 30 | 24 | 40 | 80 |
| Farnuf loam, 4 to 8 percent slopes | 28 | 22 | 36 | |
| Farnuf-Shambo loams, 0 to 4 percent slopes | 30 | 24 | 40 | |
| Farnuf-Shambo loams, 4 to 8 percent slopes | 26 | 20 | 34 | |
| Havrelon silt loam, 0 to 2 percent slopes | 28 | 22 | 38 | 80 |
| Havrelon silt loam, 2 to 4 percent slopes | 28 | 22 | 38 | 75 |
| Lambert silt loam, 2 to 8 percent slopes | 22 | 18 | 28 | |
| Lambert silt loam, 8 to 15 percent slopes | 16 | 12 | 20 | |
| Lohler silty clay loam | 28 | 22 | 38 | 75 |
| Marias silty clay, 0 to 2 percent slopes | 30 | 24 | 38 | 70 |
| Marias silty clay, 2 to 4 percent slopes | 30 | 24 | 38 | 70 |
| Marias silty clay, 4 to 8 percent slopes | 26 | 22 | 32 | |
| Regent silty clay loam, 1 to 4 percent slopes | 28 | 22 | 38 | |
| Regent silty clay loam, 4 to 8 percent slopes | 26 | 20 | 36 | |
| Regent-Dimyaw complex, 4 to 8 percent slopes | 24 | 20 | 36 | |
| Regent-Dimyaw complex, 8 to 15 percent slopes | 20 | 16 | 26 | |
| Savage silty clay loam, 0 to 2 percent slopes | 30 | 24 | 40 | 80 |
| Savage silty clay loam, 2 to 4 percent slopes | 30 | 24 | 40 | 80 |
| Shambo loam, 0 to 2 percent slopes | 30 | 24 | 40 | 80 |
| Shambo loam, 2 to 4 percent slopes | 28 | 22 | 38 | |
| Shambo loam, 4 to 8 percent slopes | 25 | 20 | 34 | |
| Shambo-Lambert complex, 4 to 8 percent slopes | 23 | 19 | 30 | |
| Shambo-Lambert complex, 8 to 15 percent slopes | 22 | 16 | 27 | |
| Tally fine sandy loam, 0 to 4 percent slopes | 25 | 20 | 32 | |
| Tally fine sandy loam, 4 to 8 percent slopes | 25 | 20 | 32 | |
| Tally fine sandy loam, 8 to 15 percent slopes | 23 | 18 | 28 | |
| Trembles fine sandy loam | 25 | 22 | 32 | 70 |
| Trembles loam | 25 | 22 | 32 | 65 |
| Turner fine sandy loam, 1 to 4 percent slopes | 25 | 20 | 32 | |
| Turner loam, 0 to 2 percent slopes | 28 | 22 | 36 | 80 |
| Turner loam, 2 to 4 percent slopes | 28 | 22 | 36 | 70 |
| Turner loam, 4 to 8 percent slopes | 25 | 20 | 32 | |
| Turner-Beaverton loams, 0 to 2 percent slopes | 26 | 20 | 32 | 70 |
| Turner-Beaverton loams, 2 to 4 percent slopes | 26 | 20 | 32 | 70 |
| Turner-Beaverton loams, 4 to 8 percent slopes | 23 | 18 | 28 | |
| Vida clay loam, gently undulating | 34 | 30 | 45 | |
| Vida clay loam, undulating | 30 | 26 | 40 | |
| Vida-Zahill complex, undulating | 28 | 24 | 40 | |
| Vida-Zahill complex, rolling | 26 | 22 | 35 | |
| Williams loam, gently undulating | 36 | 30 | 50 | |
| Williams-Vida complex, gently undulating | 36 | 30 | 50 | |
| Williams-Vida complex, undulating | 32 | 28 | 45 | |

[1] Animal-unit-month is used to express the amount of forage or feed required to maintain 1 animal unit for a period of 30 days.

*yields of principal crops*

to the particular soil or generally is not grown on it]

| Oats | | Corn for silage, irrigated | Sugar beets, irrigated | Dry beans, irrigated | Alfalfa | | Cereal hay, dryland | Tame hay, dryland | Pasture | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dryland | Irrigated | | | | Dryland | Irrigated | | | Dryland | Irrigated |
| *Bu.* | *Bu.* | *Tons* | *Tons* | *Cwt.* | *Tons* | *Tons* | *Tons* | *Tons* | *A.U.M.*[1] | *A.U.M.*[1] |
| 24 | 50 | 10 | 12 | | | 2 | 0.5 | 0.5 | | 6 |
| 45 | 100 | 26 | 18 | 26 | 1.7 | 5 | 2.0 | 1.2 | 1.2 | 9 |
| 45 | 95 | 22 | 17 | 24 | 1.7 | 5 | 2.0 | 1.2 | 1.2 | 9 |
| 40 | | 18 | | | 1.3 | 3 | 1.5 | 1.3 | .9 | |
| 35 | | | | | | | .8 | .6 | .6 | |
| 25 | | | | | | | .7 | .5 | .5 | |
| 20 | | | | | | | .7 | .5 | .5 | |
| 45 | 100 | 26 | 22 | 28 | 2.0 | 5 | 2.3 | 1.5 | 1.0 | 9 |
| 40 | | | | | 1.8 | | 2.0 | 1.4 | 1.0 | |
| 45 | | | | | 2.0 | | 2.3 | 1.5 | 1.0 | |
| 38 | | | | | 1.8 | | 1.9 | 1.3 | 1.0 | |
| 45 | 100 | 26 | 18 | 26 | 1.5 | 5 | 1.7 | 1.5 | 1.0 | 8 |
| 45 | 90 | 24 | 17 | 24 | 1.5 | 5 | 1.7 | 1.5 | 1.3 | 8 |
| 34 | | | | | | | 1.0 | .9 | .7 | |
| 25 | | | | | | | .7 | .5 | .5 | |
| 45 | 100 | 26 | 18 | 26 | 1.7 | 5 | 2.0 | 1.3 | 1.0 | 9 |
| 40 | 75 | 15 | 16 | 16 | 1.7 | 5 | 2.3 | | | 7 |
| 40 | 75 | 15 | 15 | 16 | 1.7 | 5 | 2.3 | | | 7 |
| 38 | | | | | 1.5 | | 2.0 | | | |
| 45 | | | | | 1.7 | | 2.0 | 1.4 | 1.2 | |
| 40 | | | | | 1.4 | | 1.7 | 1.2 | 1.0 | |
| 38 | | | | | 1.3 | | 1.5 | 1.3 | 1.0 | |
| 32 | | | | | | | .8 | .7 | .6 | |
| 45 | 100 | 26 | 22 | 24 | 1.7 | 5 | 2.3 | 1.7 | 1.0 | 9 |
| 45 | 100 | 24 | 21 | 22 | 1.7 | 5 | 2.3 | 1.7 | 1.0 | 9 |
| 45 | 100 | 26 | 22 | 25 | 2.0 | 5 | 2.0 | 1.7 | 1.0 | 9 |
| 40 | | | | | 1.7 | | 1.8 | 1.6 | 1.0 | |
| 36 | | | | | 1.6 | | 1.7 | 1.3 | 1.3 | |
| 33 | | | | | 1.2 | | 1.2 | 1.1 | 1.0 | |
| 30 | | | | | .5 | | .9 | .7 | .8 | |
| 36 | | | | | 1.8 | | 2.0 | 1.2 | 1.0 | |
| 36 | | | | | 1.8 | | 2.0 | 1.2 | 1.0 | |
| 32 | | | | | | | 1.5 | 1.0 | 1.1 | |
| 36 | 90 | 22 | 14 | 22 | 1.2 | 4 | 1.8 | 1.0 | 1.0 | 7 |
| 36 | 80 | 22 | 14 | 22 | 1.2 | 4 | 1.8 | 1.1 | 1.0 | 7 |
| 36 | | | | | 1.8 | | 2.0 | 1.0 | .8 | |
| 40 | 90 | 25 | 21 | 25 | 2.0 | 5 | 2.3 | 1.2 | 1.0 | 9 |
| 40 | 80 | 25 | 20 | 25 | 2.0 | 5 | 2.3 | 1.2 | 1.0 | 9 |
| 36 | | | | | 1.8 | | 2.0 | 1.1 | .9 | |
| 45 | | | 20 | 23 | 1.8 | 4 | 2.0 | 1.1 | .9 | 7 |
| 45 | | | 19 | 23 | 1.8 | 4 | 2.0 | 1.1 | .9 | 7 |
| 32 | | | | | 1.5 | | 1.8 | 1.0 | 1.0 | |
| 60 | | | | | 2.0 | | 2.3 | 1.5 | 1.0 | |
| 55 | | | | | 1.8 | | 2.0 | 1.3 | 1.2 | |
| 50 | | | | | 1.6 | | 1.8 | 1.3 | .9 | |
| 45 | | | | | 1.4 | | 1.6 | 1.2 | 1.0 | |
| 65 | | | | | 2.0 | | 2.5 | 1.6 | 1.3 | |
| 65 | | | | | 2.0 | | 2.5 | 1.6 | 1.3 | |
| 60 | | | | | 1.8 | | 2.0 | 1.5 | 1.3 | |

cies different from that of other range sites in terms of kinds or proportion of species or in total annual yield.

The soils in Dawson County have been grouped into range sites according to the kinds or amounts of climax vegetation that the soils are capable of producing. Determining the kinds and amounts of plants growing on any specified range site is necessary in planning the management of that site. For example, it is necessary to know that the Overflow range site is capable of producing a specified kind and amount of native vegetation and that the Gravel range site is capable of producing a much smaller amount of vegetation made up of entirely different plants. In Dawson County most range sites differ in their management needs as well as in the numbers of grazing animals they can support.

In this section the 14 range sites in Dawson County are described. A brief description of the soils in each range site is included. The composition of the climax, or potential, plant cover is given in terms of decreaser and increaser plants. The range condition is then discussed, and the response to forage management practices and the suitability to mechanical treatment are given. The estimated total annual yield per acre is given for each site when it is in excellent range condition.

All the soils of a given series are not necessarily in the same range site. To find the names of the soils in any one range site, refer to the "Guide to Mapping Units" at the back of this publication.

### CLAYEY RANGE SITE

This range site consists of Dimyaw, Regent, Lohler, and Marias soils. These soils are deep, slowly permeable, well-drained silty clay loams and silty clays. The Regent and Dimyaw soils are undulating to rolling and are on uplands, and the Lohler and Marias soils are nearly level on terraces and gently sloping on alluvial fans (fig. 5). Areas of this site are mainly in the southeastern part of the county. They are commonly small, and only a few small areas of the Lohler and Marias soils are used for range. This site makes up only 1.4 percent of the range in the county.

These soils have a moderately slow intake rate and high available water capacity. Runoff is slow on Lohler and Marias soils and medium on Regent and Dimyaw soils.

The approximate composition of the climax or potential plant community, by weight, is 60 percent western wheatgrass and thickspike wheatgrass, 18 percent green needlegrass, 5 percent blue grama, 7 percent perennial forbs, 5 percent big sagebrush, and 5 percent short grasses. Under

*Figure 5.*—In foreground is an area of Clayey range site, in which are Regent soils; in background is an area of Thin Hilly range site, in which are Dimyaw and Lambert soils.

continued heavy grazing, the wheatgrasses and green needlegrass decrease. Blue grama, perennial forbs, short grasses, and sagebrush increase.

Most of the site is in good condition, but in some areas where good management has allowed the better grasses to maintain or reestablish themselves, the site is in excellent condition.

This site generally responds well to such management as proper grazing use and a planned grazing system. This site is suited to mechanical treatment. Shallow chiseling, range pitting, contour furrowing, and range seeding normally bring satisfactory results if followed by proper management.

If this site is in excellent condition, the estimated annual yield of air-dry herbage ranges from 1,300 pounds in favorable years to 800 pounds in less favorable years. About 95 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

#### DENSE CLAY RANGE SITE

Vanda clay, 0 to 8 percent slopes, is the only soil in this range site. This soil is mainly on terraces and fans in the drainageway of Cedar Creek in the southeastern part of the county. Slopes range up to about 8 percent but in most places are less than 2 percent. The soil is dense, strongly alkaline to very strongly alkaline clay throughout. The areas are as much as several hundred acres in size along Cedar Creek. The site makes up about 0.4 percent of the range in the county.

Water enters and moves very slowly through these soils. Runoff is slow in most areas.

The approximate composition of the climax or potential plant community, by weight, is 80 percent western wheatgrass and thickspike wheatgrass, 5 percent perennial forbs, 5 percent short grasses, 3 percent saltgrass, 3 percent greasewood, 2 percent squirreltail, and 2 percent sagebrush. Under heavy grazing, western wheatgrass and thickspike wheatgrass are replaced by buffalobur, foxtail barley, tumblegrass, curlycup gumweed, pricklypear, false buffalograss, and annual plants.

Most of this site is in good condition. Some areas on some of the more overused flats along Cedar Creek are in fair condition. This site generally responds slowly to such management as proper grazing use and a grazing system. It is not well suited to mechanical improvement practices. Shallow chiseling temporarily increases production in places by increasing infiltration.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 800 pounds in favorable years to 400 pounds in less favorable years. About 90 percent of this production is plants that produce forage for cattle, sheep, deer, and antelope.

#### GRAVEL RANGE SITE

This range site consists of soils in the Tinsley series. These soils are undulating to very steep and are on fingerling ridges and edges of benches. In most places the surface layer and the upper part of the subsurface layer are gravelly or very gravelly sand, but in some places the upper 2 to 3 inches of the surface layer is very gravelly fine sandy loam. In most places gravel content decreases at a depth of more than about 18 inches. This site makes up about 4 percent of the range in the county.

Rainfall and snowmelt enter these soils rapidly, but most of the water is lost through deep percolation.

The approximate composition of the climax or potential plant community, by weight, is 17 percent plains muhly, 15 percent perennial forbs, 13 percent needle-and-thread, 12 percent bluebunch wheatgrass, 10 percent sand dropseed, 5 percent little bluestem, 5 percent sand bluestem, 5 percent prairie sandreed, 5 percent short grasses, 5 percent upland sedges, 3 percent western wheatgrass, 3 percent Indian ricegrass, and 2 percent woody plants. Under heavy grazing, plains muhly, needle-and-thread, bluebunch wheatgrass, and sand dropseed are replaced by short grasses, forbs, red three-awn, sandwort, and sunflowers.

This site is mostly in fair and good condition. In some places, fringed sagewort and green sagewort have increased and are a significant part of the plant cover. This site responds slowly to proper grazing use and grazing systems. It is not suited to mechanical treatment practices.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 800 pounds in favorable years to 400 pounds in less favorable years. About 95 percent of this production is plants that produce forage for cattle, sheep, deer, and antelope.

#### OVERFLOW RANGE SITE

This range site consists only of Cherry, Havrelon, and Trembles soils, occasionally flooded. These soils are in narrow valleys and along the flood plains of many intermittent streams in the county. In most places the different terrace levels are separated by short steep breaks a few feet wide and a few feet high. Stream channels in most areas are only a few feet deep, have numerous sharp bends, and meander across the entire width of the valleys. This site receives additional water as runoff from steep valley walls and side drainageways from the uplands. This water spreads over the nearly level fans and terraces. In some places the lowest terrace levels are flooded in most years. On part of this range site are dike systems designed to spread water diverted from stream-flow. These soils are deep, light-colored, well-drained silty clay loams, loams, and fine sandy loams.

This site makes up only about 5 percent of the range in the county, but because it has more favorable moisture conditions, it produces more grazeable forage per acre than other sites. Areas on the narrow, nearly level to gently sloping terraces and fans are small.

The approximate composition of the climax or potential plant community, by weight, is 30 percent western wheatgrass and thickspike wheatgrass, 20 percent other tall grasses, 15 percent green needlegrass, 10 percent woody plants, 5 percent needle-and-thread, 5 percent big bluestem, 5 percent little bluestem, 5 percent slender wheatgrass, and 5 percent perennial forbs. Under continued heavy grazing, green needlegrass, needle-and-thread, western wheatgrass, thickspike wheatgrass, and other tall grasses are replaced by increased amounts of silver sagebrush, Kentucky bluegrass, Canada bluegrass, smooth brome, tumblegrass, and annual plants.

This site is mostly in fair and good condition. In some areas good management has allowed the better grasses to maintain themselves, and the site is in excellent condition. Most of this site has been overgrazed in the past by sheep and cattle. In some small areas silver sagebrush, rosebush,

and snowberry have increased and are a dominant part of the plant cover. This site generally recovers rapidly if proper grazing use and a planned grazing system are employed. Response is slow where the plant cover is dominated by Kentucky bluegrass or smooth brome. Brush control is feasible in small local areas where silver sagebrush, rosebush, or snowberry are dominant in the plant cover. Most of this site is not suited to mechanical improvement because of the erosion hazard if the plant cover is destroyed.

An even balance of grazing between this site and adjacent sites is difficult to obtain because of the shade, shelter, longer green grass period, and available water on this site. Consequently, where tracts of this site are sufficiently large, grazed areas should be separated by fences to facilitate good grazing management.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 2,500 pounds in favorable years to 1,500 pounds in less favorable years. About 85 percent of this production is plants that produce forage for cattle, sheep, deer, and antelope.

#### PANSPOTS RANGE SITE

Absher loam, 0 to 8 percent slopes, is the only soil in this range site. This soil is nearly level to sloping and is on alluvial fans in the southeastern part of the county. In some areas this soil has a surface layer of silt loam 2 to 4 inches thick. In areas where there are nearly barren, irregularly shaped, alkali panspots, the surface layer is a fragile crust of bleached silts or very fine sands 1/8 to 1/2 inch thick. The subsoil is dense, strongly alkaline silty clay that has seams of gypsum below a depth of about 12 inches. The substratum is massive, stratified silty clay and silty clay loam. Areas are commonly less than 100 acres in size. This site makes up 0.4 percent of the range in the county.

Water moves very slowly through these soils. Runoff is slow to medium. The hazard of erosion is moderate to high.

The approximate composition of the climax or potential plant community, by weight, is 53 percent western wheatgrass, 14 percent short grasses, 10 percent needle-and-thread, 8 percent alkali sacaton, 8 percent woody plants, 5 percent green needlegrass, 5 percent perennial forbs, 5 percent winterfat, 4 percent plains reedgrass, 4 percent upland sedges, and 2 percent prairie sandreeds. Under continued heavy grazing, western wheatgrass, needle-and-thread, winterfat, alkali sacaton, and green needlegrass are replaced by increased amounts of short grasses, woody plants, cactus, false buffalograss, tumblegrass, foxtail barley, curlycup gumweed, broom snakeweed, and many annual plants.

This site ranges from fair to excellent in condition. Most of the site is in good condition. This site responds moderately well to proper grazing use and a grazing system. Shallow chiseling increases production in places by increasing infiltration. Intensive mechanical treatment can deteriorate the site by mixing the thin loam surface layer into the underlying dense clay.

If this site is in excellent condition, the estimated annual yield of air-dry herbage ranges from 800 pounds in favorable years to 400 pounds in less favorable years. About 80 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

#### SALINE LOWLAND RANGE SITE

This range site consists only of Saline land. This land type is nearly level to gently sloping and is on stream terraces. The deep loamy soil materials are strongly saline, and there is a crust of salts on the surface in many places. A water table is at or within a few inches of the surface during the growing season in most years. The areas are less than 100 acres in size. This site makes up about 0.5 percent of the range in the county.

The approximate composition of the climax or potential plant community, by weight, is 45 percent alkali sacaton, 15 percent western wheatgrass, 10 percent saltgrass, 10 percent alkali cordgrass, 5 percent alkali grass, 5 percent slender wheatgrass, 5 percent bearded wheatgrass, 5 percent sedges, and 3 percent squirreltail. Under continued heavy grazing, alkali sacaton and western wheatgrass decrease and are replaced by saltgrass, mat muhly, foxtail barley, curlycup gumweed, tumblegrass, rushes, and annual plants.

This site ranges from fair to excellent in condition, depending on how severe the use of the area by livestock has been in the past. In some areas good management has allowed the better plants to maintain themselves, and the site is in excellent condition. In some areas saltgrass has increased and is the dominant plant. This site recovers rapidly when proper grazing use and a grazing system are employed if enough of the better grasses are present. These saline-alkali soils are not suited to mechanical improvement practices.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 2,200 pounds in favorable years to 1,200 pounds in less favorable years. About 95 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

#### SALINE UPLAND RANGE SITE

This site consists of soils of the Benz series. Benz soils are nearly level to strongly sloping and are on terraces and alluvial fans. This site is mainly in the nearly level to gently sloping bottoms of coulees that drain areas of Badland and Lambert soils in the eastern part of the county. Benz soils are light colored, strongly alkaline to very strongly alkaline, and well drained. Typically, the soils are stratified loams, clay loams, and silty clay loams. This site makes up about 1.5 percent of the range in the county.

Runoff is slow to medium.

The approximate composition of the climax or potential plant community, by weight, is 30 percent western wheatgrass, 30 percent short grasses, 8 percent Nuttall saltbush, 5 percent alkali sacaton, 5 percent plains reedgrass, 5 percent needle-and-thread, 5 percent saltgrass, 5 percent squirreltail, 5 percent greasewood, and 2 percent perennial forbs. Under heavy grazing, western wheatgrass, alkali sacaton, squirreltail, Nuttall saltbush, needle-and-thread, and greasewood are replaced by false buffalograss, foxtail barley, short grasses, and annual plants.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 600 pounds in favorable years to 300 pounds in less favorable years. About 10 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

#### SANDS RANGE SITE

This range site is made up of Banks soils on low terraces of the Yellowstone River and sloping to very steep Blan-

chard and Lihen soils on uplands. These soils are deep, rapidly permeable, somewhat excessively drained loamy fine sands or loamy sands. This site makes up about 4 percent of the range in the county.

These soils have a rapid intake rate but moderate available water capacity. Gentle rains are highly effective sources of water because only a small amount of water runs off. In a few places, small areas are subject to soil blowing.

The approximate composition of the climax or potential plant community, by weight, is 30 percent prairie sandreed, 28 percent little bluestem, 10 percent sand bluestem, 10 percent woody plants, 5 percent big bluestem, 5 percent needle-and-thread, 5 percent upland sedges, 5 percent perennial forbs, and 2 percent western wheatgrass. Under heavy grazing, prairie sandreed, little bluestem, sand bluestem, and big bluestem are replaced by increased amounts of needle-and-thread, western wheatgrass, sedges, and large amounts of annual grasses and forbs.

Most of this site is in fair and good condition. In places where good management has allowed the better grasses to maintain or reestablish themselves, the site is in excellent condition. In some areas green sagewort has increased and is a significant part of the plant cover. This site ordinarily responds well to proper grazing use and a grazing system. Mechanical measures that disturb the surface can cause a very severe soil blowing and should be avoided.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 1,800 pounds in favorable years to 1,000 pounds in less favorable years. About 90 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

### SANDY RANGE SITE

This range site consists of well-drained Dast, Tally, Trembles, and Turner soils. The Dast, Tally, and Turner soils are nearly level to rolling and are on uplands, and Trembles soils are nearly level and are on parts of the terraces along most streams in the county. These soils have a surface layer of fine sandy loam. This site makes up about 4.5 percent of the range in the county.

These soils have a moderate intake rate and available water capacity.

The approximate composition of the climax or potential plant community, by weight, is 20 percent little bluestem, 20 percent needle-and-thread, 15 percent prairie sandreed, 15 percent western wheatgrass, 8 percent short grasses, 7 percent woody plants, 5 percent sand bluestem, 5 percent other tall grasses, 3 percent sand dropseed, and 2 percent side-oats grama. Under continued heavy grazing, the bluestems, needle-and-thread, prairie sandreed, side-oats grama, and other high-producing grasses are replaced by upland sedges, green sagewort, tumblegrass, and annual grasses and forbs. Vegetation in overgrazed areas is mainly smooth brome, Kentucky bluegrass, and less desirable brush plants.

Most areas of this site are in fair or good condition. This site generally responds well to such management as proper grazing and deferred rotation grazing. Recovery is very slow in areas where the better plants are nearly or completely grazed out. The more nearly level parts of this site are suited to most mechanical improvements. The response to shallow chiseling or range pitting is normally good if enough of the better grasses are present. Complete preparation of the seedbed followed by range seeding is needed in some areas. Brush control is feasible in some bottomland areas where silver sagebrush, rosebush, or snowberry are dominant in the plant cover.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 1,600 pounds in favorable years to 900 pounds in less favorable years. About 90 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

### SHALLOW CLAY RANGE SITE

Norbert clay, 8 to 65 percent slopes, is the only soil in this range site. This soil is mainly on the low clayey ridges in the Cedar Creek drainageway in the southeastern part of the county. Slopes range from 8 to more than 40 percent. It has a thin surface layer and dense subsurface layers that rest abruptly on platy, fractured claystone at a depth of less than 20 inches. Few plant roots are below a depth of 20 inches. Many areas ranging from one-fourth acre to 5 acres are eroded. This site makes up about 1 percent of the range in the county.

This soil has a slow water intake rate. Runoff is rapid.

The approximate composition of the climax or potential plant community, by weight, is 35 percent western wheatgrass, 22 percent green needlegrass, 7 percent little bluestem, 7 percent perennial forbs, 5 percent prairie sandreed, 5 percent Rocky Mountain juniper, 4 percent bluebunch wheatgrass, 3 percent plains muhly, 3 percent big sagebrush, 3 percent greasewood, 3 percent Nuttall saltbush, and 2 percent winterfat. Under heavy grazing, western wheatgrass, green needlegrass, bluebunch wheatgrass, plains muhly, prairie sandreed, Nuttall saltbush, little bluestem, winterfat, and greasewood are replaced by curly-cup gumweed, buffalobur, foxtail barley, sunflower, tumblegrass, and many annual species.

Most areas of this site are in good or excellent condition. Small areas near water and along some easily reached draws and small side drainageways are in fair condition. This site responds well to such management as proper grazing and a grazing system. This site is not suited to any mechanical improvement practices, because of the shallowness of the soil and the severe hazard of erosion. Uniform distribution of grazing is difficult to obtain on this site because of the varied terrain and lack of good permanent water developments. Small stockwater dams commonly used on this range site generally become filled with sediment in a few years. The site commonly has high wildlife potential.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 900 pounds in favorable years to 400 pounds in less favorable years. About 85 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

### SHALLOW TO GRAVEL RANGE SITE

This range site consists of Beaverton soils. The soils are mainly on low, steep ridges on high benches or on the edges of these benches, but they also are nearly level to undulating in some areas used for range. These soils have a surface layer of dark grayish-brown gravelly loam and a subsoil of gravelly clay loam that rests abruptly on a substratum of sand and gravel at a depth of 10 to 20 inches. This site makes up less than 1 percent of the range in the county.

These soils have a moderate intake rate and a low available water capacity.

The approximate composition of the climax or potential plant community, by weight, is 25 percent needle-and-thread, 20 percent western wheatgrass and thickspike wheatgrass, 10 percent little bluestem, 10 percent short grasses, 8 percent bluebunch wheatgrass, 8 percent plains muhly, 7 percent perennial forbs, 5 percent prairie sandreed, 5 percent sand dropseed, and 2 percent side-oats grama. Under continued heavy grazing, needle-and-thread, Western wheatgrass, thickspike wheatgrass, bluebunch wheatgrass, and little bluestem are replaced by upland sedges, blue grama, Sandberg bluegrass, red three-awn, hairy goldaster, and annual forbs.

This site is mostly in fair and good range condition. In some areas where good management has allowed the better grasses to maintain themselves, the site is in excellent condition. In some areas, fringed sagewort and green sagewort have increased and are a significant part of the plant cover. The areas occupied by this site are easily reached and readily grazed by livestock. During most winters the snow cover is light; consequently, the plants are exposed to heavy winter use that has helped contribute to overuse.

This site responds moderately well to proper grazing and a planned grazing system. It is suited to mechanical improvement practices, such as range pitting, shallow chiseling, or range seeding.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 800 pounds in favorable years to 400 pounds in less favorable years. About 95 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

### SILTY RANGE SITE

This range site consists of Cherry, Farnuf, Havrelon, Lambert, Savage, Shambo, Trembles, Turner, Vida, Williams, and Zahill soils. The Cherry soils are nearly level to sloping and are on smooth alluvial fans and terraces. The Havrelon, Savage, and Trembles soils are nearly level and are on stream terraces. The Farnuf, Shambo, and Turner soils are nearly level and are on high benches. The Lambert soils (fig. 6) are undulating to rolling and are on uplands. The Vida, Williams, and Zahill soils are on uplands that have been glaciated. These soils are moderately deep and deep and well drained. They have a surface layer of loam, silt loam, and silty clay loam. The Lambert soils are light colored. This range site, which is the most extensive in the county, makes up about 30 percent of the range.

The soils have a moderate intake rate and available water capacity. They take in and hold most of the rainfall. Runoff is slow to medium.

The approximate composition of the climax or potential plant community, by weight, is 45 percent western wheatgrass and thickspike wheatgrass, 20 percent needle-and-thread, 7 percent short grasses, 5 percent green needlegrass, 5 percent little bluestem, 5 percent prairie sandreed, 5 percent blue grama, 3 percent winterfat, 3 percent perennial forbs, and 2 percent sagebrush and sagewort. Under continued heavy grazing, the wheatgrasses, green needlegrass, needle-and-thread, little bluestem, prairie sandreed, and winterfat are replaced by short grasses, unpalatable forbs, clubmoss, and woody plants.

This site ranges from fair to excellent in condition. Most of the site is in fair or good range condition. There are large areas where good management has allowed the better grasses to maintain or reestablish themselves, and the site is in excellent condition. Large areas are easily reached and readily grazed by livestock throughout the year, and this contributes to the overuse of this site.

This site generally responds well to such management as proper grazing and planned grazing systems. In areas where the better grasses are nearly or completely grazed out, recovery is very slow. Most of this site is suited to mechanical treatment. Shallow chiseling, range pitting, and contour furrowing followed by deferment of grazing bring good results in most areas where there are enough of the better grasses. A weed control program following treatment is needed in places where there are significant amounts of fringed sagewort, broom snakeweed, or other weedy plants. A complete preparation of the seedbed followed by range seeding and deferment of grazing is needed in some areas. Brush control is feasible in small areas where silver sagebrush, rosebush, or snowberry completely dominate the plant cover.

If this site is in excellent condition the estimated annual yield of air-dry herbage, per acre, ranges from 1,500 pounds in favorable years to 800 pounds in unfavorable years. About 95 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

### THIN HILLY RANGE SITE

This range site consists of hilly or steep Dimyaw, Lambert, and Zahill soils and Terrace escarpments. These soils have smooth, complex slopes of more than 5 percent (fig. 7). They are deep, well-drained loams to silty clay loams. This site makes up about 29 percent of the range in the county.

These soils have a moderate to moderately slow intake rate and moderate to high available water capacity. Runoff is medium to rapid, and small eroded areas are common.

The approximate composition of the climax or potential plant community, by weight, is 20 percent little bluestem, 20 percent western wheatgrass and thickspike wheatgrass, 10 percent prairie sandreed, 10 percent needle-and-thread, 10 percent short-grass increasers, 5 percent green needlegrass, 5 percent perennial forbs, 5 percent sedge increasers, 5 percent woody plants, 4 percent plains muhly, 4 percent bluebunch wheatgrass, and 2 percent side-oats grama. Under heavy grazing, little bluestem, western wheatgrass, thickspike wheatgrass, prairie sandreed, green needlegrass, and bluebunch wheatgrass are replaced by increased amounts of short grasses, sedges, forbs, annuals, broom snakeweed, curlycup gumweed, and fringed sagewort.

This site is mostly in good and excellent range condition. Some gently sloping areas of the site where the range has been overstocked in the past or where grazing distribution is poor are in fair condition. This site responds well to such management as proper grazing use and planned grazing systems. This site is not suited to any mechanical improvement practices, because of the general steepness and the high hazard of erosion.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 1,200 pounds in favorable years to 100 pounds in less favorable years. About 95 percent of this production is plants that furnish forage for sheep, cattle, deer, and antelope.

*Figure 6.*—**In foreground is an area of Silty range site, in which are Lambert soils; in the brushy draws is an area of Overflow range site, in which are Cherry, Havrelon, and Trembles soils; and in background is an area of Thin Hilly range site, in which are Dimyaw soils.**

### VERY SHALLOW RANGE SITE

The Ringling part of the Lambert-Ringling complex, 15 to 65 percent slopes, is the only soil in this range site. Slopes are steep and very steep. The soil has a surface layer of friable, brown or reddish-brown gravelly loam that rests abruptly on hard, fractured, reddish-colored shale at a depth of about 10 inches. Gravel in the surface layer consists mainly of sharp, angular shale fragments. In some places fragments are larger than gravel size, and in a few places, on ridge crests and steep buttes, outcrops of the shale form small boulders that have the appearance of clinkers. This site is mainly in the eastern and northeastern parts of the county and makes up less than 1 percent of the range.

The soil has low available water capacity, and runoff is rapid.

The approximate composition of the climax or potential plant community, by weight, is 30 percent bluebunch wheatgrass, 12 percent plains muhly, 11 percent little bluestem, 10 percent western wheatgrass, 7 percent needle-and-thread, 5 percent prairie sandreed, 5 percent short grasses, 5 percent perennial forbs, 5 percent creeping juniper, 5 percent skunkbush sumac, and 5 percent upland sedges. Under heavy grazing, nearly all of the grasses are replaced by annuals, red three-awn, broom snakeweed, sandwort, and pussytoes.

Nearly all of this site is in good or excellent range condition. It has not been severely overused by grazing animals in the past because it is generally steep and is on rocky knolls and ridges. Once this site has deteriorated through overuse, it responds slowly to proper grazing use and deferred grazing. It is not suited to mechanical improvement practices, because the soil is very shallow and steep.

If this site is in excellent condition, the estimated annual yield of air-dry herbage, per acre, ranges from 400 pounds in favorable years to 200 pounds in less favorable years. About 90 percent of this production is plants that furnish forage for cattle, sheep, deer, and antelope.

*Figure 7.*—**Typical area of Thin Hilly range site, in which are Lambert and Dimyaw soils.**

## Use of the Soils for Wildlife [3]

The wildlife in Dawson County and the soil associations that wildlife most commonly inhabit are discussed in this section. The kinds of wildlife and their numbers vary from place to place because the kinds and amounts of food and cover required by different animals vary with the kinds of soil, topography, and land use. More detailed descriptions of the soil associations are in the section "General Soil Map."

White-tailed deer, mule deer, and antelope are the big game animals found in the county. Deer most commonly inhabit the areas of brushy range on the low terraces and alluvial fans in stream valleys of the Cherry and Trembles-Havrelon associations. These associations have many fields of alfalfa where deer feed. Deer also find food and cover in the brushy coulee bottoms of steep and broken uplands that border the stream valleys in the Badland, Lambert-Dimyaw, Norbert-Vanda, and Tinsley-Lambert-Lihen associations.

Antelope roam the Dast-Blanchard, Lambert, and Shambo-Lambert associations on the rolling uplands and the Farnuf and Turner-Beaverton associations on the high benches. They feed mainly on the forbs or weedy plants and on woody plants in areas used as range, but large herds commonly graze in cropped fields.

Game birds in the county are sharp-tailed grouse, gray partridge, ring-necked pheasant, and sage grouse. The sharp-tailed grouse and gray partridge are most commonly found in the Dast-Blanchard, Lambert, and Shambo-Lambert associations on the rolling uplands; in the Farnuf and Turner-Beaverton associations on the high benches; and in the Vida-Williams association on uplands that have been glaciated. The ring-necked pheasant inhabits the brushy range and other brushy areas, such as fence rows in cropland in the Cherry and Trembles-Havrelon associations in the stream valleys. Sage grouse are found mainly in large areas of range on the Lambert and Shambo-Lambert associations in the southwestern part of the county.

Migratory waterfowl are found along the Yellowstone River, mainly during migrations in spring and fall. Along the river the Canada goose and several species of duck are the most common. Some mallards, bluewing teal, and pintails nest along the river and around some farm ponds in other parts of the county.

Many songbirds have been recorded in the county. Some migrate through in spring and fall, but many others nest

[3] Louis M. Moos, formerly biologist, Soil Conservation Service, Bozeman, Montana, helped prepare this section.

and raise their young here. The most common of those that nest in the county are meadowlarks, mourning doves, robins, and numerous sparrows.

Predators found in the county are hawks, owls, raccoons, skunks, red fox, badgers, and a few coyotes. These animals help to control the rodent population.

Furbearers, other than predators, are mainly jackrabbits and cottontail rabbits. A few beavers and muskrats live along the streams and around some farm ponds.

Fish species native to the Yellowstone River are catfish, sauger, paddlefish, and goldeye. Some farm ponds have been stocked with largemouth bass, bluegill, and rainbow trout. A few large ponds are stocked with northern pike. Where the water level can be maintained at depths of at least 10 feet, trout are the most desirable and easiest to manage. Satisfactory sites for ponds are in most areas of the Absher, Cherry, Dimyaw, Marias, Regent, and Vanda soils.

Wildlife populations can be increased by managing range to produce more of the woody plants used as forage by game animals. This generally can be accomplished by proper grazing use and rotation-deferred grazing, which are also effective in managing range for domestic livestock. Wildlife habitat can also be improved by planting in windbreaks or shelterbelts such food-producing shrubs as caragana, chokecherry, plum, buffaloberry, Russian-olive, and Siberian crabapple.

## Use of the Soils for Windbreaks [4]

Windbreaks are narrow belts of trees and shrubs used mainly to shelter farmsteads and feedlots from wind and snow. A good windbreak, in addition to providing protection, also makes a homesite more attractive and furnishes food and cover for birds and other wildlife. Other benefits are the reduction of noise from roads and railroads and the screening of unsightly areas. Most windbreaks in Dawson County consist of a 5- to 7-row belt on the windward side of farmsteads and feedlots and single-row plantings across fields to control soil blowing.

Windbreaks should be planted in rows at right angles to the prevailing wind and as nearly as possible on the contour. If plantings are in a sloping area where there is an erosion hazard, special measures, such as diversion terraces and cross drains, are needed to control runoff. Before they are planted, these sites should be kept fallow so that weeds and grass can be eliminated and a suitable seedbed can be prepared. On dryfarmed sites continuous cultivation between the rows and along the outside rows is needed as long as the windbreak survives. Weeds within the rows generally are controlled by the use of preemergence herbicides. Grazing livestock are injurious to trees of any age, and they must be excluded. Tree rows should be at least 100 feet from buildings, feedlots, and roads to control the formation of snowdrifts.

A variety of plant species is used in windbreaks in the county. Garagana, Nanking cherry, sandcherry, American plum, and buffaloberry are the most commonly used shrubs. Honeysuckle, lilac, and skunkbush sumac are less commonly used. Chokecherry is a native shrub that could be used. Russian-olive and Siberian crabapple are better adapted than other low trees. Siberian elm is the most commonly used tall tree in dryfarmed plantings. Cottonwood, golden willow, and white willow are tall trees that are well suited to irrigated sites and to areas that receive extra moisture from runoff. Ponderosa pine, Colorado blue spruce, and Rocky Mountain juniper are used in some windbreaks.

All the soils that are suitable for crops are also suitable as sites for windbreaks. Of these, the well-drained Farnuf, Savage, Shambo, Tally, Turner, Vida, and Williams soils are the most suitable. These soils have a friable, dark grayish-brown surface layer.

Blanchard and Dast soils are light-colored fine sandy loams and loamy fine sands. They are suited to dryfarmed plantings, but these soils are less fertile and can be expected to produce slower growth.

Cherry, Havrelon, Lohler, and Trembles soils are deep, light-colored loams, silty clay loams, and fine sandy loams on stream terraces. They receive runoff and support native stands of cottonwood, willow, and green ash. Cottonwood and willow grow well in plantings on these soils. Many plantings are irrigated.

Marias silty clay and Regent silty clay loam are less permeable than the previously mentioned soils, and trees should be planted at the maximum spacing.

Beaverton soils have a surface layer of gravelly loam and a subsoil of clay loam. They are shallow to underlying beds of clean sand and gravel. The water-holding capacity is low, and growth is slow. Plants that have high moisture requirements do not grow well on these soils unless they can be irrigated.

Lambert soils, which are on uplands, are light-colored, strongly calcareous silt loams underlain by soft sedimentary beds. The growth of trees and shrubs planted on these soils is much slower than that of trees and shrubs planted on the dark-colored, nonlimy soils.

Absher, Benz, and Vanda soils are the least desirable soils in the county for tree plantings because of their strong alkalinity and strong salinity. If windbreaks are planted, alkali- and salt-tolerant species, such as Russian-olive, Rocky Mountain juniper, and buffaloberry, should be used.

## Engineering Uses of the Soils [5]

This section describes the properties of the soils that are important to engineering. Soils are natural materials that differ greatly in properties from one location to the next and even within the same area. Soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, foundations, structures for controlling erosion, facilities for storing and transporting water, systems for draining and irrigating soils, and septic tank absorption fields. Among the properties most important to the engineer are permeability, shear strength, compaction characteristics, shrink-swell characteristics, soil drainage, grain size, plasticity, and soil reaction or pH. Topography and the depth to a water table, bedrock, or sand and gravel are also important.

This survey contains information about the soils of

[4] GEORGE GABLE, woodland conservationist, Bozeman, Montana, helped prepare this section.

[5] CARROLL A. HACKBART, civil engineer, Soil Conservation Service, helped prepare this section.

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Dawson County that will be helpful to engineers. Special emphasis has been placed on the engineering properties that affect agriculture, particularly those that affect irrigation, farm ponds, and structures to control and conserve soil and water. The information in this survey can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Make preliminary estimates of the engineering properties of soils for use in planning agricultural drainage systems, farm ponds, irrigation systems, terraces and diversions, waterways, and other structures for conserving soil and water.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning detailed surveys of the soils at selected locations.
4. Locate probable sources of sand and other material for use in construction.
5. Correlate performance of engineering structures with the soil mapping units and thus develop information that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soils for movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps, reports, and aerial photographs for the purpose of making reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Used with the soil map to identify the soils, the engineering interpretations in this section are useful for many purposes. It should be emphasized, however, that these interpretations do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or where the excavations are deeper than the depth of layers reported. Even in such situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that can be expected.

Most of the information about engineering is given in tables 3 and 4. Additional information of value in planning engineering work is given in the sections "Descriptions of the Soils" and "Use of the Soils for Town and Country Planning."

Some of the terms used by soil scientists may be unfamiliar to the engineer, and some words, for example, soil, clay, silt, and sand, have special meanings in soil science. These and other special terms used are defined in the Glossary at the back of this survey.

### *Engineering classification systems*

Agricultural scientists of the United States Department of Agriculture classify soils according to texture. In some ways this system of naming textural classes is comparable to the two systems used by engineers for classifying soils; that is, the system of the American Association of State Highway Officials (AASHO) and the Unified system.

Most highway engineers classify soils in accordance with the classification developed by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven main groups. The groups range from A–1 (gravelly soils of high-bearing capacity, the best soils for subgrade) to A–7 (clay soils having low strength when wet, the poorest soils for subgrade).

Engineers engaged in the design and construction of structures in which soil is used as building or foundation material use the Unified soil classification system (*7*). In this system soil materials are identified as coarse grained, eight classes; fine grained, six classes; and highly organic. Some soil materials have characteristics that are borderline between the major classes, such as ML–CL or SW–SM.

### *Estimated soil properties*

Table 3 lists the soils and land types of Dawson County and the map symbols for each mapping unit and gives the USDA texture, the Unified classification, and the AASHO classification. In addition, estimates of the grain-size distribution, permeability, available water capacity, reaction, and shrink-swell potential are given. It also gives estimates of frost-action potential and corrosivity on untreated steel pipe and concrete. The estimates are based partly on laboratory data of the same or like soils in adjacent areas, on examinations made in the field, and partly on experience with soils in the county or with similar soils from adjoining counties. The estimates are based on more than one sample, and some variation from the recorded values can therefore be expected. More information on the range of properties of the soils can be obtained from the section "Descriptions of the Soils."

The depth from the surface shown in table 3 generally is the depth given for horizons of the profiles described in the section "Descriptions of the Soils."

Soils in Dawson County are so deep to the water table that the water table does not affect their use.

Most soils in the county are so deep over bedrock that bedrock generally does not affect their use. Soft sandstone is at a depth of 20 to 40 inches in the Dast soils, soft clay shale is at a depth of 20 to 40 inches in the Regent soils, and shale is present in the Norbert soils.

Permeability is the quality of the soil that enables water or air to move through it. Accepted as a measure of this quality is the rate at which soil transmits water while saturated, mainly downward. It is expressed in inches per hour.

The available water capacity, expressed in inches per inch of soil, is the capacity of a soil to hold water in a form available to plants. Commonly it is defined as the difference between the amount of soil water at field capacity and the amount at wilting point.

Reaction gives the degree of acidity or alkalinity of a soil, expressed in pH value. A pH value of 7.0 is neutral. A lower value indicates acidity, and a higher value indicates alkalinity.

The ratings for shrink-swell potential indicate the volume change resulting from the shrinking of a soil as it dries and the swelling of a soil as it takes up moisture. It is estimated on the basis of the amount and type of clay in the soil layers. In general, soils classified as A–7 and CH have a high shrink-swell potential. Clean sands and gravels and those having a small amount of nonplastic to slightly plastic fines have a low shrink-swell potential, as do most other nonplastic to slightly plastic soil materials.

Frost-action potential is the possible upward or lateral movement of soil by the formation of ice lenses and the subsequent collapse upon thawing. The estimates of frost-action potential are for bare soil not covered with vegetation or snow. In bare soil the most severe frost action is likely to occur.

### *Engineering interpretations*

The estimated interpretations in table 4 are based on the engineering properties of soils shown in table 3, on test data for soils in other survey areas nearby, and on the experience of engineers and soil scientists with the soils of Dawson County. Table 4 lists those soil features not to be overlooked in planning, installation, and maintenance of agricultural drainage, irrigation, ponds and reservoirs, embankments, and terraces and diversions.

Some of the column heads in table 4 are explained in the following paragraphs.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; by natural fertility of the material, or the response of plants when fertilizer is applied; and by absence of substances toxic to plants. The texture of the soil material and the content of stone fragments in the soil are characteristics that affect suitability, but damage that results in an area from which topsoil is taken is also considered.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 4 provide guidance about where to look for probable sources. A soil rated as a probable source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect the mining of the materials. Neither do they indicate the quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Pond embankments are raised structures of soil material constructed across drainageways in order to impound water. These embankments generally are less than 20 feet high, constructed of "homogeneous" soil material, and compacted to medium density. Embankments that have core and shell type construction are not rated in table 4. Embankment foundation, reservoir area, and slope are assumed to be suitable for pond construction. Soil properties are considered that affect the embankment and the availability of borrow material. The best soils have good slope stability, low permeability, slight compressibility under load, and good resistance to piping and erosion. The best borrow material is free of stones or rocks and thick enough for easy excavation.

## Use of the Soils for Town and Country Planning

This section was prepared chiefly for planners, developers, landscape architects, builders, zoning officials, realtors, landowners, and others interested in the use of the soils for purposes other than farming. Included among the uses of soils are building sites and residences, septic tank absorption fields, sewage lagoons, sanitary landfills, shallow excavations, lawns and landscaping, campsites, intensive play areas, picnic areas, paths and trails, and trafficways.

The main factors considered in the use of soils in Dawson County for these purposes are the hazard of flooding, depth to a water table, depth to hard rock, slope, drainage and permeability, and texture of the soil as it affects trafficability, shrink-swell potential, and load-bearing capacity. Some properties that severely limit the use of a soil for one purpose may make it most desirable for another purpose.

In table 5 the soils are rated as having *slight*, *moderate*, or *severe* limitations, and the major factor or factors that influenced the moderate and severe ratings are listed. Major factors are not given for those soils having slight limitation. Soils rated as having slight limitations may be used for the stated purpose as they occur naturally. A severe rating does not mean that a soil cannot be used for the specific purpose but indicates that the limitation exists and that perhaps alternative uses should be considered or that a more suitable site should be chosen.

Dwellings, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. For this, the soil material at a depth between 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, or compacted soil material. It is assumed that the embankment is compacted to medium density and that the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope, and if the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification, and

TABLE 3.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table.

| Soil series and map symbols | Depth from surface | Classification | | | Percentage larger than 3 inches in diameter discarded in sampling |
|---|---|---|---|---|---|
| | | USDA texture | Unified | AASHO | |
| | *Inches* | | | | |
| Absher: Ab | 0–26 | Silty clay | CL or CH | A–6 or A–7 | 0 |
| | 26–60 | Silty clay loam | CL | A–6 | 0 |
| Badland: Ba. No estimates made because properties are too variable. Onsite investigation needed. | | | | | |
| Banks: Bk | 0–60 | Stratified loamy fine sand and fine sand. | SM | A–2 | 0 |
| Beaverton: Bm | 0–17 | Clay loam and gravelly clay loam. | GC or CL | A–6 | 0 |
| | 17–60 | Very gravelly loamy sand | GW | A–1 | 0 |
| *Benz: Bn, Bt | 0–50 | Clay loam | CL | A–6 | 0 |
| For Trembles part of Bt, see Trembles series. | 50–60 | Fine sand | SM | A–2 | 0 |
| *Blanchard: By | 0–60 | Loamy fine sand | SM | A–2 | 0 |
| For Dimyaw part of this unit, see Dimyaw series. | | | | | |
| *Cherry: Cc, Cd, Ce, Cm, Ct | 0–60 | Silty clay loam | CL | A–6 or A–7 | 0 |
| For Lambert part of Cm, see Lambert series; for Havrelon and Trembles parts of Ct, see Havrelon and Trembles series. | | | | | |
| *Dast: Da, Db, Dc | 0–31 | Fine sandy loam | SM | A–4 | 0 |
| For Blanchard part of Db and Dc, see Blanchard series. | 31–60 | Soft sandstone. | | | |
| Dimyaw: Dm | 0–60 | Silty clay | CL or CH | A–6 or A–7 | 0 |
| *Farnuf: Fa, Fb, Ff, Fh | 0–32 | Loam, clay loam, or silty clay loam. | ML or CL | A–4 or A–6 | 0 |
| For Shambo part of Ff and Fh, see Shambo series. | 32–60 | Loam or gravelly loam | GM | A–2 | 0 |
| Havrelon: Ha, Hb | 0–60 | Silt loam | ML | A–4 | 0 |
| *Lambert: La, Lb, Lc, Ld, Le, Lm, Lr | 0–60 | Silt loam | ML | A–4 | 0 |
| For Blanchard part of Le, see Blanchard series; for Dimyaw part of Lm, see Dimyaw series; for Ringling part of Lr, see Ringling series. | | | | | |
| Lihen: Ls | 0–60 | Loamy sand | SM | A–2 | 0 |
| Lohler: Lt | 0–60 | Silty clay loam | CL or CH | A–6 or A–7 | 0 |
| Marias: Ma, Mb, Mc | 0–60 | Silty clay | CH | A–7 | 0 |

See footnotes at end of table.

*significant in engineering*

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for
The symbol > means more than; the symbol < means less than]

| Percentage passing sieve [1]— | | | | Permeability | Available water capacity | Reaction | Shrink-swell potential | Frost-action potential | Corrosivity | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 40 (0.42 mm.) | No. 200 (0.074 mm.) | | | | | | Untreated steel | Concrete |
| | | | | *Inches per hour* | *Inches per inch of soil* | *pH* | | | | |
| 100 | 100 | 100 | 90–95 | <0. 06 | 0. 16–0. 18 | 7. 0–9. 6 | High | Moderate | High | High. |
| 100 | 100 | 95–100 | 90–95 | <0. 06 | 0. 16–0. 18 | 8. 5–9. 6 | Moderate | High | High | High. |
| 90–100 | 85–90 | 75–90 | 25–35 | 6. 3–20. 0 | 0. 08–0. 12 | 7. 4–8. 4 | Low | Moderate | Moderate | Low. |
| 65–85 | 50–80 | 45–75 | 35–60 | 0. 6–2. 0 | 0. 12–0. 15 | 7. 0–8. 4 | Moderate | Moderate | High | Low. |
| 30–50 | 20–45 | 10–25 | 0–5 | >20. 0 | 0. 01–0. 03 | 7. 4–8. 4 | Low | Low | Moderate to low. | Low. |
| 100 | 100 | 100 | 70–8 | 0. 06–0. 2 | 0. 16–0. 18 | 8. 5–9. 6 | Moderate | Moderate | High | Low. |
| 100 | 100 | 65–80 | 15–35 | 6. 3–20. 0 | 0. 04–0. 08 | 8. 5–9. 6 | Low | Moderate | High | Low. |
| 100 | 100 | 75–90 | 25–30 | 6. 3–20. 0 | 0. 08–0. 12 | 6. 6–7. 8 | Low | Moderate | Low | Low. |
| 100 | 100 | 95–100 | 85–95 | 0. 2–0. 6 | 0. 18–0. 20 | 7. 9–8. 4 | Moderate | High | High | Low. |
| 100 | 100 | 70–85 | 35–50 | 2. 0–6. 3 | 0. 12–0. 16 | 7. 9–8. 4 | Low | High | Moderate | Low. |
| 100 | 100 | 95–100 | 85–95 | 0. 06–0. 2 | 0. 16–0. 20 | 7. 8–8. 4 | High | Moderate | High | Low. |
| 100 | 100 | 85–100 | 60–80 | 0. 6–2. 0 | 0. 16–0. 20 | 7. 0–8. 4 | Low | High | Moderate | Low. |
| 45–55 | 40–50 | 35–45 | 25–35 | 0. 6–2. 0 | 0. 12–0. 18 | 7. 9–8. 4 | Low | Moderate | High | Low. |
| 100 | 100 | 90–100 | 70–85 | 0. 6–2. 0 | 0. 16–0. 20 | 7. 9–8. 4 | Low | High | Moderate to high. | Low. |
| 100 | 100 | 90–100 | 75–90 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 9–8. 4 | Moderate | High | Moderate to high. | Low. |
| 100 | 100 | 50–75 | 15–30 | 6. 3–20. 0 | 0. 08–0. 12 | 7. 0–7. 8 | Low | Low | Moderate | Low. |
| 100 | 100 | 95–100 | 85–95 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 9–8. 4 | High | Moderate | High | Low. |
| 100 | 100 | 95–100 | 90–95 | 0. 06–0. 2 | 0. 18–0. 20 | 7. 9–9. 6 | High | Moderate | High | Moderate. |

TABLE 3.—*Estimated soil properties*

| Soil series and map symbols | Depth from surface | Classification | | | Percentage larger than 3 inches in diameter discarded in sampling |
|---|---|---|---|---|---|
| | | USDA texture | Unified | AASHO | |
| | *Inches* | | | | |
| Norbert: No | 0–13<br>13–60 | Clay<br>Shale (claystone). | CH | A–7 | 0 |
| *Regent: Rc, Rd, Re, Rg<br>For Dimyaw part of Re and Rg, see Dimyaw series. | 0–37<br>37–60 | Silty clay<br>Soft clay shale. | CL or CH | A–6 or A–7 | 0 |
| Ringling<br>Mapped only in a complex with Lambert soils. | 0–11<br>11–60 | Gravelly loam<br>Cobblestones and gravel | GM<br>GW | A–4<br>A–1 | 0<br>60–80 |
| Riverwash: Rw | 0–60 | Variable sands and gravel | GP or SP or SP–SM | A–1 | 0–20 |
| Saline land: Sa [2] | 0–60 | Thinly stratified loam, fine sandy loam, silt loam, and silty clay loam. | ML–CL or ML | A–4 or A–6 | 0 |
| Savage: Sc, Sd | 0–60 | Silty clay loam | CL or CH | A–6 or A–7 | 0 |
| *Shambo: Se, Sf, Sg, Sh, Sm<br>For Lambert part of Sh and Sm, see Lambert series. | 0–60 | Loam | ML–CL or ML | A–4 | 0 |
| Tally: Ta, Tb, Tc | 0–60 | Fine sandy loam | SM | A–4 | 0 |
| Terrace escarpments: Te.<br>No estimates made because properties are too variable. Onsite investigation needed. | | | | | |
| *Tinsley: Tg, Tm<br>For Lambert part of Tg, see Lambert series. | 0–60 | Very gravelly sand | GW | A–1 | 0–20 |
| Trembles: Tn, To | 0–60 | Fine sandy loam | SM | A–4 | 0 |
| *Turner: Tr, Ts, Tt, Tu, Tv, Tw, Ty<br>For Beaverton part of Tv, Tw, and Ty, see Beaverton series. | 0–28<br>28–60 | Loam or clay loam<br>Stratified sand and gravel | ML or CL<br>SW or GW | A–4 or A–6<br>A–1 | 0<br>10–20 |
| Vanda: Va | 0–36<br>36–60 | Clay<br>Silty clay loam | CH<br>CL | A–7<br>A–6 | 0<br>0 |
| *Vida: Vc, Vd, Vh, Vk<br>For Zahill part of Vh and Vk, see Zahill series. | 0–60 | Clay loam | CL or ML | A–4 or A–6 | 5–10 |
| *Williams: Wm, Wn, Wv<br>For Vida part of Wn and Wv, see Vida series. | 0–60 | Clay loam | CL | A–6 | 0–10 |
| *Zahill: Zh, Zm<br>For Lambert part of Zm, see Lambert series. | 0–60 | Clay loam | CL | A–6 | 5–10 |

[1] Data estimated for modal soil by using USDA textural chart.

*significant in engineering*—Continued

| Percentage passing sieve [1]— | | | | Permeability | Available water capacity | Reaction | Shrink-swell potential | Frost-action potential | Corrosivity | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 40 (0.42 mm.) | No. 200 (0.074 mm.) | | | | | | Untreated steel | Concrete |
| | | | | *Inches per hour* | *Inches per inch of soil* | *pH* | | | | |
| 100 | 100 | 100 | 95–100 | 0. 06–0. 2 | 0. 18–0. 20 | 7. 4–8. 4 | High | Moderate | High | Moderate. |
| 100 | 100 | 95–100 | 85–95 | 0. 06–0. 2 | 0. 16–0. 20 | 7. 9–8. 4 | High | Moderate | High | Low. |
| 60–70 | 50–70 | 50–60 | 35–50 | 0. 6–2. 0 | 0. 12–0. 16 | 7. 9–8. 4 | Low | Moderate | Moderate | Low. |
| 20–40 | 10–15 | 5–10 | 0–5 | >20. 0 | 0. 01–0. 02 | 7. 9–8. 4 | Low | Low | Low | Low. |
| 20–80 | 10–70 | 5–40 | 0–15 | 6. 3–20. 0 | 0. 02–0. 08 | 7. 0–8. 4 | Low | Low | High | Low. |
| 100 | 100 | 90–100 | 60–80 | 0. 63–2. 0 | 0. 16–0. 20 | | Low | High | Very high | High. |
| 100 | 100 | 95–100 | 85–95 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 4–8. 4 | Moderate | Moderate | High | Low. |
| 100 | 100 | 85–95 | 60–75 | 0. 6–2. 0 | 0. 16–0. 20 | 7. 4–8. 4 | Low | High | High | Low. |
| 100 | 100 | 70–85 | 35–50 | 2. 0–6. 0 | 0. 12–0. 16 | 7. 0–8. 4 | Low | Moderate | Moderate | Low. |
| 35–50 | 25–50 | 15–35 | 0–5 | >20. 0 | <0. 03 | 7. 4–8. 4 | Low | Low | Moderate | Low. |
| 100 | 100 | 70–85 | 35–50 | 2. 0–6. 3 | 0. 12–0. 16 | 7. 9–8. 4 | Low | Moderate | Moderate | Low. |
| 90–95 | 85–90 | 80–90 | 50–70 | 0. 6–2. 0 | 0. 16–0. 20 | 7. 4–8. 4 | Low | High | High | Low. |
| 35–50 | 25–50 | 12–35 | <5 | 6. 3–20. 0 | <0. 03 | 7. 4–8. 4 | Low | Low | Moderate | Low. |
| 100 | 100 | 100 | 90–95 | <0. 06 | 0. 10–0. 13 | 8. 0–9. 6 | High | Moderate | High | High. |
| 100 | 100 | 95–100 | 90–95 | <0. 06 | 0. 07–0. 10 | 8. 5–9. 6 | Moderate | High | High | High. |
| 75–85 | 70–80 | 70–80 | 65–75 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 4–9. 0 | Moderate | High | High | Low. |
| 85–100 | 80–95 | 70–80 | 65–75 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 4–9. 0 | Moderate | High | High | Low. |
| 75–85 | 70–80 | 65–75 | 50–60 | 0. 2–0. 6 | 0. 16–0. 20 | 7. 4–9. 0 | Moderate | High | High | Low. |

[2] Saline land has a water table within 5 feet of the surface most of the time and at or near the surface during most of the growing season. Salt content is greater than 30 millimhos per cm.[2] at 25° C. at the surface and decreases below the water table.

TABLE 4.—*Engineering interpretations*

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

| Soil series and map symbols | Suitability as a source of— | | |
|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill |
| Absher: Ab | Poor: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| Badland: Ba. No estimates made because properties are too variable. Onsite investigation needed. | | | |
| Banks: Bk | Poor: sandy | Poor for sand; excessive fines; no gravel. | Fair: moderate frost-action potential. |
| Beaverton: Bm | Fair in surface layer | Good for gravel and sand below a depth of 10 to 20 inches. | Good: well-graded sand or sand and gravel below a depth of 10 to 20 inches. |
| *Benz: Bn, Bt. For Trembles part of Bt, see Trembles series. | Poor: strongly alkaline to very strongly alkaline. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| *Blanchard: By. For Dimyaw part of this unit, see Dimyaw series. | Poor: sandy; susceptible to soil blowing. | Poor for sand; excessive fines; no gravel. | Fair: moderate frost-action potential. Poor where slopes are greater than 25 percent. |
| *Cherry: Cc, Cd, Ce, Cm, Ct. For Lambert part of Cm, see Lambert series; for Havrelon and Trembles parts of Ct, see Havrelon and Trembles series. | Good. Poor where slopes are greater than 8 percent. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| *Dast: Da, Db, Dc. For Blanchard part of Db and Dc, see Blanchard series. | Good: susceptible to soil blowing in places. Fair where slopes are 8 to 15 percent. Poor where slopes are greater than 15 percent. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| Dimyaw: Dm | Poor: too clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| *Farnuf: Fa, Fb, Ff, Fh. For Shambo part of Ff and Fh, see Shambo series. | Good to a depth of 6 to 10 inches; fair to poor below. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| Havrelon: Ha, Hb | Good | Not suitable: excessive fines. | Poor: high frost-action potential. |

*of soils*

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

| Soil features affecting— | | | | |
|---|---|---|---|---|
| Farm ponds | | Agricultural drainage | Irrigation | Terraces, waterways, and diversions |
| Reservoir area | Embankment | | | |
| Very slow permeability | High shrink-swell potential. | Very slow permeability | Very slow permeability | Strongly alkaline to very strongly alkaline in subsoil and substratum. |
| Rapid permeability | Low compressibility; medium shear strength; low resistance to piping. | Rapid permeability | Moderate available water capacity. | Susceptible to soil blowing. |
| Very rapid permeability within a depth of 20 inches. | Moderate shrink-swell potential in surface material to a depth of 10 to 20 inches, pervious material below. | Very rapid permeability below a depth of 10 to 20 inches. | Low available water capacity; slopes up to 15 percent. | Sand or sand and gravel at a depth of 10 to 20 inches. |
| Rapid permeability below a depth of 48 inches in some places. | Low shear strength; medium resistance to piping; medium compressibility. | Slow permeability to a depth of 4 feet, rapid below. | Strongly alkaline to very strongly alkaline; slow permeability; slopes up to 15 percent. | Strongly alkaline to very strongly alkaline. |
| Rapid permeability; slopes of 8 to 80 percent. | Low resistance to piping; medium shear strength; low compressibility. | Somewhat excessively drained; slopes of 8 to 80 percent. | Slopes of 8 to 80 percent. | Slopes of 8 to 80 percent. |
| Moderately slow permeability; slopes of 0 to 25 percent. | Low shear strength; moderate shrink-swell potential; medium compressibility. | Moderately slow permeability. | High available water capacity; slopes up to 25 percent. | Uniform slopes up to 25 percent. |
| Moderately rapid permeability; soft sandstone at a depth of 20 to 40 inches; slopes of 2 to 25 percent. | Low resistance to piping; medium compressibility; medium shear strength. | Soft sandstone at a depth of 20 to 40 inches. | Low available water capacity; slopes of 2 to 25 percent. | Soft sandstone at a depth of 20 to 40 inches. |
| Slopes of 8 to 80 percent. | High shrink-swell potential. | Slopes of 8 to 80 percent; slow permeability. | Slopes of 8 to 80 percent; slow permeability. | High erosion hazard. |
| Moderate permeability; sand and gravel below a depth of 40 inches in places. | Low to medium resistance to piping; medium compressibility; medium shear strength. | Well drained; moderate permeability. | High available water capacity; slopes up to 8 percent. | Uniform slopes of 0 to 8 percent. |
| Moderate permeability. | Low resistance to piping; low shear strength; medium compressibility. | Well drained; moderate permeability. | High available water capacity; slopes up to 4 percent. | Uniform slopes of 0 to 4 percent. |

TABLE 4.—*Engineering interpretations*

| Soil series and map symbols | Suitability as a source of— | | |
|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill |
| *Lambert: La, Lb, Lc, Ld, Le, Lm, Lr<br>For Badland part of Ld, for Blanchard part of Le, for Dimyaw part of Lm, and for Ringling part of Lr, see those series. | Good where slopes are 0 to 8 percent.<br>Fair where slopes are 8 to 15 percent; gravelly loam phase.<br>Poor where slopes are greater than 15 percent. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| Lihen: Ls | Poor: sandy; susceptible to soil blowing. | Poor for sand; excessive fines; no gravel. | Good |
| Lohler: Lt | Fair: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| Marias: Ma, Mb, Mc | Poor: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| Norbert: No | Poor: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential; shale at a depth of 10 to 20 inches. |
| *Regent: Rc, Rd, Re, Rg<br>For Dimyaw part of Re and Rg, see Dimyaw series. | Poor: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| Ringling<br>Mapped only in a complex with Lambert soils. | Poor: gravelly | Poor: 60 to 80 percent material greater than 3 inches in size. | Fair where slopes are 15 to 25 percent.<br>Poor where slopes are greater than 25 percent. |
| Riverwash: Rw | Poor: gravelly | Good for gravel.<br>Good to fair for sand. | Good |
| Saline land: Sa | Poor: excessive salts and alkali. | Not suitable: excessive fines. | Poor: high water table. |
| Savage: Sc, Sd | Poor: clayey | Not suitable: excessive fines. | Fair: moderate shrink-swell potential; moderate frost-action potential. |
| *Shambo: Se, Sf, Sg, Sh, Sm<br>For Lambert part of Sh and Sm, see Lambert series. | Good where slopes are less than 8 percent.<br>Fair where slopes are 8 to 15 percent. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| Tally: Ta, Tb, Tc | Good: susceptible to soil blowing in places.<br>Fair where slopes are 8 to 15 percent. | Not suitable: excessive fines. | Fair: moderate frost-action potential. |
| Terrace escarpments: Te | Not estimated because material is too variable. | Not estimated because material is too variable. | Not estimated because material is too variable. |

*of soils*—Continued

| Soil features affecting— | | | | |
|---|---|---|---|---|
| Farm ponds | | Agricultural drainage | Irrigation | Terraces, waterways, and diversions |
| Reservoir area | Embankment | | | |
| Moderately slow permeability; slopes of 2 to 65 percent. | Low resistance to piping; low shear strength; medium compressibility. | Moderately slow permeability; slopes of 2 to 65 percent. | High available water capacity; slopes of 2 to 65 percent. | Moderate to high erosion hazard; slopes of 2 to 65 percent. |
| Rapid permeability; slopes of 4 to 20 cent. | Medium resistance to piping; medium shear strength; low compressibility. | Somewhat excessively drained; rapid permeability. | Moderate available water capacity; slopes of 4 to 20 percent. | Susceptible to soil blowing. |
| Moderately slow permeability. | High shrink-swell potential; moderate frost-action potential. | Moderately slow permeability. | High available water capacity. | Uniform slopes of 0 to 2 percent. |
| Slow permeability | High shrink-swell potential; moderate frost-action potential. | Slow permeability | Slow permeability; high available water capacity. | Uniform slopes of 0 to 8 percent; slight to high erosion hazard. |
| Slow permeability | High shrink-swell potential; moderate frost-action potential. | Slow permeability; slopes of 8 to 65 percent. | Low available water capacity; slopes of 8 to 65 percent. | Slopes of 8 to 65 percent; high erosion hazard. |
| Slow permeability | High shrink-swell potential; moderate frost-action potential. | Slow permeability | Moderate available water capacity; slow permeability; slopes of 1 to 15 percent. | Uniform slopes of 0 to 15 percent; slight to high erosion hazard. |
| Very rapid permeability at a depth of 10 to 20 inches; slopes of 15 to 65 percent. | 60 to 80 percent material greater than 3 inches in size. | Very rapid permeability at a depth of 10 to 20 inches; slopes of 15 to 65 percent. | Low available water capacity; slopes of 15 to 65 percent. | Mass of cobblestones and gravel at a depth of 10 to 20 inches. |
| Severe flooding hazard | High permeability when compacted. | Severe flooding hazard | Severe flooding hazard | Execssive gravel and sand. |
| High water table | Low resistance to piping; low shear strength. | Water table at or within a few inches of surface. | Very strongly saline and alkali affected. | Very strongly saline and alkali affected. |
| Moderately slow permeability. | Moderate shrink-swell potential; moderate frost-action potential. | Moderately slow permeability. | High available water capacity; slopes of 0 to 4 percent. | Uniform slopes of 0 to 4 percent. |
| Moderate permeability; slopes of 0 to 15 percent. | High frost-action potential; low resistance to piping; low shear strength. | Well drained; moderate permeability. | High available water capacity; slopes of 0 to 15 percent. | Uniform slopes of 0 to 15 percent; slight to high erosion hazard. |
| Moderately rapid permeability; slopes of 0 to 15 percent. | Poor resistance to piping; moderate permeability when compacted. | Well drained; moderately rapid permeability. | High available water capacity; slopes of 0 to 15 percent. | Moderate to high soil blowing hazard; slight to high water erosion hazard where slopes are up to 15 percent. |
| Steep and very steep | Not estimated because material is too variable. | Not applicable | Not applicable | Not estimated because material is too variable. |

TABLE 4.—*Engineering interpretations*

| Soil series and map symbols | Suitability as a source of— | | |
|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill |
| *Tinsley: Tg, Tm<br>For Lambert part of Tg, see Lambert series. | Poor: gravelly | Good | Fair where slopes are 15 to 25 percent.<br>Poor where slopes are greater than 25 percent. |
| Trembles: Tn, To | Good: susceptible to blowing in places. | Not suitable: excessive fines. | Fair: moderate frost-action potential. |
| *Turner: Tr, Ts, Tt, Tu, Tv, Tw, Ty<br>For Beaverton part of Tv, Tw, and Ty, see Beaverton series. | Good to a depth of 14 to 20 inches; poor below. | Good: gravel and sand under 20 to 40 inches of overburden. | Fair to a depth of 20 to 40 inches; moderate frost-action potential. Good below this depth. |
| Vanda: Va | Poor: clayey | Not suitable: excessive fines. | Poor: high shrink-swell potential. |
| *Vida: Vc, Vd, Vh, Vk<br>For Zahill part of Vh and Vk, see Zahill series. | Fair: clay loam subsoil within 4 to 8 inches of surface. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| *Williams: Wm, Wn, Wv<br>For Vida part of Wn and Wv, see Vida series. | Fair: clay loam subsoil within 4 to 8 inches of surface. | Not suitable: excessive fines. | Poor: high frost-action potential. |
| *Zahill: Zh, Zm<br>For Lambert part of Zm, see Lambert series. | Poor: slopes are greater than 15 percent. | Not suitable: excessive fines. | Poor: high frost-action potential. |

TABLE 5.—*Degree and kind of*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Absher loam, 0 to 8 percent slopes | Severe: high shrink-swell potential. | Severe: very slow permeability. | Moderate: slope | Severe: shallow to clay. |
| Badland | Severe: very steep | Severe: very steep | Severe: very steep | Severe: very steep |
| Banks soils | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard;[3] moderately rapid permeability. | Severe: flooding hazard.[3] |
| Beaverton complex, 4 to 15 percent slopes | Moderate: slope | Moderate: slope | Severe: very rapid permeability; slope. | Severe: sand and gravel substratum. |

See footnotes at end of table.

*of soils*—Continued

| Soil features affecting— | | | | |
|---|---|---|---|---|
| Farm ponds | | Agricultural drainage | Irrigation | Terraces, waterways, and diversions |
| Reservoir area | Embankment | | | |
| Very rapid permeability. | High permeability when compacted. | Excessively drained; slopes of 15 to 65 percent. | Very low available water capacity; slopes of 15 to 65 percent. | Very gravelly sand at a depth of 2 to 7 inches. |
| Moderately rapid permeability. | Medium shear strength; medium compressibility; low resistance to piping. | Well drained; moderately rapid permeability. | High available water capacity; slopes of up to 4 percent. | Uniform slopes of 0 to 2 percent; fine sandy loam unit subject to high soil blowing. |
| Rapid permeability to a depth of 20 to 40 inches. | Moderate frost-action potential above a depth of 20 to 40 inches; sand and gravel below. | Well drained; rapid permeability below a depth of 20 to 40 inches. | Moderate available water capacity; slopes to 8 percent. | Stratified sand and gravel at a depth of 20 to 40 inches. |
| Very slow permeability. | High shrink-swell potential; moderate frost-action potential. | Very slow permeability | Very slow permeability; moderate available water capacity. | Strong to very strong alkalinity below 8 inches. |
| Moderately slow permeability; slopes of 1 to 15 percent. | Moderate shrink-swell potential; high frost-action potential. | Well drained; moderately slow permeability. | High available water capacity; slopes of 1 to 15 percent. | Uniform slopes of 1 to 15 percent; slight to high erosion hazard. |
| Moderately slow permeability. | Moderate shrink-swell potential; high frost-action potential. | Well drained; moderately slow permeability. | High available water capacity; slopes of 1 to 8 percent. | Uniform slopes of 1 to 8 percent; slight to moderate erosion hazard. |
| Moderately slow permeability; slopes of 8 to 65 percent. | Moderate shrink-swell potential; high frost-action potential. | Well drained; moderately slow permeability; slopes of 8 to 65 percent. | High available water capacity; slopes of 8 to 65 percent. | Slopes of 8 to 65 percent; high erosion hazard. |

*limitations for town and country planning*

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: shallow to clay. | Severe: strongly alkaline; very slow permeability. | Severe: strongly alkaline; dust potential. | Severe: strongly alkaline; dust potential. | Severe: strongly alkaline; dust potential. | Moderate: strongly alkaline; dust potential. | Severe: high shrink-swell potential. |
| Severe: very steep. | Severe: very steep. | Severe: very steep. | Severe: very steep. | Severe: very steep. | Severe: very steep. | Severe: very steep. |
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard;[3] loose sandy surface layer. | Severe: flooding hazard;[3] loose sandy surface layer. | Moderate: flooding hazard;[3] loose sandy surface layer. | Moderate: loose sandy surface layer. | Severe: flooding hazard.[3] |
| Severe: sand and gravel substratum. | Severe: slope; sand and gravel substratum. | Moderate: gravelly surface layer; slope. | Severe: slope; gravelly surface layer. | Moderate: gravelly surface layer; slope. | Moderate: clay loam surface layer. | Moderate: slope. |

TABLE 5.—*Degree and kind of limitations for*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Benz loam, 0 to 4 percent slopes | Severe: flooding hazard.[3] | Severe: flooding hazard;[3] slow permeability. | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Benz-Trembles complex, 2 to 15 percent slopes. | Moderate: slope; moderate frost-action potential; moderate shrink-swell potential. | Severe: complex; slow and moderately rapid permeability. | Severe: slope; moderately rapid permeability. | Severe: complex; slow and moderately rapid permeability. |
| Blanchard-Dimyaw complex, 8 to 80 percent slopes. | Severe: slope | Severe: slope | Severe: slope | Severe: slope |
| Cherry silty clay loam, 0 to 2 percent slopes. | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: moderately slow permeability. | Moderate: silty clay loam. |
| Cherry silty clay loam, 2 to 4 percent slopes. | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope; moderately slow permeability. | Moderate: silty clay loam. |
| Cherry silty clay loam, 4 to 8 percent slopes. | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope; moderately slow permeability. | Moderate: silty clay loam. |
| Cherry-Lambert complex, 4 to 25 percent slopes. | Severe: high frost-action potential. | Severe: slope | Severe: slope | Moderate: slope; silty clay loam. |
| Cherry, Havrelon, and Trembles soils, occasionally flooded. | Severe: flooding hazard;[3] high frost-action potential. | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Dast fine sandy loam, 2 to 8 percent slopes. | Slight | Slight | Severe: moderately rapid permeability. | Slight |
| Dast-Blanchard complex, 2 to 8 percent slopes. | Slight | Slight | Severe: moderately rapid permeability. | Moderate: loamy sand in Blanchard soil. |
| Dast-Blanchard complex, 8 to 25 percent slopes. | Severe: slope | Severe: slope | Severe: moderately rapid permeability. | Moderate: loamy sand in Blanchard soil. |
| Dimyaw silty clay loam, 8 to 25 percent slopes. | Severe: slope; high sbrink-swell potential. | Severe: slope; slow permeability. | Severe: slope | Moderate: slope; silty clay loam. |
| Farnuf loam, 0 to 4 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Farnuf loam, 4 to 8 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Farnuf-Shambo loams, 0 to 4 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Farnuf-Shambo loams, 4 to 8 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |

See footnotes at end of table.

*town and country planning*—Continued

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: flooding hazard.[3] | Severe: strongly alkaline. | Severe: flooding hazard.[3] | Severe: flooding hazard;[3] strongly alkaline; dust potential. | Severe:[3] strongly alkaline; dust potential. | Severe:[3] strongly alkaline; dust potential. | Severe: flooding hazard;[3] poor bearing capacity. |
| Severe: stratified clay loam and clay underlying horizons. | Moderate: complex slopes. | Moderate: complex slopes. | Severe: flooding hazard. | Severe: strongly alkaline in Benz soil; dust potential. | Severe: strongly alkaline in Benz soil; dust potential. | Severe: poor bearing capacity. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Moderate: slope. | Severe: slope; high shrink-swell potential in Dimyaw soils. |
| Slight | Slight | Moderate: silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: high frost-action potential. |
| Slight | Slight | Moderate: silty clay loam. | Moderate: slope; silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: high frost-action potential. |
| Slight | Slight | Moderate: silty clay loam. | Severe: slope | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: high frost action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Moderate: silty clay loam in Cherry soils. | Severe: high frost-action potential. |
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Moderate: silty clay loam in Cherry soils. | Moderate: silty clay loam in Cherry soils. | Severe: flooding hazard;[3] high frost-action potential. |
| Slight | Slight | Moderate: slope. | Severe: slope | Slight | Slight | Slight. |
| Slight | Slight | Slight | Severe: slope | Slight | Slight | Slight. |
| Moderate: slope. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. | Slight | Moderate: slope. |
| Severe: slope | Severe: slope | Severe: slope; silty clay loam. | Severe: slope | Severe: slope | Moderate: slope; silty clay loam. | Severe: high shrink-swell potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |

TABLE 5.—*Degree and kind of limitations for*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Havrelon silt loam, 0 to 2 percent slopes | Severe: flooding hazard;[3] high frost-action potential. | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Havrelon silt loam, 2 to 4 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: moderate permeability. | Slight |
| Lambert gravelly loam, 20 to 40 percent slopes. | Severe: slope; high frost-action potential. | Severe: slope; moderately slow permeability. | Severe: slope | Severe: slope |
| Lambert silt loam, 2 to 8 percent slopes | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Slight |
| Lambert silt loam, 8 to 15 percent slopes | Severe: high frost-action potential. | Severe: moderately slow permeability. | Severe: slope | Slight |
| Lambert-Badland complex | Severe: steep; high frost-action potential. | Severe: steep; moderately slow permeability. | Severe: steep | Severe: steep |
| Lambert-Blanchard complex, 15 to 65 percent slopes. | Severe: slope; high frost-action potential. | Severe: slope; moderately slow permeability. | Severe: slope | Severe: slope |
| Lambert-Dimyaw complex, 15 to 65 percent slopes. | Severe: slope; high frost-action potential. | Severe: slope; moderately slow permeability. | Severe: slope | Severe: slope |
| Lambert-Ringling complex, 15 to 65 percent slopes. | Severe: slope; shallow to bedrock in Ringling soils; high frost-action potential. | Severe: slope; shallow to bedrock in Ringling soils. | Severe: slope | Severe: slope; shallow to bedrock in Ringling soils. |
| Lihen loamy sand, 4 to 20 percent slopes | Moderate: slope | Severe: slope | Severe: slope; rapid permeability. | Severe: rapid permeability. |
| Lohler silty clay loam | Severe: flooding hazard;[3] high shrink-swell potential. | Severe: flooding hazard;[3] slow permeability. | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Marias silty clay, 0 to 2 percent slopes | Severe: high shrink-swell potential. | Severe: slow permeability. | Slight | Severe: silty clay |
| Marias silty clay, 2 to 4 percent slopes | Severe: high shrink-swell potential. | Severe: slow permeability. | Moderate: slope | Severe: silty clay |
| Marias silty clay, 4 to 8 percent slopes | Severe: high shrink-swell potential. | Severe: slow permeability. | Moderate: slope | Severe: silty clay |
| Norbert clay, 8 to 65 percent slopes | Severe: slope; high shrink-swell potential; shallow to shale. | Severe: slope; shallow to shale. | Severe: slope; shallow to shale. | Severe: clay; shallow to shale. |
| Regent silty clay loam, 1 to 4 percent slopes | Severe: high shrink-swell potential. | Severe: slow permeability. | Moderate: slope | Severe: silty clay |

See footnotes at end of table.

*town and country planning*—Continued

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Slight | Slight | Severe: flooding hazard;[3] high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope; high frost-action potential. |
| Slight | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential. |
| Moderate: slope. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. | Slight | Severe: high frost-action potential. |
| Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: high frost-action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: high frost-action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope; high frost-action potential. |
| Severe: slope; shallow to bedrock in Ringling soils. | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope; bedrock outcrops; high frost-action potential. |
| Moderate: slope. | Severe: slope | Moderate: slope; loamy sand. | Severe: slope; loamy sand surface layer. | Severe: loamy sand surface layer. | Moderate: slope; loamy sand surface layer. | Moderate: slope. |
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: flooding hazard.[3] |
| Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: high shrink-swell potential. |
| Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: high shrink-swell potential. |
| Severe: silty clay. | Slight: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: silty clay. | Severe: high shrink-swell potential. |
| Severe: slope; clay; shallow to shale. | Severe: slope; clay; shallow to shale. | Severe: slope; clay. | Severe: steep; clay. | Severe: slope; clay. | Severe: clay | Severe: slope; high shrink-swell potential. |
| Severe: silty clay. | Slight | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Severe: high shrink-swell potential. |

TABLE 5.—*Degree and kind of limitations for*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Regent silty clay loam, 4 to 8 percent slopes | Severe: high shrink-swell potential. | Severe: slow permeability. | Moderate: slope | Severe: silty clay |
| Regent-Dimyaw complex, 4 to 8 percent slopes. | Severe: high shrink-swell potential. | Severe: slow permeability. | Moderate: slope | Severe: silty clay |
| Regent-Dimyaw complex, 8 to 15 percent slopes. | Severe: high shrink-swell potential. | Severe: slow permeability. | Severe: slope | Severe: silty clay |
| Riverwash | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. |
| Saline land | Severe: high water table. | Severe: high water table. | Severe: high water table. | Severe: high water table. |
| Savage silty clay loam, 0 to 2 percent slopes | Moderate to severe: moderate shrink-swell potential. | Severe: moderately slow permeability. | Slight | Moderate: silty clay loam. |
| Savage silty clay loam, 2 to 4 percent slopes | Moderate to severe: moderate shrink-swell potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: silty clay loam. |
| Shambo loam, 0 to 2 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: moderate permeability. | Slight |
| Shambo loam, 2 to 4 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Shambo loam, 4 to 8 percent slopes | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Shambo-Lambert complex, 4 to 8 percent slopes. | Severe: high frost-action potential. | Moderate: moderate permeability. | Moderate: slope; moderate permeability. | Slight |
| Shambo-Lambert complex, 8 to 15 percent slopes. | Severe: high frost-action potential. | Moderate: slope; moderate permeability. | Severe: slope | Slight |
| Tally fine sandy loam, 0 to 4 percent slopes | Moderate: moderate frost-action potential. | Slight | Severe: moderately rapid permeability. | Severe: moderately rapid permeability. |
| Tally fine sandy loam, 4 to 8 percent slopes. | Moderate: moderate frost-action potential. | Slight | Severe: moderately rapid permeability. | Severe: moderately rapid permeability. |
| Tally fine sandy loam, 8 to 15 percent slopes. | Moderate: moderate frost-action potential. | Moderate: slope | Severe: moderately rapid permeability. | Severe: moderately rapid permeability. |
| Terrace escarpments | Severe: steep | Severe: steep | Severe: steep | Severe: steep |
| Tinsley-Lambert complex, 15 to 65 percent slopes. | Severe: slope | Severe: slope | Severe: slope | Severe: slope |
| Tinsley soils, 15 to 65 percent slopes | Severe: slope | Severe: slope | Severe: slope | Severe: slope |

See footnotes at end of table.

*town and country planning*—Continued

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: silty clay. | Slight | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Severe: high shrink-swell potential. |
| Severe: silty clay. | Slight | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Severe: high shrink-swell potential. |
| Severe: silty clay. | Moderate: slope | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Moderate: silty clay loam surface layer. | Severe: high shrink-swell potential. |
| Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. | Severe: flooding hazard. |
| Severe: high water table. | Severe: high water table; strongly saline. | Severe: high water table. | Severe: high water table. | Severe: high water table. | Severe: high water table. | Severe: high water table; high frost-action potential. |
| Slight | Slight | Moderate: silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: moderate to high frost-action potential. |
| Slight | Slight | Moderate: silty clay loam. | Moderate: slope; silty clay loam. | Moderate: silty clay loam. | Moderate: silty clay loam. | Severe: moderate to high frost-action potential. |
| Slight | Slight | Slight | Slight | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential. |
| Moderate: slope | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Slight | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential. |
| Moderate: slope | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. | Slight | Severe: high frost-action potential. |
| Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: steep | Severe: steep. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope; loose sandy surface layer. | Severe: slope. |

TABLE 5.—*Degree and kind of limitations for*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Trembles fine sandy loam | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Trembles loam | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] |
| Turner fine sandy loam, 1 to 4 percent slopes. | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner loam, 0 to 2 percent slopes | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner loam, 2 to 4 percent slopes | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner loam, 4 to 8 percent slopes | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner-Beaverton loams, 0 to 2 percent slopes. | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner-Beaverton loams, 2 to 4 percent slopes. | Slight | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |
| Turner-Beaverton loams, 4 to 8 percent slopes. | Slight | Slight [4] | Severe: sand and gravel substratum. | Severe: sand and gravel substratum. |

See footnotes at end of table.

*town and country planning*—Continued

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Slight | Slight | Severe: flooding hazard.[3] |
| Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Severe: flooding hazard.[3] | Slight | Slight | Severe: flooding hazard.[3] |
| Severe: sand and gravel substratum. | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Slight | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Slight | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |
| Severe: sand and gravel substratum. | Slight | Slight | Severe: slope | Slight | Slight | Severe: high frost-action potential to a depth of 20 to 40 inches, but slight below this depth. |

TABLE 5.—*Degree and kind of limitations for*

| Mapping unit | Building sites for residences | Septic tank absorption fields | Sewage lagoons | Sanitary landfills (trench type)[1] |
|---|---|---|---|---|
| Vanda clay, 0 to 8 percent slopes | Severe: high shrink-swell potential. | Severe: very slow permeability. | Moderate: slope | Severe: clay. |
| Vida clay loam, gently undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Vida clay loam, undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Vida-Zahill complex, undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Vida-Zahill complex, rolling | Severe: high frost-action potential. | Severe: moderately slow permeability. | Severe: slope | Moderate: clay loam. |
| Williams loam, gently undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Williams-Vida complex, gently undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Williams-Vida complex, undulating | Severe: high frost-action potential. | Severe: moderately slow permeability. | Moderate: slope | Moderate: clay loam. |
| Zahill loam, 15 to 65 percent slopes | Severe: slope; high frost-action potential. | Severe: slope | Severe: slope | Severe: slope |
| Zahill-Lambert complex, 15 to 65 percent slopes. | Severe: slope; high frost-action potential. | Severe: slope | Severe: slope | Severe: slope |

[1] For landfills deeper than 5 or 6 feet, deep onsite studies are needed of the underlying strata, the water table, the hazard of aquifer pollution, and the hazard of drainage into the ground water.

[2] Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet, and limitation ratings of *slight* or *moderate*, therefore, may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but onsite investigation is needed before a site is selected.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewer lines, telephone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or large stones, and freedom from flooding or a high water table.

Trafficways, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep. Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available.

*town and country planning*—Continued

| Shallow excavations | Lawns and landscaping | Campsites | Intensive play areas | Picnic areas | Paths and trails | Trafficways (low cost roads and streets)[2] |
|---|---|---|---|---|---|---|
| Severe: clay | Severe: clay; strongly alkaline. | Severe: clay | Severe: clay | Severe: clay | Severe: clay | Severe: high shrink-swell potential. |
| Moderate: clay loam. | Slight | Moderate: clay loam. | Moderate: clay loam; slope. | Moderate: clay loam. | Moderate: clay loam. | Severe: high frost-action potential. |
| Moderate: clay loam. | Slight | Moderate: clay loam. | Severe: slope | Moderate: clay loam. | Moderate: clay loam. | Severe: high frost-action potential. |
| Moderate: clay loam. | Slight | Moderate: clay loam. | Severe: slope | Moderate: clay loam. | Moderate: clay loam. | Severe: high frost-action potential. |
| Moderate: slope; clay loam. | Moderate: slope. | Moderate: slope; clay loam. | Severe: slope | Moderate: slope. | Moderate: clay loam. | Severe: high frost-action potential. |
| Moderate: clay loam. | Slight | Slight | Moderate: slope. | Slight | Slight | Severe: high frost-action potential. |
| Moderate: clay loam. | Slight | Moderate: clay loam in Vida soil. | Moderate: slope; clay loam in Vida soil. | Moderate: clay loam in Vida soil. | Moderate: clay loam in Vida soil. | Severe: high frost-action potential. |
| Moderate: clay loam. | Slight | Moderate: clay loam in Vida soil. | Severe: slope | Moderate: clay loam in Vida soil. | Moderate: clay loam in Vida soil. | Severe: high frost-action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope; high frost-action potential. |
| Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Moderate to severe: slope. | Severe: slope; high frost-action potential. |

[3] Subject to flooding in places, mainly as a result of ice jams.
[4] Pollution of the ground water is a hazard to the water supply in places.

The AASHO and Unified classifications of the soil material and also the shrink-swell potential indicate load-supporting capacity. Wetness and flooding affect the stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill material needed to reach an even grade.

## *Formation, Morphology, and Classification of the Soils*

This section discusses the major factors of soil formation as they relate to the formation of soils in Dawson County. It also discusses the morphology of soils and describes the system for classifying soils. Table 6 gives the classification of soil series into higher categories.

### Formation of the Soils

Soil is a natural body on the surface of the earth in which plants grow. It consists of organic and mineral material but is mostly mineral material. Soils differ in their appearance, composition, productivity, and management requirements in different places or even within short distances. The factors that cause soils to differ are (1) the physical and chemical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since its accumulation; (3) the biological forces; (4) the relief, or lay of the land; and (5) the length of time the forces of formation have acted on the soil material. The relative importance of each factor differs from place to place, but generally the interaction of all the factors determines the kind of soil that forms in a given place. The influence of each soil-forming

factor on the soils in Dawson County is described in the pages that follow.

### *Parent material*

Parent material is the weathered rock or unconsolidated material from which soils form. The hardness, grain size, and porosity of the parent material and its content of weatherable minerals greatly influence the formation of soils. The three sources of parent material in Dawson County are sedimentary beds, alluvium, and glacial till.

Making up the largest acreage are soils that formed in material weathered from the unconsolidated Tongue River Member of the Fort Union Formation. The Lambert and Shambo soils formed in material weathered from silty beds of this formation; Dimyaw and Regent soils formed in material weathered from clayey beds; and Ringling soils formed in material weathered from scoria beds. These beds of reddish baked shale and clinkers were formed by the burning of subterranean coal seams.

Blanchard and Dast soils formed mainly in materials weathered from weakly consolidated sandstone of the Fox Hills Formation. Norbert soils formed in material weathered from the gray, weakly consolidated clay shales of the Pierre Formation, which crops out along the Cedar Creek drainage basin. Absher soils formed in material weathered from the clayey, sodium-enriched Hell Creek Member of the Lance Formation or from local alluvium washed from this formation.

The Badlands in Dawson County formed on exposures of these soft sedimentary beds on eroded slopes where material washed away as rapidly as it weathered and no soil could develop.

Several soils in the county formed in alluvium. Beaverton, Farnuf, Tinsley, and Turner soils formed mainly in alluvium on high benches that are remnants of old terraces of the Yellowstone River. Lihen and Tally soils formed in alluvium, or eolian materials derived from alluvium, that mantles the uplands in a small part of the county. Banks, Benz, Havrelon, Lohler, Marias, Savage, Trembles, and Vanda soils formed in recent alluvium on the youthful terraces of the Yellowstone River, the Redwater River, and their tributaries. Banks soils formed in sandy alluvium on low terraces and flood plains. Havrelon and Trembles soils formed in loamy alluvium. Lohler, Marias, and Savage soils formed in clayey alluvium. The Benz soils that formed in loamy alluvium and the Vanda soils that formed in clayey alluvium contain significant quantities of sodium. Cherry soils are mainly on alluvial fans, and they formed in silty materials that derived locally from soft sedimentary beds.

Vida, Williams, and Zahill soils formed in glacial till. This material is clay loam in which rock fragments are distributed at random. It was deposited over the sedimentary material during the Wisconsin glaciation or an earlier glaciation.

### *Climate*

The climate in Dawson County is characterized by cold winters, warm summers, and a low annual precipitation. It is probably similar to the climate under which the soils formed.

The cold, dry climate tends to retard soil development. Temperatures are low enough much of the time to slow the rates of chemical reaction and biological activity that cause most of the weathering of minerals. The remains of plants decompose slowly. Small amounts of water from normal precipitation move into the soil to translocate carbonates. This is indicated by the shallowness of accumulated carbonates in most soils. Leaching and soil formation are interrupted by the freezing of soil to a depth of 3 feet or more for 3 or 4 months in most years.

The climate is fairly uniform throughout the county, even though precipitation is slightly higher in the northwest corner of the county than in the other parts.

### *Biological forces*

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Among the changes they cause are gains in content of organic matter and supply of nitrogen in the soil, gains or losses in supplies of plant nutrients, and changes in the structure and porosity of the soil.

The effect of plants on soil formation is generally greater than that of other living organisms. Grass is the dominant vegetation. Numerous plants make up a complex community on the native range. The vegetation also includes a variety of forbs and shrubs. Some native woodlands are in the stream valleys, and cottonwood, willow, and green ash are the main trees. Thin stands of scrub ponderosa pine and Rocky Mountain juniper are on some rather rough and broken land.

Low precipitation has limited the amount of plant material produced, but low temperatures favor the accumulation of organic matter. Most of the soils have at least a thin surface layer that has been darkened by organic matter, but some are darkened to a depth of several inches.

### *Relief*

Relief, or the shape of the landscape, has been a major factor of soil formation in Dawson County. It consists mainly of nearly level to rolling uplands and a few remnants of nearly level to undulating old stream terraces or benches that are a few hundred feet higher than the present stream valleys. Valley bottoms of the major streams, the Yellowstone River and the Redwater River, and larger tributaries range from a few hundred yards to about 3 miles in width. The various terraces in these valleys range from nearly level to sloping and are separated by obscure to prominent escarpments. These escarpments range from a few feet to a few tens of feet in height. Along the valley walls, geologic erosion has produced steep to very steep areas that range from a few hundred yards to a few miles in width. Many areas are marked by a series of slumps that give the slopes a stepped appearance. In other areas the slopes are smooth and rounded. Most areas are stabilized by a grass cover, but some are nearly barren, severely eroded badlands. Prominent areas of these badlands occur along the Yellowstone River south and east of Glendive and along the steep, broken, north and west face of the divide between the Yellowstone and Redwater drainage basins.

The relief is such that the soils in the county are well drained to excessively drained, except for a few insignificant areas on the flood plains of small streams and in a few swales on uplands.

The influence of relief on soil formation in Dawson County is best illustrated by comparing Vida, Williams,

and Zahill soils. These soils formed in glacial till in the northwestern part of the county. This material is relatively uniform in all of its visible characteristics and can be assumed to have a common origin and to have been deposited about the same time. Williams soils are mainly on the nearly level to gently undulating part of the plain. These soils have a surface layer of grayish-brown loam and a subsoil of grayish-brown clay loam, in which the carbonates are leached to a depth of about 14 inches. Vida soils are on the gently undulating to rolling part of the plain and are leached of carbonates to a depth of no more than 10 inches. Zahill soils are on crests of low ridges, on the plain, and on the steep to very steep edges of the plain. The only evidence of soil formation shown by Zahill soils is a surface layer, 2 to 4 inches thick, of dark grayish-brown loam that is still calcareous. Relief, by its influence on both runoff and erosion, has been the main factor in forming this soil.

Williams soils have the lowest relief and generally have the least runoff. As a result, the normal precipitation enters the soil and leaches carbonates to a greater depth than in the other soils. Vida soils have intermediate relief where some of the precipitation runs off, and consequently there has been only a shallow leaching of carbonates. Also, some material washed from areas of Vida soils has been deposited on Williams soils. Because Zahill soils are steeper than Vida and Williams soils, runoff is greater, there is little evidence of leaching, and there is marked evidence that soil material has been removed by erosion.

### *Time*

The effect of time on soil formation is best indicated by comparing Farnuf soils with Havrelon soils. Both soils formed in loamy alluvium. Farnuf soils are on the highest and oldest terraces in the stream valleys and on some of the high benches, which are remnants of old stream terraces. These soils have a dark grayish-brown surface layer and a subsoil that has distinct structure and is leached of carbonates to depths of 14 to 21 inches. Havrelon soils are on the lower and youngest terraces in the stream valleys and formed in recent alluvium. They have a surface layer of light brownish gray to grayish brown, lack a developed subsoil, and are calcareous throughout the profile.

## Morphology of the Soils

The characteristics produced by soil-forming processes are recorded in the soil profile, which is a vertical section of the soil through all its horizons, or layers. The horizons differ in one or more properties, such as color, texture, structure, consistence, porosity, and reaction.

Most soil profiles contain three major horizons, called A, B, and C horizons. These major horizons may be subdivided in some soil profiles.

The A horizon is the surface layer. It can be either the horizon of maximum organic-matter content, called the A1 horizon, or the horizon of maximum leaching of dissolved or suspended materials, called the A2 horizon. A plowed layer is denoted by the symbol Ap.

The B horizon lies immediately beneath the A horizon and is called the subsoil. It is a horizon of maximum accumulation of dissolved or suspended materials, such as iron or clay. The B horizon generally is firmer than the horizons immediately above and below it and commonly has a blocky or prismatic structure.

The C horizon is beneath the B horizon. This horizon, or parent material, is relatively little affected by the soil-forming processes, but it can be materially modified by weathering.

Other symbols added to the A, B, and C horizons denote special features. The symbol *ca* denotes an accumulation of carbonates, commonly of calcium. The symbol *cs* denotes an accumulation of gypsum. The suffix *t* added to B, as in B2t, indicates accumulations of translocated silicate clay.

Several processes have been involved in the formation of soil horizons in Dawson County. These processes are: (1) accumulation of organic matter, (2) leaching of calcium carbonates and more soluble salts, and (3) formation and translocation of silicate clay minerals. In most soils, more than one of these processes has been active in the development of horizons.

The accumulation of organic matter in the upper profile has been sufficient to form a darkened A1 horizon in most soils of Dawson County. Some A1 horizons are only 2 inches thick, but others are as much as 16 inches thick. The amount of accumulated organic matter varies considerably.

Leaching of carbonates has been limited in most of the soils in the county because annual precipitation is low. In some of the soils the lime has been leached from the A horizon and the upper part of the B horizon and has accumulated in distinct layers at depths ranging from about 8 to 30 inches. In only a few soils is the lime leached to depths of more than 30 inches. Many of the soils, mainly the more youthful ones, have lime throughout the soil profile and lack distinct horizons of lime accumulation.

The formation of clay by chemical weathering of clay-forming minerals and their translocation has contributed to horizon development in some of the soils. In most of these soils, translocated clays have not accumulated in large amounts. Clay films in pores and on ped faces are the most obvious evidence of a B2t horizon.

## Classification of the Soils

Classification is an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge to farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*4*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (*6*) and was adopted in 1965 (*3*). It is under continual study.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but

the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 6 shows the classification of each soil series of Dawson County by family, subgroup, and order, according to the current system.

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

Four soil orders are represented in Dawson County: Aridisols, Entisols, Inceptisols, and Mollisols. Aridisols generally are dry soils. They commonly have light-colored surface horizons and distinct subsoil horizons. Entisols are recent soils. They are without genetic horizons or have only the beginnings of such horizons. Inceptisols are soils that are found on young but not recent land surfaces. Their name is derived from the Latin word, inception, for beginning. Mollisols are soils that have a dark-colored, friable surface layer that has a high base saturation.

SUBORDERS: Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences that result from the climate or from vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Borolls (Bor, meaning cold, and oll, from Mollisol).

GREAT GROUPS: Soil suborders are separated into great groups based on the presence or absence of certain significant genetic horizons; certain significant properties of these horizons, if present; or certain significant soil properties at specified depths. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Argiboroll (Argi, meaning a clay enriched B horizon, bor, for cold, and oll, from Mollisol).

SUBGROUPS: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soils intergrade outside of the range of any other group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Argiboroll (a typical Argiboroll).

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and other properties that are used to differentiate families. An example is the fine-silty, mixed, frigid family of Typic Ustochrepts.

TABLE 6.—*Soil series classified into higher categories*

| Series | Family | Subgroup | Order |
|---|---|---|---|
| Absher | Fine, montmorillonitic | Borollic Natrargids | Aridisols. |
| Banks | Sandy, mixed, frigid | Typic Ustifluvents | Entisols. |
| Beaverton | Loamy-skeletal, mixed | Typic Argiborolls | Mollisols. |
| Benz | Fine-loamy, mixed, calcareous, frigid | Ustic Torrifluvents | Entisols. |
| Blanchard | Mixed, frigid | Typic Ustipsamments | Entisols. |
| Cherry | Fine-silty, mixed, frigid | Typic Ustochrepts | Inceptisols. |
| Dast | Coarse-loamy, mixed, calcareous, frigid | Typic Ustorthents | Entisols. |
| Dimyaw | Fine, montmorillonitic, calcareous, frigid | Typic Ustorthents | Entisols. |
| Farnuf | Fine-loamy, mixed | Typic Argiborolls | Mollisols. |
| Havrelon | Fine-loamy, mixed, calcareous, frigid | Typic Ustifluvents | Entisols. |
| Lambert | Fine-silty, mixed, calcareous, frigid | Typic Ustorthents | Entisols. |
| Lihen | Sandy, mixed | Entic Haploborolls | Mollisols. |
| Lohler | Fine, montmorillonitic, calcareous, frigid | Typic Ustifluvents | Entisols. |
| Marias | Fine, montmorillonitic, calcareous, frigid | Ustertic Torriorthents | Entisols. |
| Norbert | Clayey, montmorillonitic, calcareous, frigid, shallow | Typic Ustorthents | Entisols. |
| Regent | Fine, montmorillonitic | Typic Argiborolls | Mollisols. |
| Ringling | Fragmental, mixed | Typic Haploborolls | Mollisols. |
| Savage | Fine, montmorillonitic | Typic Argiborolls | Mollisols. |
| Shambo | Fine-loamy, mixed | Typic Haploborolls | Mollisols. |
| Tally | Coarse-loamy, mixed | Typic Haploborolls | Mollisols. |
| Tinsley | Sandy-skeletal, mixed, frigid | Typic Ustorthents | Entisols. |
| Trembles | Coarse-loamy, mixed, calcareous, frigid | Typic Ustifluvents | Entisols. |
| Turner | Fine-loamy over sandy or sandy-skeletal, mixed | Typic Argiborolls | Mollisols. |
| Vanda | Fine, montmorillonitic, calcareous, frigid | Ustic Torriorthents | Entisols. |
| Vida | Fine-loamy, mixed | Typic Argiborolls | Mollisols. |
| Williams | Fine-loamy, mixed | Typic Argiborolls | Mollisols. |
| Zahill | Fine-loamy, mixed, calcareous, frigid | Typic Ustorthents | Entisols. |

## Climate [6]

Dawson County lies within an area that has generally a continental climate. It has cold winters, warm summers, and a marked variation in seasonal precipitation. The climate throughout the county is fairly homogenous as topography is not a major influencing factor.

Data on temperature and precipitation are given in table 7. The probabilities of low temperatures in spring and fall are given in table 8.

During a normal year about 80 percent of the annual precipitation falls during the growing season of April to September. Ordinarily June is the wettest month by far, but July is next in wetness and then May. Almost all the area averages 12 to 14 inches of precipitation a year. Winter snowfall usually is not heavy and averages about 28 inches in Yellowstone Valley and slightly more in the uplands. Although the amount of annual snowfall in this county is not large compared with that in other counties of the State, heavy snowfall does occur infrequently, usually late in winter or early in spring. Precipitation in summer generally occurs as showers, but steady, gentle rains do occur in May, June, and September. Summer thundershowers are fairly frequent and occasionally produce hail heavy enough to damage crops.

The county is in one of the colder sections of the State. Some spells of severe cold can occur each winter, but they ordinarily last only a few days at a time. About once every 9 or 10 years the temperature in January or February averages below 0° F. Relatively mild winter weather is not uncommon, but the periods of mild weather do not occur so frequently during the winter in Dawson County as in the counties to the west that are nearer to the Rocky Mountains. In spring the change from wintry to warmer weather is quite rapid, and the progressive cooling of the fall is very noticeable during October and November.

Summers are characterized by warm weather that commonly lasts for weeks at a time. Sunny weather prevails 70 to 80 percent of the summer and is interrupted mostly

[6] By GRAYSON V. CORDELL, JR., climatologist for Montana, National Weather Service, Department of Commerce.

TABLE 7.—*Temperature and precipitation data*

[Glendive, elevation 2,076 feet]

| Month | Temperature | | | | Precipitation [1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average daily maximum | Average daily minimum | Average monthly maximum | Average monthly minimum | Average total | 1 year in 10 will have— | | 2 years in 10 will have— | | 3 years in 10 will have— | | 4 years in 10 will have— | |
| | | | | | | Less than— | More than— | Less than— | More than— | Less than— | More than— | Less than— | More than— |
| | °F. | °F. | °F. | °F. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| January | 27 | 4 | 48 | −22 | 0.4 | 0.2 | 0.6 | 0.2 | 0.6 | 0.3 | 0.5 | 0.3 | 0.3 |
| February | 31 | 6 | 53 | −22 | .4 | .1 | .6 | .2 | .6 | .2 | .5 | .3 | .4 |
| March | 43 | 19 | 67 | −7 | .6 | .2 | 1.0 | .4 | .8 | .5 | .8 | .7 | .7 |
| April | 60 | 33 | 81 | 16 | 1.1 | .1 | 2.3 | .3 | 2.0 | .5 | 1.6 | .8 | 1.2 |
| May | 73 | 44 | 91 | 29 | 1.6 | .2 | 2.9 | .7 | 2.3 | 1.0 | 2.2 | 1.1 | 1.8 |
| June | 80 | 53 | 96 | 41 | 3.1 | 1.6 | 5.3 | 2.0 | 3.9 | 2.3 | 3.6 | 2.8 | 3.4 |
| July | 90 | 59 | 103 | 48 | 1.6 | .6 | 3.5 | .8 | 2.4 | 1.2 | 2.0 | 1.3 | 1.9 |
| August | 89 | 56 | 102 | 43 | 1.5 | .3 | 3.2 | .4 | 2.1 | .6 | 1.8 | 1.0 | 1.6 |
| September | 77 | 44 | 95 | 29 | .9 | .1 | 2.6 | .1 | 1.8 | .2 | 1.1 | .4 | .8 |
| October | 64 | 34 | 85 | 20 | .7 | .1 | 2.1 | .1 | 1.3 | .2 | .8 | .3 | .6 |
| November | 44 | 21 | 64 | 0 | .4 | .1 | .7 | .2 | .6 | .4 | .5 | .4 | .4 |
| December | 34 | 11 | 54 | −16 | .3 | .1 | .6 | .1 | .4 | .2 | .3 | .3 | .3 |
| Year | 59 | 32 | [2] 104 | [3] −29 | 12.6 | 8.4 | 16.8 | 9.2 | 15.7 | 10.6 | 14.8 | 10.7 | 13.6 |

[Richey, elevation 2,476 feet]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 22 | 0 | 47 | −30 | .4 | .1 | .8 | .2 | .6 | .3 | .6 | .3 | .4 |
| February | 29 | 7 | 49 | −23 | .3 | .2 | .7 | .2 | .5 | .2 | .4 | .3 | .4 |
| March | 37 | 15 | 63 | −14 | .4 | .1 | .7 | .1 | .5 | .2 | .4 | .3 | .4 |
| April | 55 | 29 | 78 | 10 | 1.2 | .1 | 2.3 | .2 | 2.0 | .3 | 1.4 | .7 | 1.2 |
| May | 68 | 40 | 87 | 24 | 2.0 | .8 | 6.0 | .9 | 3.3 | 1.1 | 2.0 | 1.2 | 1.6 |
| June | 76 | 49 | 94 | 34 | 2.6 | 1.2 | 4.5 | 1.4 | 3.5 | 1.7 | 3.2 | 2.0 | 3.1 |
| July | 85 | 55 | 99 | 40 | 2.2 | .5 | 6.0 | .9 | 2.6 | 1.4 | 2.5 | 1.6 | 2.4 |
| August | 85 | 53 | 99 | 36 | 1.7 | .3 | 3.3 | .4 | 2.6 | .8 | 2.2 | 1.2 | 1.8 |
| September | 73 | 43 | 87 | 25 | 1.3 | .1 | 3.1 | .2 | 2.9 | .4 | 1.7 | .6 | 1.6 |
| October | 61 | 32 | 82 | 14 | .6 | .1 | 1.3 | .1 | .9 | .4 | .8 | .5 | .7 |
| November | 42 | 19 | 65 | −5 | .4 | .1 | 1.0 | .1 | .7 | .2 | .4 | .3 | .3 |
| December | 30 | 8 | 51 | −21 | .3 | .1 | .8 | .1 | .4 | .2 | .4 | .2 | .3 |
| Year | 55 | 29 | [2] 102 | [3] −32 | 13.4 | 8.5 | 19.8 | 10.2 | 19.3 | 11.2 | 14.7 | 12.2 | 13.9 |

[1] Data from Glendive based on records for the period 1932–1961; those from Richey based on records for the period 1948–1969.

[2] Average annual highest maximum temperature.

[3] Average annual lowest minimum temperature.

TABLE 8.—*Probabilities of low temperatures in spring and fall*

[Based on records kept at Glendive]

| Probability | Dates for given probability and temperature | | |
|---|---|---|---|
| | 24° F. or lower | 28° F. or lower | 32° F. or lower |
| Spring: | | | |
| 1 year in 10 later than | May 6 | May 15 | May 25 |
| 2 years in 10 later than | May 1 | May 10 | May 20 |
| 5 years in 10 later than | April 21 | April 30 | May 10 |
| Fall: | | | |
| 1 year in 10 earlier than | October 1 | September 19 | September 12 |
| 2 years in 10 earlier than | October 6 | September 24 | September 17 |
| 5 years in 10 earlier than | October 16 | October 4 | September 27 |

during the afternoons by occasional showers and thundershowers. Some hot weather does occur almost every year, but hot spells seldom last more than a few days. Temperatures can reach highs of 90° or more during any month from May to September, and on about half of the afternoons in July and August temperatures will reach 90° or higher.

Because the winters are cold and summers are warm, the length of the growing season is important, particularly to the growth of vegetation and the harvesting of crops. The average length of the growing season, or the period between the last temperature of 32° in spring and the first in fall, ranges from about 110 days in the uplands to more than 130 days in Yellowstone Valley. The average period between the last temperature of 28° in spring and the first in fall is as much as 150 days in Yellowstone Valley. As shown in table 8, for 1 year in 10, the last temperature of 32° or lower in spring can be expected about May 25 or later and the first in fall can be expected about September 12 or earlier.

Local flash flooding caused by sudden heavy thunderstorms occurs somewhere in the county about every 2 or 3 years. A more general type of flooding develops after a cold spell late in winter. It is caused by ice jams that occur when thawing begins upstream but freezing continues downstream. These ice jams tend to remain localized and to recur at bridges, in shallows, and in other places where ice can become lodged and begin to pile up.

Winds of sufficient speeds to cause some soil blowing occur almost every month. In spring, usually the windiest time of year, winds average more than 20 miles per hour about 15 percent of the time. Windspeeds of 50 miles per hour or more occasionally occur as a weather system crosses the State during fall and winter and during thunderstorms in summer. The strongest winds usually come from a westerly direction.

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## Glossary

**Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is poor from this cause.

**Available water capacity (also termed available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

**Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium 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.

**Clay film.** A thin coating of clay on the surface of a soil aggregate. Synonym: clay coating.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

*Cemented.*—Hard and brittle; little affected by moistening.

**Contour farming.** Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

**Drainage class** (natural). Drainage that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

*Excessively drained* soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

*Somewhat excessively drained* soils are also very permeable and are free from mottling throughout their profile.

*Well-drained* soils are nearly free from mottling and are commonly of intermediate texture.

*Moderately well drained* soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizons and have mottling in the lower part of the B horizon and in the C horizon.

*Somewhat poorly drained* soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

*Poorly drained* soils are wet for long periods; they are light gray and generally mottled from the surface downward, but some have few or no mottles.

*Very poorly drained* soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

**Fallow.** Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residue, and to encourage the storage of moisture for the succeeding grain crop.

**Fertility, soil.** The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

*O horizon.*—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

*A horizon.*—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

*R layer.*—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are—

*Border.*—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

*Basin.*—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

*Controlled flooding.*—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

*Corrugation.*—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards to confine the flow of water to one direction.

*Furrow.*—Water is applied in small ditches made by cultivation implements used for tree and row crops.

*Sprinkler.*—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

*Subirrigation.*—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

*Wild-flooding.*—Irrigation water, released at high points, flows onto the field without controlled distribution.

**Mottling, soil.** Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

**Munsell notation.** A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

**Parent material.** Disintegrated and partly weathered rock from which soil has formed.

**Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

**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. In words, the degrees of acidity or alkalinity are expressed thus:

| | *pH* | | *pH* |
|---|---|---|---|
| Extremely acid | Below 4.5 | Mildly alkaline | 7.4 to 7.8 |
| Very strongly acid | 4.5 to 5.0 | Moderately alkaline | 7.9 to 8.4 |
| Strongly acid | 5.1 to 5.5 | Strongly alkaline | 8.5 to 9.0 |
| Medium acid | 5.6 to 6.0 | Very strongly alkaline | 9.1 and higher |
| Slightly acid | 6.1 to 6.5 | | |
| Neutral | 6.6 to 7.3 | | |

**Saline soil.** A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

**Sand.** As a soil separate, individual rock or mineral fragments that range from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but the sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

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

**Stripcropping.** Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

**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 either *single grain* (each grain by itself, as in dune sand) or *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 solum below plow depth.

**Substratum.** Technically, the part of the soil below the solum.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

**Terrace** (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the 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.

**Topsoil.** A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

**Water table.** The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

## GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit and range site, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Estimated yields, table 2, page 34.

Engineering uses of the soils, table 3, page 46; and table 4, page 50.
Town and country planning, table 5, page 54.

| Map symbol | Mapping unit | Page | Capability unit Dryland Symbol | Dryland Page | Capability unit Irrigated Symbol | Irrigated Page | Range site Name | Range site Page |
|---|---|---|---|---|---|---|---|---|
| Ab | Absher loam, 0 to 8 percent slopes | 9 | VIe-1 | 29 | ----- | -- | Panspots | 38 |
| Ba | Badland | 9 | VIIIe-1 | 30 | ----- | -- | ------ | -- |
| Bk | Banks soils | 9 | IVe-4 | 29 | IVe-1 | 32 | Sands | 38 |
| Bm | Beaverton complex, 4 to 15 percent slopes | 10 | IVe-3 | 29 | ----- | -- | Shallow to Gravel | 39 |
| Bn | Benz loam, 0 to 4 percent slopes | 10 | VIe-1 | 29 | ----- | -- | Saline Upland | 38 |
| Bt | Benz-Trembles complex, 2 to 15 percent slopes | 10 | VIe-1 | 29 | ----- | -- | ------ | -- |
| | Benz part | -- | ----- | -- | ----- | -- | Saline Upland | 38 |
| | Trembles part | -- | ----- | -- | ----- | -- | Sandy | 39 |
| By | Blanchard-Dimyaw complex, 8 to 80 percent slopes | 11 | VIe-2 | 29 | ----- | -- | ------ | -- |
| | Blanchard part | -- | ----- | -- | ----- | -- | Sands | 38 |
| | Dimyaw part | -- | ----- | -- | ----- | -- | Thin Hilly | 40 |
| Cc | Cherry silty clay loam, 0 to 2 percent slopes | 11 | IIIc-1 | 28 | IIc-1 | 31 | Silty | 40 |
| Cd | Cherry silty clay loam, 2 to 4 percent slopes | 11 | IIIe-1 | 27 | IIe-1 | 30 | Silty | 40 |
| Ce | Cherry silty clay loam, 4 to 8 percent slopes | 11 | IIIe-2 | 27 | IIIe-1 | 31 | Silty | 40 |
| Cm | Cherry-Lambert complex, 4 to 25 percent slopes | 11 | VIe-3 | 30 | ----- | -- | Silty | 40 |
| Ct | Cherry, Havrelon, and Trembles soils, occasionally flooded | 12 | VIw-1 | 30 | ----- | -- | Overflow | 37 |
| Da | Dast fine sandy loam, 2 to 8 percent slopes | 12 | IVe-2 | 29 | ----- | -- | Sandy | 39 |
| Db | Dast-Blanchard complex, 2 to 8 percent slopes | 12 | IVe-2 | 29 | ----- | -- | ------ | -- |
| | Dast part | -- | ----- | -- | ----- | -- | Sandy | 39 |
| | Blanchard part | -- | ----- | -- | ----- | -- | Sands | 38 |
| Dc | Dast-Blanchard complex, 8 to 25 percent slopes | 12 | VIe-2 | 29 | ----- | -- | ------ | -- |
| | Dast part | -- | ----- | -- | ----- | -- | Sandy | 39 |
| | Blanchard part | -- | ----- | -- | ----- | -- | Sands | 38 |
| Dm | Dimyaw silty clay loam, 8 to 25 percent slopes | 13 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |
| Fa | Farnuf loam, 0 to 4 percent slopes | 13 | IIIe-1 | 27 | IIe-1 | 30 | Silty | 40 |
| Fb | Farnuf loam, 4 to 8 percent slopes | 13 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Ff | Farnuf-Shambo loams, 0 to 4 percent slopes | 13 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Fh | Farnuf-Shambo loams, 4 to 8 percent slopes | 13 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Ha | Havrelon silt loam, 0 to 2 percent slopes | 14 | IIIc-1 | 28 | IIc-1 | 31 | Silty | 40 |
| Hb | Havrelon silt loam, 2 to 4 percent slopes | 14 | IIIe-1 | 27 | IIe-1 | 30 | Silty | 40 |
| La | Lambert gravelly loam, 20 to 40 percent slopes | 14 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |
| Lb | Lambert silt loam, 2 to 8 percent slopes | 14 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Lc | Lambert silt loam, 8 to 15 percent slopes | 15 | IVe-1 | 28 | ----- | -- | Silty | 40 |
| Ld | Lambert-Badland complex | 15 | VIe-3 | 30 | ----- | -- | ------ | -- |
| | Lambert part | -- | ----- | -- | ----- | -- | Thin Hilly | 40 |
| | Badland part | -- | ----- | -- | ----- | -- | ------ | -- |
| Le | Lambert-Blanchard complex, 15 to 65 percent slopes | 15 | VIe-3 | 30 | ----- | -- | ------ | -- |
| | Lambert part | -- | ----- | -- | ----- | -- | Thin Hilly | 40 |
| | Blanchard part | -- | ----- | -- | ----- | -- | Sands | 38 |
| Lm | Lambert-Dimyaw complex, 15 to 65 percent slopes | 16 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |
| Lr | Lambert-Ringling complex, 15 to 65 percent slopes | 16 | VIe-3 | 30 | ----- | -- | ------ | -- |
| | Lambert part | -- | ----- | -- | ----- | -- | Thin Hilly | 40 |
| | Ringling part | -- | ----- | -- | ----- | -- | Very Shallow | 41 |
| Ls | Lihen loamy sand, 4 to 20 percent slopes | 16 | VIe-2 | 29 | ----- | -- | Sands | 38 |
| Lt | Lohler silty clay loam | 16 | IIIs-1 | 28 | IIs-1 | 31 | Clayey | 36 |

| Map symbol | Mapping unit | Page | Capability unit Dryland Symbol | Dryland Page | Irrigated Symbol | Irrigated Page | Range site Name | Range site Page |
|---|---|---|---|---|---|---|---|---|
| Ma | Marias silty clay, 0 to 2 percent slopes | 17 | IIIs-1 | 28 | IIs-1 | 31 | Clayey | 36 |
| Mb | Marias silty clay, 2 to 4 percent slopes | 17 | IIIe-4 | 28 | IIe-2 | 31 | Clayey | 36 |
| Mc | Marias silty clay, 4 to 8 percent slopes | 17 | IIIe-5 | 28 | ----- | -- | Clayey | 36 |
| No | Norbert clay, 8 to 65 percent slopes | 17 | VIe-3 | 30 | ----- | -- | Shallow Clay | 39 |
| Rc | Regent silty clay loam, 1 to 4 percent slopes | 18 | IIIe-4 | 28 | ----- | -- | Clayey | 36 |
| Rd | Regent silty clay loam, 4 to 8 percent slopes | 18 | IIIe-5 | 28 | ----- | -- | Clayey | 36 |
| Re | Regent-Dimyaw complex, 4 to 8 percent slopes | 18 | IIIe-5 | 28 | ----- | -- | Clayey | 36 |
| Rg | Regent-Dimyaw complex, 8 to 15 percent slopes | 18 | IVe-1 | 28 | ----- | -- | Clayey | 36 |
| Rw | Riverwash | 19 | VIIIw-1 | 30 | ----- | -- | ------ | -- |
| Sa | Saline land | 19 | VIw-2 | 30 | ----- | -- | Saline Lowland | 38 |
| Sc | Savage silty clay loam, 0 to 2 percent slopes | 19 | IIIc-1 | 28 | ----- | -- | Silty | 40 |
| Sd | Savage silty clay loam, 2 to 4 percent slopes | 19 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Se | Shambo loam, 0 to 2 percent slopes | 20 | IIIc-1 | 28 | ----- | -- | Silty | 40 |
| Sf | Shambo loam, 2 to 4 percent slopes | 20 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Sg | Shambo loam, 4 to 8 percent slopes | 20 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Sh | Shambo-Lambert complex, 4 to 8 percent slopes | 20 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Sm | Shambo-Lambert complex, 8 to 15 percent slopes | 20 | IVe-1 | 28 | ----- | -- | Silty | 40 |
| Ta | Tally fine sandy loam, 0 to 4 percent slopes | 21 | IIIe-3 | 27 | ----- | -- | Sandy | 39 |
| Tb | Tally fine sandy loam, 4 to 8 percent slopes | 21 | IIIe-3 | 27 | ----- | -- | Sandy | 39 |
| Tc | Tally fine sandy loam, 8 to 15 percent slopes | 21 | IVe-2 | 29 | ----- | -- | Sandy | 39 |
| Te | Terrace escarpments | 21 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |
| Tg | Tinsley-Lambert complex, 15 to 65 percent slopes | 22 | VIIs-1 | 30 | ----- | -- | ------ | -- |
| | Tinsley part | -- | ----- | -- | ----- | -- | Gravel | 37 |
| | Lambert part | -- | ----- | -- | ----- | -- | Thin Hilly | 40 |
| Tm | Tinsley soils, 15 to 65 percent slopes | 22 | VIIs-1 | 30 | ----- | -- | Gravel | 37 |
| Tn | Trembles fine sandy loam | 22 | IIIe-3 | 27 | IIIe-2 | 32 | Sandy | 39 |
| To | Trembles loam | 22 | IIIc-1 | 28 | IIc-1 | 31 | Silty | 40 |
| Tr | Turner fine sandy loam, 1 to 4 percent slopes | 23 | IIIe-3 | 27 | ----- | -- | Sandy | 39 |
| Ts | Turner loam, 0 to 2 percent slopes | 23 | IIIc-1 | 28 | IIs-2 | 31 | Silty | 40 |
| Tt | Turner loam, 2 to 4 percent slopes | 23 | IIIe-1 | 27 | IIe-3 | 31 | Silty | 40 |
| Tu | Turner loam, 4 to 8 percent slopes | 23 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Tv | Turner-Beaverton loams, 0 to 2 percent slopes | 23 | IVs-1 | 29 | IVs-1 | 32 | ------ | -- |
| | Turner part | -- | ----- | -- | ----- | -- | Silty | 40 |
| | Beaverton part | -- | ----- | -- | ----- | -- | Shallow to Gravel | 39 |
| Tw | Turner-Beaverton loams, 2 to 4 percent slopes | 23 | IVs-1 | 29 | IVe-2 | 32 | ------ | -- |
| | Turner part | -- | ----- | -- | ----- | -- | Silty | 40 |
| | Beaverton part | -- | ----- | -- | ----- | -- | Shallow to Gravel | 39 |
| Ty | Turner-Beaverton loams, 4 to 8 percent slopes | 23 | IVe-3 | 29 | ----- | -- | ------ | -- |
| | Turner part | -- | ----- | -- | ----- | -- | Silty | 40 |
| | Beaverton part | --- | ----- | -- | ----- | -- | Shallow to Gravel | 39 |
| Va | Vanda clay, 0 to 8 percent slopes | 24 | VIe-1 | 29 | ----- | -- | Dense Clay | 37 |
| Vc | Vida clay loam, gently undulating | 24 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Vd | Vida clay loam, undulating | 24 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Vh | Vida-Zahill complex, undulating | 24 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Vk | Vida-Zahill complex, rolling | 24 | IVe-1 | 28 | ----- | -- | Silty | 40 |
| Wm | Williams loam, gently undulating | 25 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Wn | Williams-Vida complex, gently undulating | 25 | IIIe-1 | 27 | ----- | -- | Silty | 40 |
| Wv | Williams-Vida complex, undulating | 25 | IIIe-2 | 27 | ----- | -- | Silty | 40 |
| Zh | Zahill loam, 15 to 65 percent slopes | 25 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |
| Zm | Zahill-Lambert complex, 15 to 65 percent slopes | 25 | VIe-3 | 30 | ----- | -- | Thin Hilly | 40 |

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