

SOIL SURVEY OF

CASCADE COUNTY AREA, MONTANA

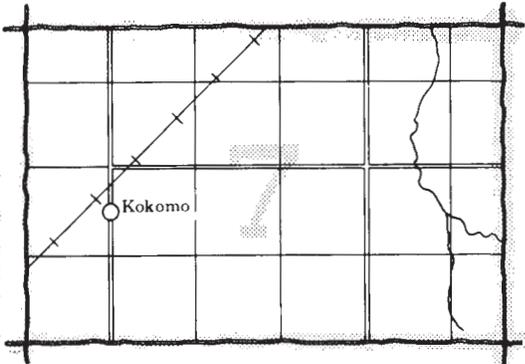
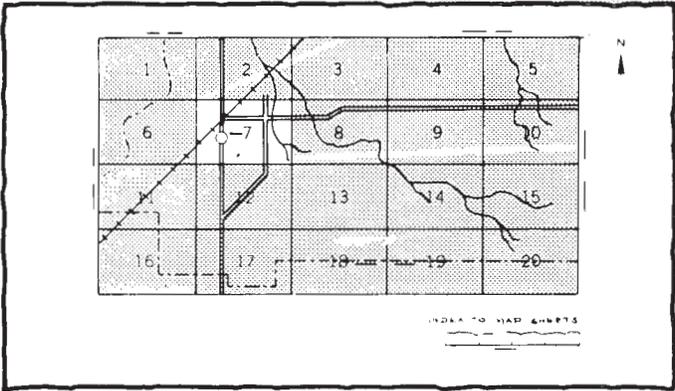
United States Department of Agriculture

Soil Conservation Service

in cooperation with

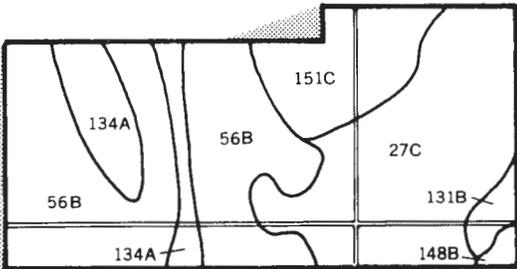
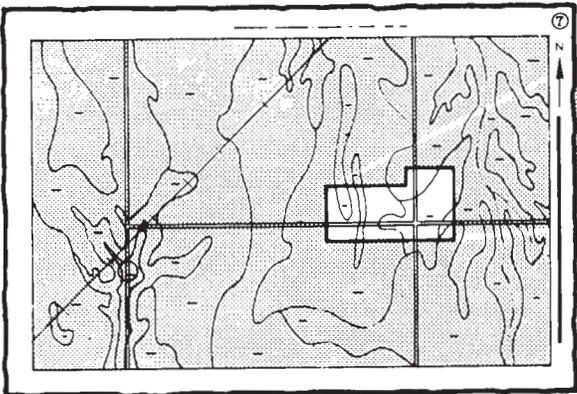
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

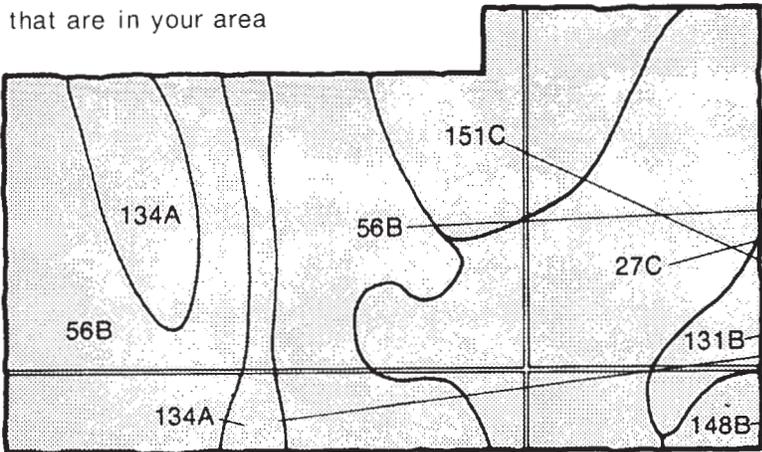


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



4. List the map unit symbols that are in your area

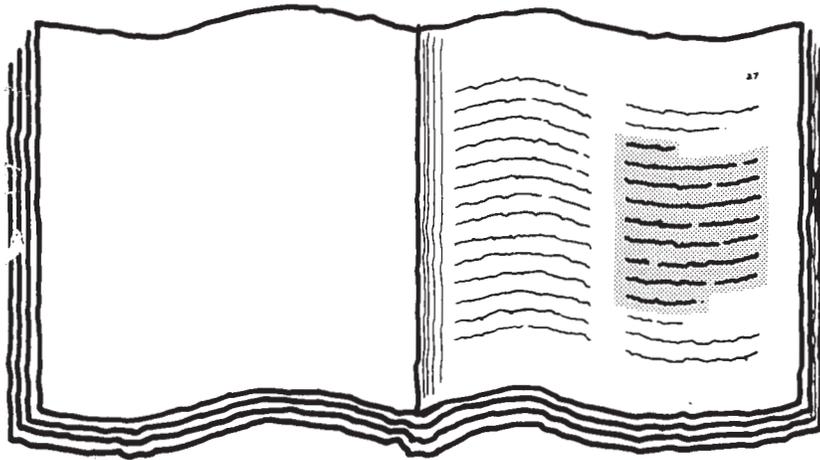


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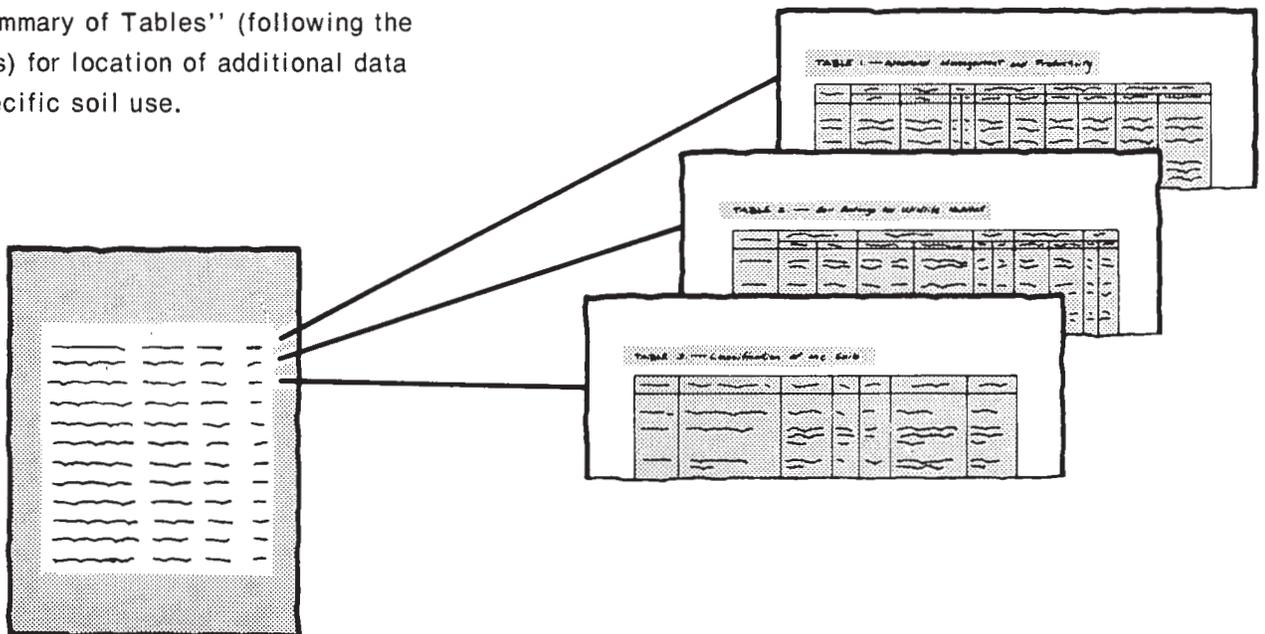
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

A detailed illustration of a table with multiple columns and rows of text, representing the 'Index to Soil Map Units'. The table is shaded and has a grid-like structure.

6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

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

Major fieldwork for this soil survey was completed in the period 1961 to 1973. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1973. 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 Cascade County Conservation District.

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

Cover: Field stripping and farmstead windbreaks, Cascade
County Soil and Water Conservation District.

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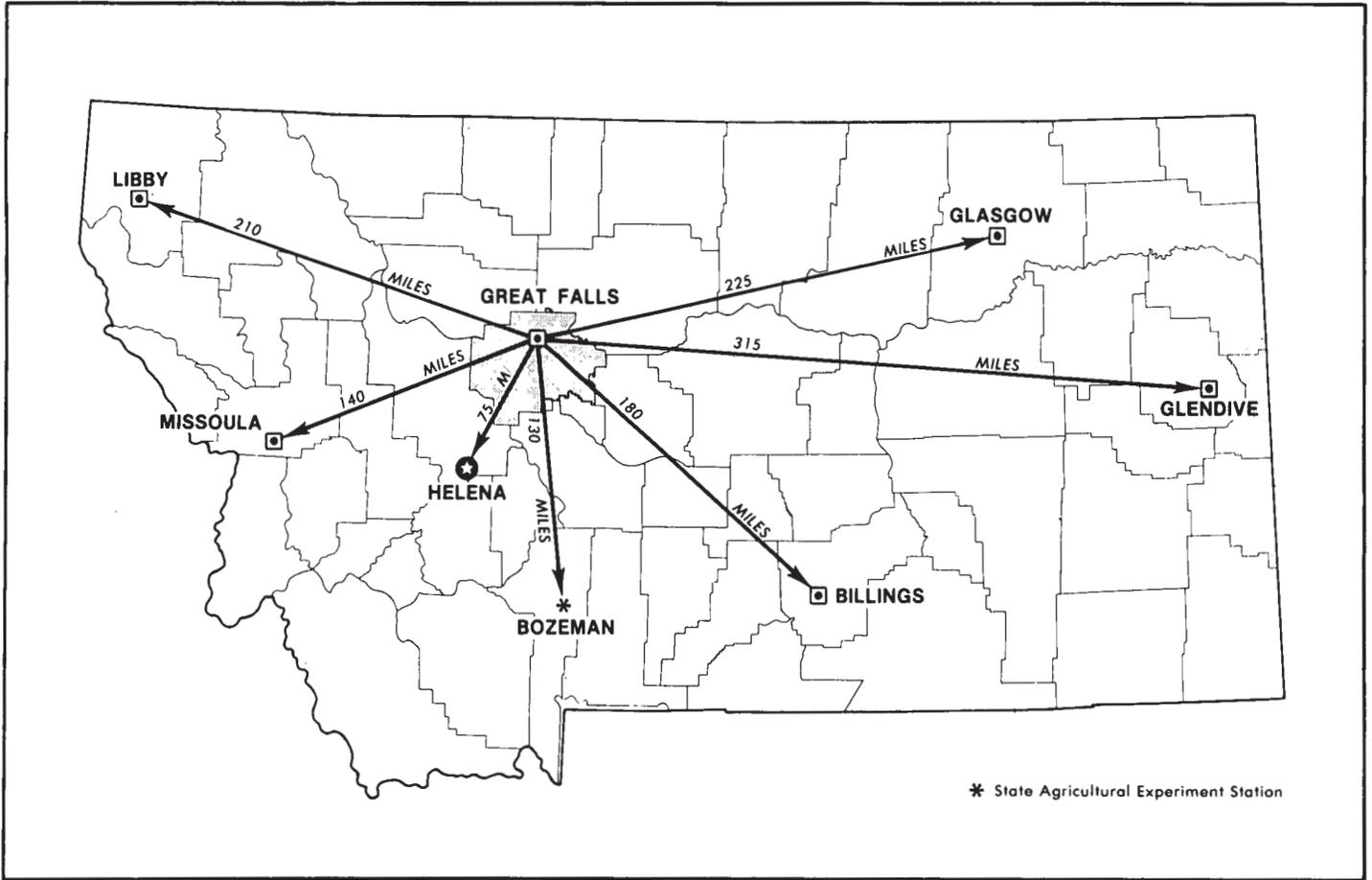
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Location of Cascade County Area in Montana.

SOIL SURVEY OF CASCADE COUNTY AREA, MONTANA

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

CASCADE COUNTY AREA, within Cascade County, is in the north-central part of Montana (see map on facing page). It excludes the part of the Lewis and Clark National Forest that occurs in the southeastern part of the county and in the Highwood Mountains area. It has a land area of about 1,527,071 acres, or about 2,386 square miles. Great Falls, the county seat, is in the north-central part of the county. About 35 percent of the Cascade County Area is cropland. The rest is used mainly for range. The principal crops are wheat, barley, hay, and pasture. About 37,345 acres of cropland is irrigated.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; 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, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the

individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, 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 soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The map units in this survey have been grouped into 31 general kinds of landscape for broad interpretive purposes. Each broad group and the map units are described on the following pages. The terms for texture used in the title of the map unit apply to the texture of the surface layer, or the upper 5 or 6 inches.

Deep, nearly level to hilly, well drained soils that are mainly on flood plains, fans, and terraces

The soils in this group are dominantly loamy sands to silty clay loams. They formed mainly in alluvium. The average annual precipitation ranges from 11 to 19 inches. The growing season is 105 to 135 days. Most of the acreage is cropland and rangeland. Some areas are woodland. The native vegetation is chiefly tall and mid grasses.

Four map units are in this group.

1. Fergus-Twin Creek

Nearly level and gently sloping loams and silty clay loams that formed in alluvium; on terraces, fans, and foot slopes

This map unit is in Sand Coulee Creek Valley and on Johnson Flats. It makes up about 1 percent of the survey area. About 45 percent is Fergus soils, 40 percent Twin Creek soils, and 15 percent minor soils.

Fergus soils are nearly level or gently sloping. They are on terraces and fans. Typically the surface layer is

dark grayish brown silty clay loam about 6 inches thick. The subsoil is mostly brown silty clay loam that is moderately alkaline in the lower part. It is underlain by pinkish gray, strongly alkaline, stratified silt loam and silty clay loam.

Twin Creek soils are nearly level and gently sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is brown loam about 7 inches thick. The subsoil is mostly brown loam that is moderately alkaline in the lower part. It is underlain by pinkish gray, strongly alkaline, stratified loam and clay loam.

Minor in this unit are Absher, Gerber, and Lawther soils. The Absher clay loams are moderately well drained and are on terraces adjacent to Sand Coulee Creek. Gerber silty clays are in slightly higher areas of the landscape. Lawther clays are in nearly level areas.

Nearly all the acreage is used as cropland.

2. Harlem-Havre

Nearly level silty clay loams and loams that formed in alluvium; on terraces

This map unit is along the Sun River and its tributaries between Simms and Great Falls. It makes up about 2 percent of the survey area. About 35 percent is Harlem soils, 20 percent Havre soils, and 45 percent minor soils.

Typically, the surface layer of Harlem soils is grayish brown, calcareous silty clay loam about 8 inches thick. It is underlain by light brownish gray and grayish brown, moderately alkaline, stratified silty clay, silty clay loam, and clay loam.

Typically, the surface layer of Havre soils is grayish brown, calcareous loam about 8 inches thick. It is underlain by light brownish gray, moderately alkaline, stratified loam, silt loam, sandy loam, and silty clay loam.

Minor in this unit are Glendive, Lallie, and Rivra soils. The Glendive fine sandy loams are in nearly level or slightly convex areas. The poorly drained Lallie silty clay loams are in nearly level or slightly concave areas. Rivra soils are mostly gravelly sandy loam and are along rivers and in convex areas.

This unit is used mainly as cropland and rangeland, but in some places it is woodland.

3. Straw-Glendive-Rivra

Nearly level loams, fine sandy loams, and gravelly sandy loams that formed in alluvium; on flood plains and terraces

This map unit is in the Missouri and Smith River Valleys southwest of Great Falls and in the Belt Creek Valley. It is nearly level. In places it is dissected by old stream channels.

This unit makes up about 1 percent of the survey area. About 50 percent is Straw soils, 15 percent Glendive soils, 10 percent Rivra soils, and 25 percent minor soils.

Straw soils are on flood plains and terraces. Typically the surface layer is grayish brown, calcareous loam about 10 inches thick. The underlying material is grayish brown and light brownish gray loam and silt loam that is moderately alkaline. Some areas are underlain by loamy sand below 40 inches.

Glendive soils are on low terraces and some islands in the river. Typically the surface layer is grayish brown, calcareous loam. The underlying material is grayish brown and light brownish gray, calcareous loam, silt loam, and fine sandy loam that is moderately or strongly alkaline. Some areas are underlain by gravelly loamy sand below 30 inches.

Rivra soils are on flood plains dissected by old stream channels. Typically the surface layer is light brownish gray gravelly sandy loam about 8 inches thick. The underlying material is grayish brown very gravelly loamy coarse sand and sand.

Minor soils in this unit are Harlem, Korent, and Lallie soils. The Harlem silty clay loams, the Korent loams, and the Lallie silty clay loams are all on terraces. The Lallie soils are poorly drained and strongly alkaline.

This unit is used mainly for crops and range, but some areas are woodland.

4. Korent-Lihen-Yetull

Nearly level to hilly loamy sands and loams that formed in alluvium and eolian sand; on terraces, fans, foot slopes, and uplands

This map unit is in the Missouri River Valley between Great Falls and Ulm. It makes up about 2 percent of the survey area. About 30 percent is Korent soils, 10 percent Lihen soils, 10 percent Yetull soils, and 50 percent minor soils.

Korent soils are nearly level. They are on terraces. Typically the surface layer is grayish brown, calcareous loam about 9 inches thick. The underlying material is mostly light brownish gray, gray, and grayish brown, stratified loam and silt loam with thin layers of silty clay loam to loamy sand. It is moderately alkaline.

Lihen soils are nearly level to hilly. They are on terraces, fans, and uplands. Typically the surface layer is dark grayish brown and dark gray loamy sand about 21 inches thick. It is underlain by grayish brown and light grayish brown loamy sand and loamy fine sand.

Yetull soils are gently rolling to hilly. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous loamy sand about 5 inches thick. It is underlain by grayish brown and light brownish gray loamy coarse sand and sand.

Minor in this unit are Glendive, Lallie, and Rivra soils. Glendive fine sandy loams are on low terraces. Lallie silty clay loams, which are poorly drained and strongly alkaline, are on terraces. The Rivra gravelly sandy loams are on flood plains along the river and on islands in the river.

This unit is used mainly for range. Some areas are cropland or woodland.

Deep and moderately deep, nearly level to steep, well drained and moderately well drained soils that are mainly on terraces, fans, and foot slopes

The soils in this group are dominantly sandy loams to clays. They formed mainly in alluvium, glaciolacustrine deposits, and material weathered from sandstone and shale. The average annual precipitation is 11 to 16 inches. The growing season is 105 to 135 days. Most of the acreage is cropland and rangeland. The native vegetation is chiefly mid grasses.

Six map units are in this group.

5. Abor-Marias-Kobar

Deep, nearly level to gently rolling, well drained silty clays and silty clay loams that formed in alluvium, glaciolacustrine material, and material weathered from shale and sandstone; on fans, terraces, and uplands

This map unit is north of the Sun River between Great Falls and the town of Sun River. It makes up about 2 percent of the survey area. About 30 percent is Abor soils, 30 percent Marias soils, 20 percent Kobar soils, and 20 percent minor soils.

Abor soils are nearly level to gently rolling. They are on uplands that form divides between fans and terraces. Typically the surface layer is light brownish gray silty clay about 6 inches thick. The subsoil is grayish brown and light brownish gray silty clay about 24 inches thick. The underlying material is light yellowish brown, interbedded shale and sandstone.

Marias soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay about 8 inches thick. The underlying material is grayish brown and light brownish gray silty clay that is mildly or moderately alkaline.

Kobar soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is light brownish gray and light yellowish brown, calcareous silty clay loam. It is underlain at a depth of about 26 inches by light brownish gray, mildly or moderately alkaline, stratified silty clay and silty clay loam.

Minor in this unit are Marvan, Vanda, and Rentsac soils. Marvan and Vanda soils are nearly level, moderately and strongly alkaline clays on fans and terraces. The Rentsac soils are shallow channery loams in slightly higher areas on the landscape.

This unit is used as cropland and rangeland.

6. Yamac-Kobar-Rivra

Deep, nearly level to strongly sloping, well drained clay loams, silty clay loams, and gravelly clay loams that formed in alluvium; on flood plains, terraces, fans, and foot slopes

This map unit is in the Sun River Valley near Fort Shaw and Simms. It makes up about 2 percent of the survey area. About 30 percent is Yamac soils, 15 percent Kobar soils, 10 percent Rivra soils, and 45 percent minor soils.

Yamac soils are nearly level to strongly sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous clay loam about 8 inches thick. The subsoil is light brownish gray clay loam and loam that is moderately alkaline. It is underlain by light brownish gray, stratified loam, fine sandy loam, and clay loam.

Kobar soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous silty clay loam about 6 inches thick. The subsoil is light brownish gray and light yellowish brown silty clay loam that is moderately alkaline. It is underlain by light brownish gray, stratified silty clay loam, silty clay, and silt loam.

Rivra soils are nearly level and are on flood plains and terraces that are dissected by old stream channels. Typically the surface layer is light brownish gray gravelly sandy loam about 8 inches thick. The underlying material is grayish brown very gravelly loamy coarse sand and very gravelly sand.

Minor in this unit are Glendive, Havre, and Lallie soils. Glendive fine sandy loams and Havre loams are on low terraces. Lallie silty clay loams, which are poorly drained and strongly alkaline, are on terraces.

This unit is used mainly as cropland. Some areas are in range and woodland.

7. Crago-Rothiemay-Binna

Deep, nearly level to steep, well drained loams and very cobbly loams that formed in alluvium; on terraces, fans, and foot slopes

This map unit is mainly on the Crowe and Ashuelot Benches in the northwestern part of the survey area. It makes up about 4 percent of the survey area. About 25 percent is Crago soils, 25 percent Rothiemay soils, 20 percent Binna soils, and 30 percent minor soils.

Crago soils are nearly level to steep and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown and light brownish gray, calcareous very cobbly loam and very gravelly loam about 9 inches thick. The underlying material is white and pale brown very gravelly sandy loam.

Rothiemay soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous loam about 7

inches thick. The subsoil is pale brown and light brownish gray loam that is moderately alkaline. It is underlain by white light clay loam that is slowly permeable.

Binna soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous loam about 9 inches thick. The underlying material is light gray loam about 15 inches thick over light gray and light brownish gray gravelly and very gravelly loamy sand.

Minor in this unit are Evanston, Rothiemay, wet, and Yawdim soils. The Evanston loams are on terraces, fans, and foot slopes. Rothiemay loam, wet, is on terraces and fans and has a seasonal high water table within a depth of 30 inches. The Yawdim silty clay loams are shallow over shale and are at bench edges and on foot slopes.

This unit is used for crops and range.

8. Absher-Nobe

Deep, nearly level to moderately sloping, well drained and moderately well drained silty clays that formed in alluvium; on terraces, fans, and foot slopes

This map unit is in the west central part of the survey area. Small areas are also in the vicinity of Blackhorse Lake. The unit makes up about 3 percent of the survey area. About 40 percent is Absher soils, 20 percent Nobe soils, and 40 percent minor soils.

Absher soils are nearly level to moderately sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is light brownish gray loam about 2 inches thick. The subsoil is grayish brown silty clay that is strongly alkaline in the lower part. It is underlain at a depth of about 16 inches by grayish brown and very pale brown, strongly alkaline, stratified clay, silty clay loam, and clay loam.

Nobe soils are nearly level to moderately sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is light brownish gray loam about 1 inch thick. The subsoil is grayish brown silty clay that is strongly alkaline in the lower part. It is underlain by grayish brown and light brownish gray, strongly alkaline clay loam, silty clay loam, and silty clay.

Minor in this unit are Assiniboine, Lennep, and Vanda soils. The Assiniboine fine sandy loams are slightly higher on the landscape. The Lennep loams are in slightly higher areas, among areas of Nobe soils. Vanda clays are in nearly level areas. They are very hard and firm clay throughout the profile.

This unit is used mainly for range. Some areas are used for crops, but the high salt content of these soils precludes their use for most cultivated crops.

9. Benz-Marvan

Deep, nearly level to strongly sloping, well drained clay loams and clays that formed in alluvium; on terraces, fans, and foot slopes

This map unit is in the northwestern part of the survey area. Small areas also occur in the vicinity of Blackhorse Lake. This unit makes up about 4 percent of the survey area. About 40 percent is Benz soils, 35 percent Marvan soils, and 25 percent minor soils.

Benz soils are nearly level to strongly sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown clay loam about 2 inches thick. The underlying material is light brownish gray, strongly alkaline, stratified clay loam, loam, and fine sandy loam.

Marvan soils are nearly level to moderately sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is light brownish gray, calcareous clay about 4 inches thick. The underlying material is light brownish gray and grayish brown, moderately alkaline clay. In the lower part, below 11 to 24 inches, are many masses of gypsum and other salts.

Minor in this unit are Kobar, Marias, and Vanda soils. The Kobar silty clay loams are in some slightly higher areas between areas of Benz and Marvan soils. The Marias silty clays are in nearly level areas. Vanda clays, which are in nearly level areas, are very hard and firm clay throughout the profile.

This unit is used as cropland and rangeland. The high salt content in the underlying material reduces yields of most crops.

10. Evanston-Abor

Deep and moderately deep, nearly level to moderately steep, well drained loams and silty clays that formed in alluvium and in material weathered from shale and sandstone; on terraces, fans, foot slopes, and uplands

This map unit is in the northeastern part of the survey area, west of Ashuelot Bench. It makes up about 3 percent of the survey area. About 30 percent is Evanston soils, 25 percent Abor soils, and 45 percent minor soils.

Evanston soils are nearly level to moderately sloping and are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown and light brownish gray clay loam that is moderately alkaline in the lower part. It is underlain by light brownish gray, stratified loam, gravelly sandy loam, and clay loam.

Abor soils are nearly level to moderately steep. They are on uplands that form local divides between fans and terraces. Typically the surface layer is light brownish gray silty clay about 6 inches thick. The subsoil is grayish brown and light brownish gray silty clay about 24 inches thick. The underlying material is light yellowish brown, interbedded shale and sandstone.

Minor in this unit are Lallie, Rothiemay, wet, and Yawdim soils. The Lallie silty clay loams are poorly drained and strongly alkaline soils on fans and terraces. Rothiemay loam, wet, is on fans and terraces. It has a

seasonal high water table within a depth of 30 inches as a result of irrigation ditch seepage. The Yawdim clay loams are shallow over shale and are at terrace edges and in some convex areas.

This unit is mainly rangeland.

Deep, nearly level to very steep, well drained soils that are mainly on glaciated terraces, fans, and uplands

The soils in this group are dominantly silt loams to clays. They formed mainly in glacial till, glaciolacustrine material, and glacial outwash. The average annual precipitation ranges from 11 to 17 inches. The growing season is 105 to 135 days. Most of the acreage is cropland. Some areas are rangeland. The native vegetation is chiefly mid grasses.

Six map units are in this group.

11. Linnet-Marias

Nearly level to gently rolling soils that formed in alluvium, glaciolacustrine material, and glacial outwash; on terraces and uplands

This map unit is north and east of Great Falls. It makes up about 2 percent of the survey area. About 40 percent is Linnet soils, 30 percent Marias soils, and 30 percent minor soils.

Linnet soils are nearly level to moderately sloping and are on terraces and uplands. Typically the surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is brown and light brownish gray silty clay that is mildly alkaline in the lower part. It is underlain by light brownish gray and grayish brown, moderately alkaline silty clay loam and clay loam.

Marias soils are nearly level to gently sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay about 8 inches thick. The underlying material is grayish brown and light brownish gray silty clay that is mildly or moderately alkaline.

Minor in this unit are Lothair, McKenzie, and Rentsac soils. The Lothair silty clay loams are in strongly rolling or steep areas along drainageways. McKenzie clays are in nearly level clay basins. The shallow Rentsac chanery loams, which are underlain by sandstone bedrock, are at terrace edges.

This unit is mainly cropland. Some areas are rangeland.

12. Gerber-Acel

Nearly level to strongly rolling silty clay loams and silty clays that formed in glacial till, glaciolacustrine material, and glacial outwash; on terraces and fans

This map unit is in the glaciated plains east and south-east of Great Falls. It makes up about 4 percent of the

survey area. About 60 percent is Gerber soils, 10 percent Acel soils, and 30 percent minor soils.

Gerber soils are nearly level to strongly rolling and are on terraces and fans. Typically the surface layer is dark grayish brown silty clay loam or silty clay about 7 inches thick. The subsoil is brown, grayish brown, and light brownish gray silty clay that is moderately alkaline in the lower part. It is underlain by grayish brown clay loam.

Acel soils are nearly level to moderately sloping and are on terraces. Typically the surface layer is grayish brown silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is brown and grayish brown silty clay that is moderately alkaline in the lower part. It is underlain by light brownish gray silty clay loam that is moderately or strongly alkaline.

Minor in this unit are Hillon and Lawther soils. The Hillon clay loams are in convex areas and at terrace edges. The Lawther clays are in nearly level areas.

This unit is mainly cropland. Some areas are rangeland.

13. Pendroy-Marias

Nearly level to strongly sloping clays and silty clays that formed in alluvium and in lacustrine deposits; on terraces, fans, and foot slopes

This map unit is around the Benton Lake Wildlife Refuge and east of Great Falls, north of Fife. It makes up about 3 percent of the survey area. About 55 percent is Pendroy soils, 20 percent Marias soils, and 25 percent minor soils.

Pendroy soils are nearly level to strongly sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous clay about 7 inches thick. The underlying material is grayish brown clay and silty clay that is moderately alkaline in the lower part.

Marias soils are nearly level to gently sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay about 8 inches thick. The underlying material is grayish brown and light brownish gray silty clay that is mildly or moderately alkaline.

Minor in this unit are Lawther, Lothair, and Marvan soils. The Lawther clays are in slightly higher, nearly level areas. The Lothair silty clay loams are in strongly rolling to steep areas along drainageways. The Marvan clays are moderately and strongly alkaline and are on nearly level terraces.

This unit is used as cropland and rangeland.

14. Lothair-Ethridge-Kobar

Nearly level to very steep silty clay loams that formed in alluvium and glaciolacustrine material; on terraces, fans, and foot slopes

This map unit is in the northeastern part of the survey area north of the Missouri River. It makes up about 2 percent of the survey area. About 50 percent is Lothair soils, 15 percent Ethridge soils, 15 percent Kobar soils, and 20 percent minor soils.

Lothair soils are strongly rolling to very steep and are on fans and at terrace edges. Typically the surface layer is light brownish gray, calcareous silty clay loam about 3 inches thick. The underlying material is light brownish gray, moderately alkaline silty clay stratified with silty clay loam and clay loam.

Ethridge soils are nearly level to moderately sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay loam about 7 inches thick. The subsoil is brown and light brownish gray silty clay and silty clay loam that is moderately alkaline in the lower part. The underlying material is light brownish gray and grayish brown silty clay loam, and it is calcareous.

Kobar soils are nearly level to moderately sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is grayish brown, calcareous silty clay loam about 6 inches thick. The subsoil is mostly light brownish gray silty clay loam that is moderately alkaline. It is underlain by light brownish gray, stratified silty clay loam and silty clay.

Minor in this unit are Floweree, Lambeth, and Marias soils. The Floweree silt loams are nearly level to moderately sloping and are on terraces and fans. Lambeth silt loams are in convex areas and at terrace edges. The Marias silty clays are on terraces and fans.

This unit is used as cropland and rangeland.

15. Scobey-Hillon-Acel

Nearly level to steep clay loams and silty clay loams that formed in alluvium, glacial till, and glacial outwash; on terraces and uplands

This map unit is in the northern part of the survey area east of the Benton Lake Wildlife Refuge. It makes up about 1 percent of the survey area. About 55 percent is Scobey soils, about 20 percent Hillon soils, 15 percent Acel soils, and 10 percent minor soils.

Scobey soils are nearly level to moderately sloping and are on uplands. Typically the surface layer is grayish brown clay loam about 7 inches thick. The subsoil is brown, grayish brown, and light brownish gray clay and clay loam that is moderately alkaline. It is underlain by light brownish gray clay loam that has very coarse platy structure.

Hillon soils are nearly level to steep and are on uplands. Typically the surface layer is grayish brown, calcareous clay loam about 5 inches thick. The underlying material is light brownish gray and grayish brown clay loam that is moderately alkaline.

Acel soils are nearly level to moderately sloping. They are on terraces. Typically the surface layer is grayish

brown silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is mostly grayish brown silty clay that is moderately alkaline in the lower part. It is underlain by light brownish gray silty clay loam that is moderately or strongly alkaline.

Minor in this unit are Kevin and Linnet soils. The Kevin clay loams are on glacial till uplands. The Linnet silty clay loams are on outwash terraces.

This unit is used as cropland and rangeland.

16. Ethridge-Lambeth-Floweree

Nearly level to very steep silt loams and silty clay loams that formed in alluvium, glacial outwash, and glaciolacustrine material; on terraces, fans, foot slopes, and uplands

This map unit is in the northeastern part of the survey area north of the Missouri River. It makes up about 1 percent of the survey area. About 35 percent is Ethridge soils, 35 percent Lambeth soils, 15 percent Floweree soils, and 15 percent minor soils.

Ethridge soils are nearly level to moderately sloping. They are on plane to concave terraces, fans, and foot slopes. Typically the surface layer is grayish brown silty clay loam about 7 inches thick. The subsoil is brown and light brownish gray silty clay and silty clay loam that is moderately alkaline in the lower part. The underlying material is light brownish gray and grayish brown, calcareous silty clay loam.

Lambeth soils are nearly level to very steep. They are on convex uplands and at terrace edges. Typically the surface layer is light yellowish brown, calcareous silt loam about 4 inches thick. It is underlain by light yellowish brown and pale yellow, moderately alkaline, thinly stratified silt loam.

Floweree soils are nearly level to moderately sloping. They are on fans and terraces. Typically the surface layer is grayish brown silt loam about 6 inches thick. The subsoil is grayish brown and light yellowish brown silty clay loam that is moderately alkaline in the lower part. It is underlain by light brownish gray silty clay loam.

Minor in this unit are Evanston and Lothair soils. The Evanston loams and clay loams are on terraces and fans. The Lothair silty clays are in strongly sloping or steep areas along drainageways.

This unit is used mainly as cropland. Some areas are rangeland.

Deep to shallow, nearly level to very steep, well drained soils that are mainly on shale uplands

The soils of this group are dominantly stony loams to clays. They formed mainly in clay or silty clay derived from shale. The average annual precipitation ranges from 11 to 19 inches. The growing season is 105 to 135 days. Part of the acreage is cropland. The rest is range-

land. The native vegetation is chiefly tall and mid grasses.

Four map units are in this group.

17. Dutton-Pylon

Moderately deep, nearly level to moderately sloping silty clays and silty clay loams that formed in material weathered from shale and sandstone; on uplands

This map unit is in the northwestern part of the survey area. It consists of shale benches in the uplands. It makes up about 1 percent of the survey area. About 60 percent is Dutton soils, 25 percent Pylon soils, and 15 percent minor soils.

Dutton soils are nearly level to moderately sloping. Typically the surface layer is grayish brown silty clay about 6 inches thick. The subsoil is brown and grayish brown silty clay that is moderately alkaline in the lower part. The underlying material is grayish brown very channery loam and clay. Shale bedrock is at a depth of about 36 inches.

Pylon soils are nearly level or gently sloping. Typically the surface layer is light brownish gray, massive silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is brown and grayish brown silty clay that is strongly alkaline in the lower part. The underlying material is light brownish gray silty clay. Shale bedrock is at a depth of about 34 inches.

Minor in this unit are Ernem, McKenzie, and Tanna soils. The shallow Ernem very stony loams are in nearly level to strongly sloping areas, along terrace edges, and in convex positions. McKenzie clays are in nearly level clay basins. The Tanna clay loams are moderately deep over shale and are in slightly convex areas.

This unit is used mainly as cropland. Some areas are rangeland.

18. Eltsac-Lisam-Shane

Moderately deep and shallow, gently sloping to very steep clays and silty clay loams that formed in material weathered from shale; on uplands

This map unit is in the northeastern part of the survey area. It consists of shale benches in the uplands and deep dissected drainageways. It makes up about 2 percent of the survey area. About 40 percent is Eltsac soils, 25 percent Lisam soils, 15 percent Shane soils, and 20 percent minor soils.

Eltzac soils are moderately deep and gently rolling to very steep. Typically the surface layer is grayish brown, calcareous clay about 6 inches thick. The underlying material is grayish brown clay. Clay shale is at a depth of about 26 inches.

Lisam soils are shallow and are gently rolling to very steep. Typically the surface layer is grayish brown, calcareous clay about 5 inches thick. The underlying materi-

al is light brownish gray clay that is moderately alkaline. Hard platy clay shale is at a depth of about 18 inches.

Shane soils are moderately deep and gently sloping to strongly sloping. Typically the surface layer is grayish brown silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is brown clay. The underlying material below about 32 inches is dark gray weathered clay shale. Clay shale bedrock is at a depth of about 38 inches.

Minor in this unit are Absarokee, Sinnigam, and Work soils. Absarokee clay loams are gently rolling to steep and are moderately deep over shale and sandstone. Sinnigam very stony loams are shallow and are underlain by sandstone. Work clay loams are on fans and foot slopes.

This unit is used mainly as cropland and rangeland.

19. Big Timber-Terrad-Timberg

Deep to shallow, gently undulating to very steep silty clays, silty clay loams, and clay loams that formed in alluvium and in material weathered from interbedded shale and sandstone; on uplands and foot slopes

This map unit is in the northeastern part of the survey area in the vicinity of Belt. It consists of shale and sandstone benches in the uplands and very deep dissecting drainageways. It makes up about 3 percent of the survey area. About 25 percent is Big Timber soils, 15 percent Terrad soils, 15 percent Timberg soils, and 45 percent minor soils.

Big Timber soils are shallow and rolling to very steep. They are on shale uplands. Typically the surface layer is reddish brown clay loam about 6 inches thick. The underlying material is reddish brown clay loam that is moderately alkaline. Reddish brown platy shale is at a depth of about 15 inches.

Terrad soils are deep and gently undulating to strongly rolling. They are on uplands and foot slopes. Typically the surface layer is dark reddish gray silty clay about 6 inches thick. The subsoil is weak red and reddish brown clay that is moderately alkaline in the lower part. The underlying material is reddish brown silty clay. Interbedded shale and mudstone is at a depth of about 45 inches.

Timberg soils are moderately deep and gently undulating to steep. They are on uplands. Typically the surface layer is dark reddish gray silty clay loam about 7 inches thick. The subsoil is calcareous, weak red silty clay loam and silty clay that is moderately alkaline. The underlying material is weak red silty clay. Clay shale is at a depth of about 35 inches.

Minor in this unit are Castner and Fergus soils. The Castner channery loams are shallow over sandstone bedrock and are in narrow bands along bench edges. The Fergus silty clay loams are deep soils on fans and foot slopes.

This unit is used as cropland and rangeland.

20. Castner-Bitton-Yawdim-Rock outcrop

Deep to shallow, nearly level to very steep stony loams, very channery loams, and clay loams that formed in alluvium and in material weathered from shale, igneous rock, and sandstone; and Rock outcrop; all on dissected foot slopes and uplands

This map unit is mainly at upland bench edges and on ridgetops throughout much of the survey area. Geologic erosion is active. The unit makes up about 9 percent of the survey area. About 20 percent is Castner soils, 10 percent Bitton soils, 10 percent Yawdim soils, 10 percent Rock outcrop, and 50 percent minor soils.

Castner soils are nearly level to very steep and are shallow. They are on upland ridgetops, in convex areas, and at bench edges. Typically the surface layer is dark grayish brown and brown channery loam 10 inches thick. The underlying material is pale brown, calcareous very channery loam. Sandstone bedrock is at a depth of about 16 inches.

Bitton soils are strongly sloping to very steep. They are on foot slopes and uplands. Typically the surface layer is dark grayish brown stony loam about 7 inches thick. The underlying material is pale brown and light brownish gray very stony loam and stony clay loam.

Yawdim soils are shallow and are gently rolling to very steep. They are on uplands. Typically the surface layer is light brownish gray, calcareous clay loam about 3 inches thick. The underlying material is light yellowish brown and light brownish gray silty clay loam and silty clay. Shale bedrock is at a depth of about 16 inches.

Shale and sandstone crop out on ridgetops and on some convex slopes.

Minor in this unit are Lisam, Lothair, and Roy soils. The Lisam clays are shallow over shale and are at bench edges. The Lothair silty clay loams and silty clays are deep and are in strongly rolling or steep areas along foot slopes. Roy stony loams are on strongly sloping to steep foot slopes and fans.

This unit is used for range.

Deep to shallow, nearly level to very steep, well drained and excessively drained soils that are mainly on sandstone and shale uplands

The soils in this group are dominantly loamy sands to silty clays. They formed mainly in loam, very stony loam, silty clay loam, and silty clay material weathered from sandstone and shale. The average annual precipitation ranges from 11 to 19 inches. The growing season is 105 to 135 days. Part of the acreage is cropland. The rest is rangeland. The native vegetation is chiefly mid and tall grasses.

Six map units are in this group.

21. Yawdim-Winifred-Rentsac

Moderately deep and shallow, gently sloping to very steep, well drained and excessively drained silty clay loams, silty clays, and channery loams that formed in material weathered from shale, sandstone, and siltstone; on uplands and foot slopes

This map unit is in the western part of the survey area south of Sun River. It makes up about 5 percent of the survey area. About 25 percent is Yawdim soils, 15 percent Winifred soils, 10 percent Rentsac soils, and 50 percent minor soils.

Yawdim soils are gently rolling to very steep. They are on ridgetops and in convex positions on uplands. Typically the surface layer is light brownish gray, calcareous silty clay loam about 3 inches thick. The underlying material is light yellowish brown and light brownish gray silty clay loam and silty clay. Shale bedrock is at a depth of about 16 inches.

The Winifred soils are gently sloping to steep. They are on smooth foot slopes and slightly concave side slopes on shale uplands. Typically the surface layer is gray and dark gray silty clay loam 7 inches thick. The subsoil is grayish brown and light olive gray silty clay that is moderately alkaline. The underlying material is light gray silty clay. Shale is at a depth of about 36 inches.

Rentsac soils are gently undulating to steep. They are on ridgetops and bedrock uplands. Typically the surface layer is grayish brown channery loam about 2 inches thick. The underlying material is light brownish gray, channery and very channery loam. Sandstone bedrock is at a depth of about 18 inches.

Minor in this unit are Fairfield, Work, and Yamac soils. Fairfield clay loams and silty clay loams are on foot slopes. Work clay loams are on fans and foot slopes. The Yamac loams and clay loams are on fans.

This unit is used mainly for range. Some areas are used as cropland.

22. Absarokee-Work-Sinnigam

Deep to shallow, nearly level to very steep, well drained loams, clay loams, and very stony loams that formed in alluvium and in material weathered from sandstone and shale; on terraces, fans, foot slopes, and uplands

This map unit is in the south central part of the survey area between Cascade and Belt. It consists of dissected bedrock benches, steep valley sides, rock outcrop, and narrow valleys. It makes up about 7 percent of the survey area. About 50 percent is Absarokee soils, 25 percent Work soils, 10 percent Sinnigam soils, and 15 percent minor soils.

Absarokee soils are nearly level to steep and moderately deep. They are on uplands. Typically the surface layer is dark gray clay loam about 8 inches thick. The subsoil is dark brown, brown, and light brownish gray clay loam that is moderately alkaline in the lower part.

The underlying material is light gray, calcareous clay loam. Shale bedrock is at a depth of about 36 inches.

Work soils are deep and are nearly level to strongly sloping. They are on terraces, fans, and foot slopes. Typically the surface layer is dark gray clay loam about 6 inches thick. The subsoil is brown, pale brown, and very pale brown clay loam that is moderately alkaline in the lower part. The underlying material is very pale brown, calcareous clay loam and sandy loam that is strongly alkaline in the lower part.

Sinnigam soils are shallow and are nearly level to gently rolling. They are on ridgetops and convex areas on bedrock uplands. Typically the surface layer is dark grayish brown very stony loam about 6 inches thick. The subsoil is brown flaggy and very flaggy clay loam. Fractured sandstone bedrock is at a depth of about 17 inches.

Minor in this unit are Borky, Roy, and Shawa soils. Sandstone crops out along the very steep bench edges. The Borky stony loams are gently rolling to strongly sloping, moderately deep soils on bedrock uplands. The Roy stony loams are deep, strongly sloping to steep soils on foot slopes and fans. Shawa loams are deep. They are on terraces, fans, and foot slopes in narrow upland valleys.

This unit is used mainly as cropland and rangeland.

23. Tanna-Marmarth

Moderately deep, nearly level to strongly sloping, well drained clay loams that formed in material weathered from interbedded shale and sandstone; on uplands

This map unit is west of Great Falls. It is along bench edges on the uplands. It makes up about 2 percent of the survey area. About 60 percent is Tanna soils, 30 percent Marmarth soils, and 10 percent minor soils.

Tanna soils are nearly level to strongly sloping. Typically the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is brown and light brownish gray clay loam that is moderately alkaline. It is underlain by pale brown very channery loam. Interbedded sandstone and platy shale is at a depth of about 31 inches.

Marmarth soils are nearly level to gently sloping. Typically the surface layer is grayish brown clay loam about 7 inches thick. The subsoil is brown and pale brown clay loam that is moderately alkaline in the lower part. It is underlain by light brownish gray, moderately alkaline channery loam. Interbedded sandstone and shale is at a depth of about 24 inches.

Minor in this unit are Castner, Ethridge, and Marias soils. The Castner channery loams are shallow over sandstone bedrock. The Ethridge silty clay loams are deep and are on foot slopes and fans. The Marias silty clays are deep and are on terraces and fans. Some soils in swales and on foot slopes are wet and saline because of seepage along contact zones of the shale and sandstone beds.

This unit is used mainly for crops. Some areas are range.

24. Abor-Cargill

Moderately deep, nearly level to strongly sloping, well drained silty clay loams to silty clays that formed in material weathered from siltstone and interbedded shale and sandstone; on uplands

This map unit is in the northwestern part of the survey area, north of Vaughn. It consists mainly of short slopes along bench edges and drainageways. It makes up about 1 percent of the survey area. About 50 percent is Abor soils, 35 percent Cargill soils, and 15 percent minor soils.

Abor soils are nearly level to strongly sloping. Typically the surface layer is light brownish gray, calcareous silty clay about 6 inches thick. The subsoil is grayish brown and light brownish gray silty clay about 24 inches thick. The underlying material is light yellowish brown interbedded shale and sandstone.

Cargill soils are nearly level to moderately sloping. Typically the surface layer is grayish brown, calcareous silty clay loam about 6 inches thick. The subsoil is pale brown silty clay loam that is moderately alkaline. It is underlain by light gray and pale yellow silty clay loam. Interbedded siltstone and shale is at a depth of about 30 inches.

Minor in this unit are Dutton, Ernem, and Pylon soils. The Dutton silty clay loams are on nearly level or gently undulating uplands. The Ernem soils are in nearly level to strongly sloping areas along bench edges and in convex positions. Pylon soils are in slightly concave areas. They have a silty clay loam surface layer that forms a hard crust when dry. Some soils in swales and drainageways are wet and saline.

This unit is mainly cropland. Some areas are rangeland.

25. Ipano-Bitton-Castner

Deep to shallow, nearly level to very steep, well drained loams, stony loams, and channery loams that formed in alluvium and in material weathered from sandstone; on uplands and foot slopes

This map unit is along bench areas in the central part of the survey area and south and west of Belt. It makes up about 7 percent of the survey area. About 25 percent is Ipano soils, 15 percent Bitton soils, 10 percent Castner soils, and 50 percent minor soils.

Ipano soils are deep and are nearly level to strongly sloping. They are on uplands. Typically the surface layer is grayish brown loam about 8 inches thick. The subsoil is light brownish gray and light gray silt loam that is moderately alkaline. It is underlain by light brownish gray and pale brown gravelly and channery loam. Sandstone bedrock is at a depth of about 34 inches.

Bitton soils are strongly sloping to very steep. They are on foot slopes and uplands. Typically the surface layer is dark grayish brown stony loam about 7 inches thick. The underlying material is pale brown and light brownish gray very stony loam and stony clay loam.

Castner soils are nearly level to very steep, shallow soils. They are on upland ridgetops, in convex areas, and at bench edges. Typically the surface layer is dark grayish brown and brown very channery loam 10 inches thick. The underlying material is pale brown, calcareous very channery loam. Sandstone bedrock is at a depth of about 16 inches.

Minor in this unit are Big Timber, Terrad, Twin Creek, and Work soils. Big Timber clay loams are shallow and are in convex areas. Terrad silty clays are on uplands, are deep, and are underlain by shale at about 45 inches. Twin Creek loams are deep and are on foot slopes and fans in narrow valleys. Work clay loams are deep soils on upland foot slopes and in swales.

This unit is used for crops and range.

26. Tally-Azaar-Lihen

Moderately deep and deep, nearly level to steep, well drained fine sandy loams and loamy sands that formed in material deposited over sandstone, in alluvium, and in eolian sand; on terraces, fans, foot slopes, and uplands

This map unit is in the north central part of the survey area, south and west of Great Falls. It makes up about 2 percent of the survey area. About 45 percent is Tally soils, 20 percent Azaar soils, 15 percent Lihen soils, and 20 percent minor soils.

The Tally soils are deep and are nearly level to steep. They are on terraces, fans, and foot slopes. Typically the surface layer is dark grayish brown fine sandy loam 7 inches thick. The subsoil is brown and grayish brown fine sandy loam. The underlying material is pale brown fine sandy loam and sandy loam.

The Azaar soils are nearly level to undulating, are moderately deep, and are on bedrock uplands. Typically the surface layer is dark grayish brown fine sandy loam about 7 inches thick. The subsoil is brown fine sandy loam. The underlying material is light gray and grayish brown silt loam and silty clay loam. Sandstone is at a depth of about 32 inches.

The Lihen soils are deep and are nearly level to strongly rolling. They are on terraces, fans, and uplands. Typically the surface layer is dark grayish brown and dark gray loamy sand 21 inches thick. The underlying material is grayish brown and light grayish brown loamy sand and loamy fine sand.

Minor in this unit are Castner, Ervide, and Yetull soils. The Castner channery loams are shallow over sandstone bedrock. They are in convex areas and at bench edges. The Ervide loamy fine sands are moderately deep. Sandstone is at a depth of about 32 inches. The Yetull loamy sands are deep and calcareous.

This unit is used for crops and range.

Deep to shallow, nearly level to very steep, well drained soils that are mainly on mountain fans, foot slopes, and uplands

The soils in this group are dominantly flaggy sandy loams to silty clay loams. They formed mainly in material weathered from igneous bedrock, limestone, sandstone, and shale. The average annual precipitation ranges from 14 to 24 inches. The growing season is 60 to 135 days. Most of the acreage is cropland and rangeland. Some areas are woodland. The native vegetation is chiefly tall and mid grasses.

Five map units are in this group.

27. Loberg-Blythe-Absarokee

Deep to moderately deep, nearly level to very steep clay loams, silt loams, and stony loams that formed in alluvium and in material weathered from shale and sandstone; on fans, foot slopes, and uplands

This map unit is in the eastern part of the survey area. It consists of mountain slopes, deeply dissected plateaus in the foothills of the Highwood Mountains, and narrow valleys. It makes up about 1 percent of the survey area. About 55 percent is Loberg soils, 20 percent Blythe soils, 15 percent Absarokee soils, and 10 percent minor soils.

Loberg soils are deep and are moderately steep to very steep. They are on fans and foot slopes. Typically the surface layer is covered with an inch of undecomposed needles and twigs and partially decomposed organic material. It is very pale brown stony loam 10 inches thick. The subsoil is very pale brown, yellowish brown, and light yellowish brown stony clay loam and very stony clay.

Blythe soils are nearly level to very steep and moderately deep. They are on uplands. Typically the surface layer is gray silt loam about 7 inches thick. The subsoil is dark grayish brown and brown clay. The underlying material is gray clay shale over platy shale.

Absarokee soils are nearly level to very steep and moderately deep. They are on uplands. Typically the surface layer is dark gray clay loam 8 inches thick. The subsoil is dark brown, brown, and light brownish gray clay loam 18 inches thick. The underlying material is light gray clay loam. Shale bedrock is at a depth of about 36 inches.

Minor in this unit are Cheadle, Shawa, and Work soils. Wet loams occur along some drainageways. The shallow Cheadle stony loams are on ridges. The deep Shawa loams are on fans and terraces. The deep Work clay loams are on fans and foot slopes.

This unit is used mainly for crops and range. Some areas are woodland.

28. Hanson-Sheege-Woosley

Deep to shallow, gently sloping to very steep loams, stony loams, and silty clay loams that formed in alluvium and in material weathered from limestone; on fans, foot slopes, and uplands

This map unit is in the southern and southeastern part of the survey area. It makes up about 4 percent of the survey area. About 30 percent is Hanson soils, 10 percent Sheege soils, 10 percent Woosley soils, and 50 percent minor soils.

Hanson soils are deep and are moderately sloping to steep. They are on fans and foot slopes. Typically the surface layer is dark gray and dark grayish brown loam 14 inches thick. The lower 6 inches is calcareous. The underlying material is very pale brown and pale yellow very cobbly loam.

Sheege soils are shallow, are gently rolling to very steep, and are on uplands. Typically the surface layer is dark gray and grayish brown stony loam about 11 inches thick. The underlying material is pale brown stony loam. Limestone bedrock is at a depth of about 16 inches.

Woosley soils are gently sloping to strongly rolling and moderately deep. They are on uplands and foot slopes. Typically the surface layer is very dark gray silt loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light gray silty clay loam and gravelly clay loam. The underlying material is hard fractured limestone bedrock.

Minor in this unit are Bridger, Raynesford, and Waybe soils. The deep Bridger loams and Raynesford loams are on foot slopes and fans. The calcareous Waybe clay loams are only 18 inches deep over shale.

This unit is used as cropland, rangeland, and woodland.

29. Monad-Loggert-Tigeron

Deep, gently sloping to steep loams, flaggy sandy loams, and extremely stony loams that formed in alluvium and in material weathered from sandstone; on fans, foot slopes, and uplands

This map unit is in the southeastern part of the survey area, north and east of Tiger Butte. It makes up about 5 percent of the survey area. About 45 percent is Monad soils, 25 percent Loggert soils, 5 percent Tigeron soils, and 25 percent soils of minor extent.

Monad soils are gently sloping to steep. They are on fans, foot slopes, and uplands. Typically the surface layer is very dark gray loam 9 inches thick. The subsoil is brown, pale brown, and very pale brown loam, clay loam, and stony clay loam.

Loggert soils are gently sloping to steep and are on uplands. Typically the upper 7 inches of the surface layer

is very dark grayish brown extremely stony loam, and the lower 12 inches is pinkish gray extremely stony loam. The subsoil is brown and reddish brown extremely stony sandy clay loam.

Tigeron soils are gently rolling to moderately steep and are on uplands. Typically the surface layer is covered with an inch or undecomposed needles, twigs, and cones. It is light brownish gray and light gray flaggy sandy loam 13 inches thick. The subsoil is pale brown flaggy and very flaggy sandy clay loam with clay bands and clay balls surrounded by light gray sandy loam. The underlying material is gray very flaggy loam.

Minor in this unit are Bridger, Cheadle, and Libeg soils. The deep Bridger loams are on fans and terraces. The shallow, stony loam Cheadle soils are on the ridges. The deep Libeg stony loams formed in sandstone and stony alluvium.

This unit is used as cropland, rangeland, and woodland.

30. Hilger-Castner-Perma-Rock outcrop

Deep and shallow, nearly level to very steep channery loams, very stony loams, and very cobbly loams that formed in alluvium and in material weathered from sandstone and igneous rock; and Rock outcrop; all on terraces, fans, foot slopes, and uplands

This map unit is in the mountainous areas along the southwest side of the survey area. It makes up about 12 percent of the survey area. About 40 percent is Hilger soils, 20 percent Castner soils, 15 percent Perma soils, 5 percent Rock outcrop, and 20 percent minor soils.

Hilger soils are deep and are gently sloping to very steep. They are on fans and foot slopes. Typically the surface layer is very dark grayish brown very stony loam about 5 inches thick. The subsoil is brown and light brownish gray very cobbly clay loam and very cobbly loam. The underlying material is light gray and light yellowish brown very cobbly loam.

Castner soils are shallow and are nearly level to very steep. They are on upland ridgetops, in convex areas, and at bench edges. Typically the surface layer is dark grayish brown and brown channery loam. The underlying material is pale brown very channery loam. Igneous bedrock is at a depth of about 16 inches.

Perma soils are gently sloping to very steep and are on terraces, fans, and foot slopes. Typically the surface layer is dark gray very cobbly loam 11 inches thick. The subsoil is brown and pale brown very cobbly loam. It is underlain by light brownish gray very cobbly sandy loam.

The Rock outcrop is mainly igneous rock on ridgetops and some convex slopes.

Minor in this unit are Cheadle, Loberg, and Shawa soils. The shallow Cheadle stony loams are on ridgetops and some convex slopes at higher elevations than the Castner soils. The deep Loberg stony loams are on

wooded foot slopes. The deep Shawa loams are on fans and terraces.

This unit is used mainly as rangeland. Small areas are cropland and woodland.

31. Sheege-Whitore-Rock outcrop

Deep and shallow, gently rolling to very steep stony loams and silty clay loams that formed in alluvium and in material weathered from limestone; and Rock outcrop; all on foot slopes and uplands

This map unit is in the southern part of the survey area, in the limestone mountains in the vicinity of Black Butte and Tiger Butte. It makes up about 2 percent of the survey area. About 40 percent is Sheege soils, 25 percent Whitore soils, 10 percent limestone rock outcrop, and 25 percent minor soils.

Sheege soils are gently rolling to very steep, shallow soils on uplands. Typically the surface layer is dark gray and grayish brown, calcareous stony loam 11 inches thick. The underlying material is pale brown stony loam. Limestone bedrock is at about 14 inches.

Whitore soils are deep and are moderately steep to very steep. They are on foot slopes and uplands. Typically the surface is covered with about an inch of undecomposed needles, twigs, and cones. The surface layer is grayish brown silt loam about 2 inches thick. The subsoil is brown and pale brown silty clay loam and very channery silty clay loam. The underlying material is calcareous, light brownish gray and light gray very channery silty clay loam.

The Rock outcrop is mainly limestone. It occurs on ridgetops, some convex slopes, and the very steep slopes of deep drainageways.

Minor in this unit are Adel, Hanson, and Raynesford soils. The Adel loams, the Hanson loams or stony loams, and the Raynesford loams or clay loams, which are all deep soils, are on fans and foot slopes.

This unit is used mainly as rangeland and woodland. Small areas are in crops.

Detailed soil descriptions

This section describes the soil series and map units in the survey area. Each soil is described in detail, and each map unit in that series is described briefly. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and

a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series* (θ). Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Gerber silty clay loam, 0 to 4 percent slopes, is one of several phases within the Gerber series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes, soil associations, and undifferentiated groups.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Kobar-Marias complex, 0 to 4 percent slopes, is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Hanson-Skaggs association, steep, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Bitton and Roy soils, 10 to 65 percent slopes, is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and

thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

This survey area has both broadly defined and narrowly defined map units. Broadly defined units, identified by an asterisk on the soil legend, are likely to be larger and to vary more in composition than units mapped in greater detail. Composition has been controlled well enough, however, for the expected use of the soils.

Listed at the end of each description of a map unit is the capability unit, range site, and windbreak group to which the map unit has been assigned.

The acreage and proportionate extent of each map unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary. For information on the terminology and methods of soil mapping, see the Soil Survey Manual (θ).

Soil maps of the Cascade County Area, completed in 1973, will not necessarily match those of Judith Basin County Area, Montana. New criteria for soil series and interpretations that have been developed and further information on climatic conditions have changed some delineations or soil series.

Abor series

The Abor series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over the interbedded shale and sandstone. Slopes are 0 to 20 percent. The elevation is 3,300 to 4,300 feet. The native vegetation is mainly western wheatgrass, green needlegrass, blue grama, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous silty clay about 6 inches thick. The subsoil is grayish brown and light brownish gray calcareous silty clay. Below 30 inches is light yellowish brown interbedded shale and sandstone.

Permeability is very slow. The available water capacity is low. Reaction is mildly alkaline in the upper 6 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Abor silty clay, 0 to 4 percent slopes, in cropland, 110 feet north and 1,000 feet west of the S1/4 corner sec. 19, T. 22 N., R. 2 E.

Ap—0 to 6 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate very fine granular structure; very hard, friable, sticky,

very plastic; slightly effervescent; mildly alkaline; abrupt smooth boundary.

B2—6 to 16 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure that parts to strong fine and medium blocky; extremely hard, firm, sticky, very plastic; many fine and very fine roots and pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

B31ca—16 to 26 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse blocky structure; extremely hard, firm, sticky, very plastic; many fine and very fine roots and pores; few fine distinct masses of lime; strongly effervescent; strongly alkaline; gradual wavy boundary.

B32ca—26 to 30 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse blocky structure; extremely hard, firm, sticky, very plastic; many fine and very fine roots and pores; 5 percent very dark gray (N3/) shale fragments; few fine distinct masses of lime and threads of gypsum; strongly effervescent; strongly alkaline; clear smooth boundary.

Cr—30 to 60 inches; light yellowish brown (2.5Y 6/4) interbedded shale and sandstone.

The A horizon is clay, silty clay, or clay loam. Depth to shale is 20 to 40 inches thick. The B horizon is silty clay or clay. It is moderately or strongly alkaline.

1—Abor silty clay, 0 to 4 percent slopes. This nearly level and undulating soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is silty clay loam and small areas of Pylon, Tanna, and Yawdim soils. The Yawdim soils are on narrow ridges and knolls.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-6 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

2—Abor-Yawdim clay loams, 4 to 8 percent slopes. This map unit is a complex of gently rolling soils on uplands. It is about 55 percent Abor clay loam and 25 percent Yawdim clay loam. The Abor soil has plane slopes. In places the slopes are convex. In some convex areas the surface layer is a gravelly and cobbly clay loam. In some small areas it is silty clay. Yawdim clay loam occupies the ridges and knolls. About 20 percent of the unit is included areas of Tanna soils.

The Abor soil in this unit has a profile similar to the one described as typical of the series, but it has a clay

loam surface layer. The Yawdim soil has a profile similar to the one described as typical of the Yawdim series, but the surface layer is clay loam.

Surface runoff is medium. The erosion hazard is moderate from both water and wind.

This unit is well suited to hay and range. It is suited to wheat, barley, and pasture under dryland management. Capability unit IVe-6 dryland. Abor soil in Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M. Yawdim soil in Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

3—Abor-Yawdim clays, 8 to 20 percent slopes. This map unit is a complex of strongly sloping and hilly soils on uplands. It is about 55 percent Abor clay and 30 percent Yawdim clay. The Abor soil is strongly sloping, and the Yawdim soil is hilly. About 15 percent of this unit is included areas of Tanna and Ethridge soils and a few small saline areas.

The Abor soil in this unit has a profile similar to the one described as typical of the series, but it has a clay surface layer. The Yawdim soil has a profile similar to the one described as typical of the Yawdim series, but the surface layer is clay.

Surface runoff is rapid. The erosion hazard is moderate from both water and wind.

This unit is well suited to range. Capability unit VIe-1 dryland. Abor soil in Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M if slope is less than 15 percent, group 4-0 if more than 15 percent. Yawdim soil in Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M if slope is less than 15 percent, group 4-0 if more than 15 percent.

Absarokee series

The Absarokee series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over the interbedded shale and sandstone. Slopes are 0 to 45 percent. The elevation is 3,500 to 4,700 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, forbs, and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark gray clay loam about 8 inches thick. The subsoil is dark brown, brown, and light brownish gray clay loam about 18 inches thick. The substratum is light gray, calcareous clay loam about 10 inches thick. Below 36 inches is very pale brown interbedded shale and sandstone.

Permeability is moderately slow. The available water capacity is low to moderate. Reaction is neutral in the upper 13 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Absarokee clay loam, 4 to 8 percent slopes, in cropland, 100 feet north and 50 feet east of the southwest corner SE1/4 sec. 14, T. 18 N., R. 5 E.

Ap—0 to 8 inches; dark gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) moist; moderate medium and fine granular structure; slightly hard, very friable, sticky, plastic; common fine and very fine roots; neutral; abrupt wavy boundary.

B21t—8 to 13 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium and fine prismatic structure parting to strong fine and very fine subangular blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on all ped surfaces; very dark brown (10YR 2/2) moist organic matter stains on prism faces; few sandstone fragments; neutral; clear wavy boundary.

B22t—13 to 21 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine and very fine subangular blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on all faces of peds; few sandstone fragments; mildly alkaline; clear wavy boundary.

B3ca—21 to 26 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to strong medium and fine subangular blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; less than 5 percent sandstone fragments; few fine and medium soft masses and threads of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cca—26 to 36 inches; light gray (2.5Y 7/2) clay loam, pale brown (10YR 6/3) moist; massive; hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; 10 percent sandstone fragments; common fine and medium soft masses of segregated lime; violently effervescent; moderately alkaline; gradual wavy boundary.

IIR—36 to 48 inches; very pale brown (10YR 7/3) interbedded shale and sandstone.

The A horizon is a clay loam or loam. The noncalcareous A and B horizons combined are 15 to 24 inches thick. The texture of the B horizon ranges from clay loam to clay. The A horizon is slightly acid or neutral. The noncalcareous B horizon is slightly acid to mildly alka-

line. The C horizon is mildly alkaline or moderately alkaline. The depth to hard interbedded shale and sandstone is 20 to 40 inches.

4—Absarokee clay loam, 0 to 4 percent slopes. This nearly level and undulating soil is on uplands. Included in mapping are a few small areas where the surface layer is loam and small areas of Borky, Work, and Sinnigam soils.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

5—Absarokee clay loam, 4 to 8 percent slopes. This gently rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is loam and small areas of Castner, Work, and Sinnigam soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

6—Absarokee clay loam, 8 to 15 percent slopes. This strongly rolling soil is on uplands. Included in mapping are a few small areas where the slope is less than 8 percent or more than 15 percent and small areas of Castner, Work, and Sinnigam soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

7—Absarokee, Borky, and Blythe soils, 15 to 45 percent slopes. This map unit consists of hilly and steep Absarokee loam, Borky stony loam, and Blythe loam. These soils are on uplands. Included in mapping are a few small areas of very stony loams that are 10 to 20 inches deep over interbedded sandstone and shale. Also included are small areas of Castner stony loam and Work clay loam.

Surface runoff is medium. The wind erosion hazard is slight, and the water erosion hazard is moderate or severe.

These soils are used for range. Capability unit VIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

8—Absarokee-Sinnigam complex, 2 to 8 percent slopes. This map unit is a complex of undulating and

gently rolling soils on uplands. It is about 65 percent Absarokee clay loam and 20 percent Sinnigam channery loam. Absarokee clay loam has smooth slopes and is in slightly concave areas. Sinnigam channery loam occupies knolls and ridges. About 15 percent of this unit is included areas of Work clay loam and Castner channery loam.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is used mostly for wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-4 dryland. Absarokee soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Sinnigam soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

Absher series

The Absher series consists of deep, moderately well drained soils formed in alluvium from alkaline shales. These soils occupy fans, foot slopes, and terraces at elevations of 3,300 to 4,000 feet. Slopes are 0 to 5 percent. The native vegetation is mainly western wheatgrass, green needlegrass, blue grama, and some forbs and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray loam about 2 inches thick. The subsoil is grayish brown clay loam and clay about 14 inches thick. The substratum is grayish brown and very pale brown clay loam and clay to a depth of 60 inches or more. The soil is calcareous below 5 inches.

Permeability is very slow. The available water capacity is moderate. Reaction is mildly alkaline in the upper 5 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Absher clay loam in an area of Absher-Nobe complex, 0 to 5 percent slopes, in native grass, 120 feet east and 60 feet south of center sec. 17, T. 19 N., R. 1 E.

A2—0 to 2 inches; light brownish gray (2.5Y 6/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate very fine platy structure parting to moderate very fine and fine granular; soft, very friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine and fine pores; many unstained sand grains; neutral; abrupt wavy boundary.

B21t—2 to 5 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; strong medium columnar structure; extremely hard, firm, sticky, plastic; many very fine and fine roots; many very fine and fine pores and few medium pores; few discon-

tinuous faint unstained sand grains on vertical ped faces; mildly alkaline; clear wavy boundary.

B22t—5 to 11 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; extremely hard, firm, sticky, plastic; many very fine and fine roots and pores; clay films on faces of peds; slightly effervescent; moderately alkaline; clear wavy boundary.

B3tcs—11 to 16 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong fine and medium subangular blocky structure; extremely hard, friable, sticky, plastic; many very fine and fine roots and pores; few very fine masses of lime; fine and medium gypsum crystals; clay films on faces of peds; strongly effervescent; strongly alkaline; clear wavy boundary.

C1cs—16 to 32 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very friable, sticky, plastic; many very fine and fine roots and pores; many medium and coarse gypsum crystals; strongly effervescent; strongly alkaline; clear wavy boundary.

C2cs—32 to 42 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, friable, sticky, plastic; common very fine and fine roots; many very fine and fine pores and few medium pores; common gypsum crystals; common salt crystals; slightly effervescent; strongly alkaline; diffuse wavy boundary.

C3cs—42 to 60 inches; very pale brown (10YR 7/3) clay, grayish brown (2.5Y 5/2) and brown (10YR 5/3) moist; varves which are silt loam and of one centimeter average thickness; massive; extremely hard, friable, sticky, plastic; few very fine and fine roots; few very fine and fine gypsum crystals; slightly effervescent; strongly alkaline.

The A horizon is loam, clay loam, or silty clay loam. The B horizon is silty clay or clay loam. It is moderately or strongly alkaline below a depth of 5 inches.

9—Absher complex, 0 to 2 percent slopes. This map unit consists of nearly level soils on terraces and fans. It is about 65 percent Absher clay loam and silty clay and 25 percent Harlem and Korent soils. The Absher clay loam occupies the concave areas in narrow stringers or circular areas. The Harlem and Korent soils are in the nearly level and slightly convex areas. About 10 percent of this unit is sandy loam soils in convex areas and clay soils in drainageways.

Surface runoff is slow. The erosion hazard is slight or moderate from wind and is slight from water.

This unit is well suited to hay, pasture, and range. It is suited to wheat and barley under dryland management. Under irrigation, it is also suited to wheat, barley, hay, and pasture. Capability unit IVs-1 dryland, IVs-1 irrigated;

Dense Clay range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S.

10—Absher-Nobe complex, 0 to 5 percent slopes.

This map unit consists of nearly level to moderately sloping soils on terraces and foot slopes and in swales. It is about 50 percent Absher clay loam and 30 percent Nobe silty clay. Absher clay loam is in the slightly elevated areas, and Nobe clay is in the nearly barren depressions. About 20 percent of the unit is included areas of Vanda and Lennep soils. The Absher and Nobe soils in this unit have the profiles described as typical of their respective series.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

These soils are used mostly for range. Capability unit Vls-1 dryland. Absher soil in Dense Clay range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S. Nobe soil in Saline Upland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-5.

Acel series

The Acel series consists of deep, well drained soils formed in alluvium and glacial outwash. These soils occupy outwash terraces and swales at elevations of 3,300 to 3,900 feet. Slopes are 0 to 8 percent. The native vegetation is mainly western wheatgrass, blue-bunch wheatgrass, green needlegrass, and some forbs and shrubs. The mean annual precipitation is 12 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silty clay loam about 6 inches thick. It forms a hard crust after drying. The subsoil is brown and grayish brown silty clay about 22 inches thick. The substratum is light brownish gray silty clay loam to depths of 66 inches or more. The soil is calcareous below a depth of 20 inches.

Permeability is slow. The available water capacity is high. Reaction is neutral or mildly alkaline in the upper 20 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Acel silty clay loam in an area of Linnet-Acel silty clay loams, 0 to 2 percent slopes, in cropland, 1,570 feet north and 80 feet west of southeast corner sec. 9, T. 22 N., R. 4 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; thin hard crust when dry over weak fine granular structure; very hard, friable, slightly sticky, slightly plastic; abundance of unstained silt and sand grains with some silt flow evidence in cracks; many fine and very fine roots; neutral; abrupt smooth boundary.

B21t—6 to 9 inches; brown (10YR 5/3) silty clay, dark brown (10YR 3/3) moist; moderate medium prismatic

ic structure parting to strong fine and very fine subangular blocky; extremely hard, firm, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on faces of peds; dark grayish brown (10YR 4/2) coats on peds; neutral; clear wavy boundary.

B22t—9 to 15 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine blocky; extremely hard, firm, sticky, very plastic; few fine and very fine roots; many fine and very fine pores; thin continuous clay films on all peds; grayish brown (10YR 5/2) coats on faces of peds; neutral; gradual wavy boundary.

B23t—15 to 20 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong fine and medium blocky; very hard, firm, sticky, plastic; few fine and very fine roots; common fine and very fine pores; thin continuous clay films on all peds; mildly alkaline; clear wavy boundary.

B3ca—20 to 28 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to strong medium blocky; very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; slightly effervescent with a few masses and threads of segregated lime; moderately alkaline; gradual wavy boundary.

C1ca—28 to 42 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak medium and coarse blocky; very hard, friable, sticky, plastic; few fine roots; common fine and very fine pores; strongly effervescent with common masses and threads of segregated lime; moderately alkaline; diffuse wavy boundary.

C2ca—42 to 66 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; very hard, friable, sticky, plastic; few very fine roots; common fine and very fine pores; a few masses and threads of segregated lime; strongly effervescent; strongly alkaline.

The A and B horizons combined are 20 to 36 inches thick. The B horizon is silty clay or clay.

11—Acel silty clay loam, 0 to 2 percent slopes.

This nearly level soil occupies outwash terraces and swales. Included are areas of Linnet soils and small areas where the surface layer is silty clay.

Surface runoff is slow. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, pasture, and hay under dryland management. Capability unit I1ls-2 dryland; windbreak suitability group 1; not assigned to a range site.

12—Acel silty clay loam, 2 to 8 percent slopes.

This undulating and moderately sloping soil occupies foot slopes, fans, and terraces. Included in mapping are a few small areas where slopes are less than 2 percent or more than 8 percent. Also included are areas where the surface layer is clay loam and small areas of Gerber soils.

Surface runoff is slow. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-10 dryland; Dense clay range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

Adel series

The Adel series consists of deep, well drained soils formed in alluvium from quartzite, limestone, sandstone, and igneous rocks. These soils occupy foot slopes and fans at elevations of 4,500 to 5,200 feet. Slopes are 4 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, Columbia needlegrass, rough fescue, and some forbs and shrubs. The mean annual precipitation is 17 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the surface layer is very dark gray and dark gray loam about 23 inches thick. The underlying material is gray loam to a depth of 66 inches or more. The soil is calcareous below a depth of 16 inches.

Permeability is moderate. The available water capacity is high. Reaction is neutral to a depth of about 16 inches and neutral or mildly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Adel loam, 4 to 15 percent slopes, in cropland, 900 feet west and 420 feet north of E1/4 corner sec. 36, T. 17 N., R. 7 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate very fine granular structure; slightly hard, very friable, nonsticky, slightly plastic; many very fine and fine roots; few limestone and sandstone pebbles; neutral; abrupt wavy boundary.

A12—7 to 16 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure that parts to moderate very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine and fine roots; few limestone and sandstone pebbles; neutral; clear wavy boundary.

A13—16 to 23 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine and fine roots; 10 percent limes-

tone and sandstone pebbles; slightly effervescent; mildly alkaline; clear wavy boundary.

C1—23 to 43 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common very fine and fine roots; 10 percent limestone and sandstone pebbles; strongly effervescent; mildly alkaline; gradual wavy boundary.

C2—43 to 66 inches; gray (10YR 6/1) loam, very dark gray (10YR 3/1) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; 15 percent limestone and sandstone pebbles; common fine distinct lime threads; strongly effervescent; mildly alkaline.

The A horizon is slightly acid to mildly alkaline. The C horizon is neutral to mildly alkaline.

13—Adel loam, 4 to 15 percent slopes. This gently sloping to strongly sloping soil is on foot slopes. It has the profile described as typical of the series. Included in mapping are a few small areas where the slope is less than 4 percent. Also included are small areas where the surface layer is gravelly loam and small areas of Hanson soil.

Surface runoff is slow. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1.

14—Aquepts and Aquolls, saline. This nearly level to moderately sloping map unit is made up of loams, clay loams, and silty clays. These poorly drained saline soils occupy fans, foot slopes, and swales. They are seeped by water that moves downslope in the soil material over shale or clay beds and surfaces on slopes, in swales, and in drainageways. A water table is at a depth of 1 to 3 feet in summer. Included in mapping are a few small areas where shale or sandstone is at 40 to 60 inches.

Surface runoff is medium. The erosion hazard is slight from wind and water.

These soils are used mostly for pasture or range. Capability unit VIw-1 dryland; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-5.

Assinniboine series

The Assinniboine series consists of deep, well drained soils formed in alluvium and eolian sands of mixed mineralogy. These soils occupy fans, terraces, and uplands at elevations of 3,300 to 4,100 feet. Slopes are 0 to 8 percent. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14

inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is brown and grayish brown sandy clay loam about 8 inches thick and light brownish gray fine sandy loam 6 inches thick. The substratum is light brownish gray fine sandy loam to a depth of 60 inches or more. The soil is calcareous below 15 inches.

Permeability is moderate. The available water capacity is moderate. Reaction is neutral or mildly alkaline in the surface layer and mildly or moderately alkaline in the subsoil and underlying material.

These soils are mainly used for dryland crops and range.

Typical profile of Assinniboine fine sandy loam, 0 to 4 percent slopes, in native grass, 500 feet east and 150 feet south of northwest corner NE1/4 sec. 6, T. 19 N., R. 2 E.

A1—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine platy structure parting to weak very fine granular; soft, very friable, slightly sticky, nonplastic; many fine roots and pores; neutral; clear wavy boundary.

B21t—7 to 11 inches; brown (10YR 5/3) sandy clay loam, dark grayish brown (10YR 4/2) moist; strong medium and coarse prismatic structure parting to moderate coarse blocky; very hard, friable, sticky, plastic; many fine roots and pores; mildly alkaline; clear irregular boundary.

B22t—11 to 15 inches; grayish brown (2.5Y 5/2) sandy clay loam, dark grayish brown (2.5Y 4/2) moist; strong coarse prismatic structure; very hard, friable, slightly sticky, slightly plastic; common fine roots; many fine pores; mildly alkaline; clear boundary.

B3—15 to 21 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky, nonplastic; common fine roots; common fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—21 to 26 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; hard, very friable, slightly sticky, nonplastic; common fine roots; common fine pores; few fine distinct lime threads and masses; strongly effervescent; moderately alkaline; diffuse boundary.

C2ca—26 to 60 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, nonsticky, nonplastic; few fine roots; common fine pores; strongly effervescent; moderately alkaline.

The noncalcareous part of the solum is 12 to 18 inches thick.

15—Assinniboine fine sandy loam, 0 to 4 percent slopes. This nearly level or undulating soil occupies terraces, fans, and uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is loamy fine sand and small areas of Tally and Yetull soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is also well suited to range. Capability unit IIIe-1 dryland, IIs-1 irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

16—Assinniboine fine sandy loam, 4 to 8 percent slopes. This moderately sloping soil occupies fans and uplands. Included in mapping are a few small areas where the surface layer is loamy fine sand and small areas of Tally and Yetull soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management. It is also well suited to range. Capability unit IIIe-1 dryland; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

17—Assinniboine-Absher complex, 0 to 2 percent slopes. This map unit consists of nearly level soils on terraces and fans. It is about 55 percent Assinniboine fine sandy loam and about 35 percent Absher clay loam. Assinniboine fine sandy loam is in the slightly elevated areas and Absher clay loam is in the depressions. About 10 percent of the unit is included areas of Nobe soils.

The Assinniboine soil in this unit has a profile similar to the one described as typical of the series, but the underlying material is strongly alkaline.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This unit is used mainly for growing wheat and barley under dryland management. It is suited to pasture and range. Capability unit IVs-1 dryland. Assinniboine soil in Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M. Absher soil in Dense Clay range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S.

Azaar series

The Azaar series consists of moderately deep, well drained soils formed in transported materials deposited over sandstone. These soils are on uplands. They are only 20 to 40 inches deep over the sandstone. Slopes are 0 to 4 percent. The elevation is 3,400 to 4,300 feet. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, and forbs and shrubs. The mean annual precipitation is 14 to 16

inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is a dark grayish brown fine sandy loam about 7 inches thick. The subsoil is about 6 inches of brown fine sandy loam. The substratum is light gray and grayish brown silt loam and silty clay loam about 19 inches thick. Below this is fractured indurated sandstone.

Permeability is moderately slow. The available water capacity is low or moderate. Reaction is neutral in the surface layer, mildly alkaline in the subsoil, and moderately or strongly alkaline in the underlying material.

These soils are mainly used for dryland crops and range.

Typical profile of Azaar fine sandy loam, in cropland, 660 feet east and 600 feet south of northwest corner SW1/4 sec. 34, T. 19 N., R. 2 E.

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

B2—7 to 13 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3, crushed 3/2 coats) moist; weak coarse and medium prismatic structure; slightly hard, very friable, slightly sticky, nonplastic; many fine and very fine roots; many fine and very fine pores; few medium pores; mildly alkaline; clear wavy boundary.

lIC1ca—13 to 22 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, very friable, sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; few medium pores; few fine faint lime masses; few fine angular sandstone fragments with lime crusts on underside; violently effervescent; moderately alkaline; diffuse wavy boundary.

lIC2ca—22 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; common medium distinct lime masses; few fine angular lime coated sandstone fragments; violently effervescent; strongly alkaline; abrupt wavy boundary.

lIR—32 inches; fractured indurated sandstone.

Depth to sandstone is generally between 30 and 40 inches but ranges from 20 and 40 inches. The A and B horizons are neutral to mildly alkaline. The C horizon is moderately to strongly alkaline.

18—Azaar fine sandy loam. This nearly level or undulating soil formed in transported materials over sand-

stone. It has the profile described as typical of the series. Slopes are 0 to 4 percent. Included in mapping are a few small areas where the surface layer is loam and a few small areas of Ticell and Lihen soils.

Surface runoff is slow. The erosion hazard is moderate from wind and slight from water.

This soil is suited to growing wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-1 dryland; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

Benz series

The Benz series consists of deep, well drained soils formed in loamy alluvium. These soils occupy fans, foot slopes, and terraces at elevations of 3,300 to 3,800 feet. Slopes are 0 to 10 percent. The native vegetation is mainly western wheatgrass, blue grama, Sandberg bluegrass, cactus, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown clay loam about 2 inches thick. The underlying material to a depth of 24 inches is light brownish gray clay loam stratified with loam. Below 24 inches is light brownish gray loam stratified with fine sandy loam. The soil is calcareous throughout.

Permeability is slow. The available water capacity is low to moderate. The reaction is strongly alkaline in the upper 2 inches and very strongly alkaline below.

These soils are mainly used for range.

Typical profile of Benz clay loam, 2 to 10 percent slopes, in native grass, 120 feet north and 1,400 feet west of southeast corner NE1/4 sec. 8, T. 21 N., R. 4 E.

A1—0 to 2 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak fine granular structure with 3 mm (1/8 inch) thick vesicular crust on surface; very hard, friable, sticky, plastic; slightly effervescent; strongly alkaline; clear boundary.

C1—2 to 12 inches; light brownish gray (2.5Y 6/2) clay loam stratified with loam, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, friable, sticky, plastic; common fine and very fine pores; slightly effervescent; strongly to very strongly alkaline; diffuse wavy boundary.

C2ca—12 to 24 inches; light brownish gray (2.5Y 6/2) clay loam stratified with loam, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, friable, sticky, plastic; few fine and very fine roots and pores; slightly effervescent with few threads and masses of segregated lime; very strongly alkaline; diffuse boundary.

C3—24 to 60 inches; light brownish gray (2.5Y 6/2) loam stratified with thin lenses of fine sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, friable, sticky, slightly plastic; few roots and pores; few threads of lime and few threads of gypsum; strongly effervescent; very strongly alkaline.

The depth to the ca horizon ranges from 9 to 15 inches. The A horizon is moderately alkaline or strongly alkaline. The C horizon is stratified loam, clay loam, and fine sandy loam. It is strongly alkaline or very strongly alkaline.

19—Benz clay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces. Included in mapping are areas where the surface layer is loam and small areas of Marvan and Vanda soils.

Surface runoff is slow. The hazard of wind and water erosion is slight.

This soil is suited to range. Capability unit VIs-1 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S.

20—Benz clay loam, 2 to 10 percent slopes. This gently sloping to strongly sloping soil occupies fans and foot slopes below alkaline shale uplands. It is dissected by numerous shallow drainageways. It has the profile described as typical of the series. Included in mapping are areas where the surface layer is loam and small areas of Marvan and Nobe soils.

Surface runoff is rapid. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to range. Capability unit VIs-1 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S.

Big Timber series

The Big Timber series consists of shallow, well drained soils formed in interbedded shale and sandstone of mixed mineralogy. These soils are on uplands. They are only 10 to 20 inches deep over interbedded shale and sandstone. Slopes are 8 to 70 percent. The elevation is 3,500 to 5,000 feet. The native vegetation is mainly bluebunch wheatgrass, rough fescue, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 16 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is reddish brown clay loam about 6 inches thick. The underlying material is reddish brown clay loam about 9 inches thick. Below this is platy shale bedrock. The soil is calcareous throughout.

Permeability is moderately slow. The available water capacity is very low. Reaction is moderately alkaline.

These soils are mainly used as rangeland.

Typical profile of Big Timber clay loam in an area of Big Timber-Castner complex, 30 to 70 percent slopes, in native grass, about 1,500 feet north and 100 feet east of southwest corner sec. 31, T. 19 N., R. 7 E.

A1—0 to 6 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; strong fine granular structure; hard, friable, sticky, plastic; many fine and few medium roots; many fine pores; 5 to 10 percent flat sandstone fragments; moderately alkaline; strongly effervescent; clear wavy boundary.

C1—6 to 15 inches; reddish brown (2.5YR 5/4) clay loam; dark reddish brown (2.5YR 3/4) moist; weak fine blocky structure; hard, friable, sticky, plastic; common fine and few medium roots; many fine pores; 15 percent fine sandstone and shale fragments; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2r—15 to 40 inches; reddish brown (2.5YR 5/4) platy clay loam shale, dark reddish brown (2.5YR 3/4) moist; some interbedded thin layers of hard sandstone.

Depth to interbedded shale and sandstone ranges from 10 to 20 inches. The volume of coarse fragments throughout the soil ranges from 0 to 25 percent. Reaction is mildly or moderately alkaline throughout the soil.

21—Big Timber-Castner complex, 8 to 30 percent slopes. This map unit consists of strongly rolling and hilly soils on sedimentary uplands. It is about 55 percent Big Timber clay loam and 30 percent Castner channery loam. Big Timber clay loam occupies the reddish brown clay loam shale areas. Castner channery loam occupies sandstone ledges. About 15 percent of the unit is included areas of Darret and Timberg soils.

The Big Timber soil in this unit has a profile similar to the one described as typical of the series. The Castner soil has a profile similar to the one described as typical of the Castner series, but it is generally reddish brown or brown.

Surface runoff is rapid. The erosion hazard is slight from wind and is moderate or severe from water.

This unit is used mostly for range. Capability unit VIe-1 dryland; Shallow range site, 15- to 19-inch precipitation zone. Big Timber soil in windbreak suitability group 3M if slope is less than 15 percent, group 4-0 if more than 15 percent. Castner soil in windbreak suitability group 4-1.

22—Big Timber-Castner complex, 30 to 70 percent slopes. This map unit consists of steep and very steep soils on sedimentary uplands. It is about 55 percent Big Timber clay loam and 25 percent Castner channery loam. Big Timber clay loam occupies areas where the reddish brown clay loam shale is interbedded with sandstone. Castner channery loam occupies areas above sandstone ledges. About 15 percent of the unit is included

ed sandstone and shale exposures and ledges along very steep slopes and on knolls. About 5 percent is Roy soils on short steep foot slopes.

The Big Timber soil in this unit has the profile described as typical of the series. The Castner soil has a profile similar to the one described as typical of the Castner series, but it is generally reddish brown or brown.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

This unit is used for range. Capability unit VIIe-1 dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

Binna series

The Binna series consists of deep, well drained soils formed in alluvium. They occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,100 feet. Slopes are 0 to 10 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown loam about 9 inches thick and is calcareous. The underlying material is light gray and light grayish brown, calcareous loam, gravelly sandy loam, and very gravelly loamy sand to a depth of 60 inches or more.

Permeability is moderate to a depth of about 28 inches and moderately rapid below. The available water capacity is moderate. Reaction is mildly alkaline in the upper 9 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops. Some areas are used for irrigated crops.

Typical profile of Binna loam, in cropland, 1,200 feet east and 1,800 feet north of southwest corner sec. 14, T. 20 N., R. 3 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; hard, friable, sticky, plastic; many fine roots; many fine pores; 5 percent gravel; slightly effervescent; mildly alkaline; abrupt wavy boundary.

C1ca—9 to 13 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; weak fine and very fine subangular blocky structure; hard, friable, sticky, plastic; common fine roots; many fine pores; 10 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

C2ca—13 to 24 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; hard, friable, sticky, plastic; common fine roots; many fine pores; 10 percent lime coated gravel; common medium distinct masses of lime;

strongly effervescent; strongly alkaline; clear wavy boundary.

C3—24 to 28 inches; light gray (2.5Y 7/2) gravelly sandy loam, grayish brown (2.5Y 5/2) moist; massive; hard, very friable, nonsticky, nonplastic; few fine roots; 25 percent gravel; strongly effervescent; moderately alkaline; gradual boundary.

IIC4—28 to 41 inches; light brownish gray (2.5Y 6/2) very gravelly loamy sand, grayish brown (2.5Y 5/2) moist; massive; hard, very friable, nonsticky, nonplastic; 65 percent gravel; strongly effervescent; moderately alkaline; diffuse boundary.

IIC5—41 to 60 inches; light brownish gray (2.5Y 6/2) very gravelly loamy sand, grayish brown (2.5Y 5/2) moist; massive; hard, very friable, slightly sticky, nonplastic; 60 percent gravel; strongly effervescent; moderately alkaline.

The A horizon is loam, fine sandy loam, or cobbly loam. It is mildly or moderately alkaline. The percentage of coarse fragments increases below 24 inches, and in the lower horizons coarse fragments make up 35 to 60 percent of the volume. The C horizon is moderately or strongly alkaline.

23—Binna fine sandy loam, 0 to 4 percent slopes.

This nearly level and undulating soil is on terraces and uplands. It has a profile similar to the one described as typical of the series, but it has a noncalcareous fine sandy loam surface layer and is underlain by sandstone or shale between 40 and 60 inches in some areas. Included in mapping are a few small, slightly convex areas of Azaar soils and small areas of Ervide soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 2M; not assigned to a range site.

24—Binna loam, 0 to 2 percent slopes. This nearly level soil is on terraces. It has the profile described as typical of the series. Included in mapping are a few areas where the surface layer is clay loam. Also included are small areas of Crago and Wabek soils that occupy slightly convex positions along terrace edges.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIs-1 dryland, IIIs-2 irrigated; windbreak suitability group 2M; not assigned to a range site.

25—Binna loam, 2 to 5 percent slopes. This gently sloping soil occupies terraces and fans. Included in mapping are small areas where the surface layer is gravelly loam and small areas of Wabek and Yamac soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-1 dryland, IIe-1 irrigated; windbreak suitability group 2M; not assigned to a range site.

26—Binna cobbly loam, 0 to 2 percent slopes. This nearly level soil is on terraces. It has a profile similar to the one described as typical of the series, but the surface layer is cobbly loam. Included in mapping are a few small areas in convex positions where cemented gravel is at a depth of about 15 inches. Also included are small areas of Crago soil on low convex ridges and terrace edges and areas of Rothiemay soils on smooth slopes.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IVs-1 dryland, IIIs-2 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

27—Binna-Evanston complex, 5 to 10 percent slopes. This map unit consists of moderately sloping and strongly sloping soils on foot slopes and fans dissected by deep drainageways. It is about 65 percent Binna loam and 25 percent Evanston clay loam. Binna soils occupy the smooth or slightly convex slopes, and Evanston soils are in slightly concave areas. About 10 percent of the unit is included areas of Wabek soils and areas of soils that have a very cobbly loam surface layer in some convex positions and along rims of deeply dissected drainages.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is used mostly for range. Capability unit IVE-3 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Bitton series

The Bitton series consists of deep, well drained soils formed in alluvium. These soils are on uplands and foot slopes at elevations of 3,300 to 4,600 feet. Slopes are 10 to 65 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown stony loam about 7 inches thick. The underlying material is pale brown very stony loam and light brownish gray very stony clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is low. Reaction is mildly alkaline in the upper 7 inches and moderately alkaline below.

These soils are mainly used for range.

Typical profile of Bitton stony loam, in native grass, 800 feet north and 530 feet west of center of sec. 1, T. 18 N., R. 6 E.

A11—0 to 3 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; strong very fine granular structure; soft, very friable, slightly sticky, nonplastic; many fine roots; 20 percent sandstone fragments; slightly effervescent; mildly alkaline; abrupt wavy boundary.

A12—3 to 7 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine roots; 20 percent sandstone fragments; slightly effervescent; mildly alkaline; gradual wavy boundary.

C1ca—7 to 40 inches; pale brown (10YR 6/3) very stony loam; brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky, nonplastic; common fine roots; many fine and very fine pores; 60 percent sandstone fragments; strongly effervescent; moderately alkaline; diffuse boundary.

C2—40 to 60 inches; light brownish gray (2.5Y 6/2) stony clay loam; dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, sticky, plastic; few fine roots; few fine and very fine pores; 50 percent sandstone fragments; strongly effervescent; moderately alkaline.

The A horizon is 7 to 12 inches thick. The C horizon is 35 to 70 percent coarse fragments, by volume. The A horizon is neutral or mildly alkaline. The C horizon is mildly or moderately alkaline.

28—Bitton and Roy soils, 10 to 65 percent slopes.

This map unit consists of strongly sloping to very steep Bitton stony loams and Roy stony loams. These soils occupy foot slopes, fans, and uplands. Both have the profile described as typical of their respective series. Included in mapping are narrow valley bottoms and small areas of Castner and Sinnigam soils along ridgetops.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is severe from water.

These soils are used mostly for range. Capability unit VIIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

Blythe series

The Blythe series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over interbedded sandstone and shale. Slopes are 0 to 45 percent. The elevation is 4,000 to 4,800 feet. The native vegeta-

tion is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 16 to 20 inches. The mean annual air temperature is 40 to 44 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is gray silt loam about 7 inches thick. The subsurface layer is light gray silt loam 4 inches thick. The subsoil is dark grayish brown and grayish brown clay 25 inches thick. Below 36 inches is platy clay shale. The soil is calcareous below 24 inches.

Permeability is very slow. The available water capacity is moderate. Reaction is slightly acid to a depth of 11 inches, neutral to 24 inches, and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Blythe silt loam, 0 to 5 percent slopes, in cropland, 1,320 feet south and 200 feet west of northeast corner sec. 31, T. 20 N., R. 3 W.

Ap—0 to 7 inches; gray (10YR 5/1) silt loam, black (10YR 2/1) moist; strong fine granular structure; hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; slightly acid; abrupt wavy boundary.

A2—7 to 11 inches; light gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; weak coarse platy parting to moderate very fine blocky structure; hard, very friable, slightly sticky, slightly plastic; many fine roots; many fine pores; slightly acid; abrupt smooth boundary.

B21t—11 to 15 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; strong medium columnar structure parting to strong medium and fine blocky; light gray (10YR 6/1) coatings of silt and sand on tops and sides of columnar structure; extremely hard, very firm, sticky, plastic; few fine roots; common fine and very fine pores; thin continuous clay films on ped surfaces; neutral; clear wavy boundary.

B22t—15 to 24 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; very hard, very firm, sticky, plastic; few fine roots; common fine and very fine pores; thin continuous clay films on ped surfaces; neutral; clear wavy boundary.

B3ca—24 to 36 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few fine distinct mottles of yellowish brown (10YR 5/6); moderate medium subangular blocky structure; very hard, firm, sticky, plastic; few fine roots; common fine and very fine pores; slightly effervescent with common medium distinct masses of segregated lime; mildly alkaline; gradual boundary.

Cr—36 inches; platy clay shale.

The A horizon is mainly silt loam, but in places is loam. Depth to interbedded shale and sandstone is 20 to 40 inches. The A horizon is slightly acid or neutral. The B horizon is neutral or mildly alkaline.

29—Blythe silt loam, 0 to 5 percent slopes. This nearly level and undulating soil occupies sedimentary uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is clay loam and a few small areas of Shane and Work soils.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 2M; not assigned to a range site.

30—Blythe silt loam, 5 to 10 percent slopes. This gently rolling and strongly rolling soil is on uplands. Included in mapping are a few small areas where the surface layer is clay loam and a few small areas of Shane and Work soils.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

31—Blythe silt loam, 10 to 20 percent slopes. This strongly rolling and hilly soil occupies sedimentary uplands. Included in mapping are small areas where the surface layer is clay loam and small areas of Shane and Work soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M if slope is less than 15 percent, group 4-0 if more than 15 percent.

Borky series

The Borky series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone of mixed mineralogy. These soils are on uplands. They are only 20 to 40 inches deep over interbedded shale and sandstone. Slopes are 2 to 45 percent. The elevation is 3,500 to 4,700 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, basin wildrye, forbs, and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown very stony loam about 4 inches thick. The subsoil is dark brown and brown very stony clay 10 inches thick. The substratum is pale yellow, calcareous very stony silty clay 18 inches thick. Below 32 inches is pale yellow siltstone.

Permeability is slow. The available water capacity is very low. Reaction is neutral in the upper 8 inches and mildly or moderately alkaline to the shale.

These soils are used for range.

Typical profile of Boriky very stony loam, in an area of Boriky-Sinnigam very stony loams, 2 to 15 percent slopes, in native grass, 1,600 feet east and 1,700 feet north of the southeast corner sec. 11, T. 19 N., R. 6 E.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) very stony loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; 25 percent stones, 15 percent pebbles, 5 percent cobbles; neutral; clear wavy boundary.

B21t—4 to 8 inches; dark brown (10YR 4/3) very stony clay, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong fine subangular blocky; very hard, friable, sticky, very plastic; many fine and very fine roots; many fine and very fine pores; 30 percent stones, 15 percent pebbles; neutral; clear wavy boundary.

B22t—8 to 14 inches; brown (10YR 5/3) very stony clay, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine subangular blocky; very hard, firm, sticky, very plastic; many fine and very fine roots; many fine and very fine pores; thin clay film on ped faces; 35 percent stones, 10 percent pebbles; mildly alkaline; clear irregular boundary.

C1ca—14 to 32 inches; pale yellow (2.5Y 8/4) very stony silty clay, pale yellow (2.5Y 7/4) moist; moderate medium prismatic structure parting to moderate fine and very fine subangular blocky; very hard, firm, sticky, plastic; common fine and very fine roots; common very fine pores; 35 percent stones, 20 percent pebbles; common threads and soft masses of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2r—32 inches; pale yellow (2.5Y 8/4) siltstone containing thin (1/4 to 1/2 inch thick) lenses of sandstone.

The A horizon is very stony loam or stony loam. The B2t horizon is very stony clay or very stony heavy clay loam. The volume of rock fragments ranges from 35 to 60 percent in the B and C horizons. Depth to sandstone and shale is 20 to 40 inches.

32—Boriky-Sinnigam very stony loams, 2 to 15 percent slopes. This map unit consists of undulating to

strongly rolling soils on sedimentary uplands. It is about 60 percent Boriky very stony loam and 25 percent Sinnigam very stony loam. The Boriky soil occupies the long concave side slopes, and the Sinnigam soil is on the convex ridges and knolls. About 15 percent of the unit is included areas of Absarokee and Work soils at the base of smooth slopes and in swales. The Boriky and Sinnigam soils in this unit have the profile described as typical of their respective series.

Surface runoff is medium. The erosion hazard is slight.

These soils are used for range. Capability unit Vlls-1 dryland. Boriky soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Sinnigam soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

Bridger series

The Bridger series consists of deep, well drained soils formed in alluvium. They occupy fans, foot slopes, and terraces at elevations of 4,500 to 5,500 feet. Slopes are 2 to 20 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, and forbs and shrubs. The mean annual precipitation is 18 to 22 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the upper 8 inches of the surface layer is very dark gray loam and the lower 2 inches is very dark gray clay loam. The subsoil is brown and grayish brown clay loam 18 inches thick. The substratum is light brownish gray and light gray, calcareous gravelly clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is high. Reaction is neutral to a depth of 24 inches, mildly alkaline to 28 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Bridger loam, 10 to 20 percent slopes, in native grass, 1,320 feet north and 1,056 feet west of southeast corner sec. 36, T. 17 N., R. 6 E.

A11—0 to 8 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; strong fine granular structure; slightly hard, very friable, slightly sticky, non-plastic; many fine and very fine roots; neutral; abrupt wavy boundary.

A12—8 to 10 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; strong fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; clear wavy boundary.

B2t—10 to 24 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; strong fine and medium blocky structure; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very

fine pores; thin continuous clay films on ped surfaces; dark grayish brown (10YR 4/2) coats on peds; few sandstone fragments; neutral; clear wavy boundary.

B3—24 to 28 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; strong fine and medium blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; mildly alkaline; gradual boundary.

C1ca—28 to 36 inches; light brownish gray (10YR 6/2) gravelly clay loam, grayish brown (10YR 5/2) moist; weak medium blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; 20 percent sandstone fragments by volume; strongly effervescent; moderately alkaline; diffuse boundary.

C2ca—36 to 60 inches; light gray (10YR 7/2) gravelly clay loam, pale brown (10YR 6/3) moist; massive; hard, friable, sticky, plastic; few fine roots; common fine and very fine pores; 25 percent sandstone and limestone fragments by volume; violently effervescent; moderately alkaline.

Gravel, cobbles, and stones make up from 5 to 30 percent, by volume, of the solum. A Cca horizon generally occurs at a depth of 24 to 30 inches, but in places the soil is noncalcareous to depths of as much as 40 inches. The A horizon is slightly acid or neutral. The B horizon is neutral or mildly alkaline. The C horizon is mildly or moderately alkaline.

33—Bridger loam, 2 to 10 percent slopes. This gently sloping to strongly sloping soil occupies terraces and fans. Included in mapping are small areas where the surface layer is stony loam and small areas of Hilger and Adel soils.

Surface runoff is slow or medium. The wind erosion hazard is slight, and the water erosion hazard is slight or moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVc-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1.

34—Bridger loam, 10 to 20 percent slopes. This strongly sloping and moderately steep soil is on foot slopes and fans. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is silt loam and small areas of Adel and Monad soils.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1 if

slope is less than 15 percent, group 4-0 if more than 15 percent.

Bynum series

The Bynum series consists of moderately deep, well drained soils formed in material weathered from shale and limestone. These soils are on uplands. They are only 20 to 40 inches deep over shale and limestone. Slopes are 20 to 50 percent. The elevation is 4,600 to 5,500 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, Idaho fescue, forbs and shrubs, and a low density stand of fir trees. The mean annual precipitation is 18 to 20 inches. The mean annual air temperature is 39 to 42 degrees F. The growing season is 60 to 90 days.

Typically 1 1/2 to 2 inches of forest litter of needles, twigs, and humus is on the surface. The surface layer is very dark gray clay loam about 4 inches thick. The subsoil is dark gray and gray clay loam 12 inches thick. The substratum is light gray gravelly clay loam 13 inches thick. Below 29 inches is white clay loam platy shale.

Permeability is moderate. The available water capacity is low or moderate. Reaction is neutral in the upper 9 inches and mildly or moderately alkaline below.

These soils are mainly woodland and rangeland.

Typical profile of Bynum clay loam, in an area of Waybe-Bynum clay loams, 20 to 50 percent slopes, in native vegetation, 2,400 feet east and 1,600 feet north of southwest corner sec. 10, T. 16 N., R. 7 E.

O1—1 1/2 to 1/2 inch; forest litter of needles and twigs.

O2—1/2 inch to 0; decomposed humus.

A1—0 to 4 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; weak fine and medium platy structure parting to moderate fine granular; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium to coarse roots; 10 percent limestone fragments; neutral; clear wavy boundary.

B2—4 to 9 inches; dark gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; moderate fine blocky structure; slightly hard, friable, sticky, plastic; many fine and very fine roots; few medium and coarse roots; many fine and very fine pores; neutral; clear wavy boundary.

B3—9 to 16 inches; gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist; moderate fine blocky structure; slightly hard, friable, sticky, plastic; common fine and very fine roots; few medium to coarse roots; many fine and very fine pores; few medium and coarse pores; 15 percent limestone fragments; strongly effervescent; mildly alkaline; gradual wavy boundary.

C1ca—16 to 29 inches; light gray (2.5Y 7/2) gravelly clay loam, grayish brown (2.5Y 5/2) moist; moderate fine blocky structure; slightly hard, friable, sticky,

plastic; few fine, medium and coarse roots; common fine and very fine pores; 30 percent limestone fragments; moderately alkaline; gradual wavy boundary.
 C2r—29 to 60 inches; white (2.5Y 8/2) clay loam platy shale, light brownish gray (2.5Y 6/2) moist; violently effervescent.

In some areas the soil lacks the O horizon. The thickness of the A and B horizons combined ranges from 11 to 20 inches. The B horizon is clay loam or silty clay loam. The depth to clay loam platy shale and limestone ranges from 20 to 40 inches. The C horizon is 5 to 30 percent limestone fragments. The A horizon is neutral or mildly alkaline.

Cabbart series

The Cabbart series consists of shallow, well drained soils formed in material weathered from interbedded siltstone and sandstone. These soils are on uplands at elevations of 3,500 to 4,500 feet. Slopes are 4 to 50 percent. The native vegetation is mainly bluebunch wheatgrass, prairie sandreed, green needlegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous loam about 3 inches thick. The underlying material is light brownish gray and pale yellow, calcareous loam 15 inches thick. Below 18 inches is pale yellow interbedded siltstone and sandstone.

Permeability is moderate. The available water capacity is very low. Reaction is moderately alkaline.

These soils are mainly used for range.

Typical profile of Cabbart loam, in native grass, 2,450 feet east and 1,200 feet north of southwest corner sec. 7, T. 20 N., R. 3 W.

A1—0 to 3 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline; clear wavy boundary.

C1ca—3 to 7 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure; hard, very friable, slightly sticky, slightly plastic; few masses of segregated lime; strongly effervescent; moderately alkaline; clear wavy boundary.

C2ca—7 to 16 inches; pale yellow (2.5Y 7/4) loam, light yellowish brown (2.5Y 6/4) moist; weak coarse prismatic structure; hard, very friable, slightly sticky, slightly plastic; common masses and threads of segregated lime; strongly effervescent; moderately alkaline; clear wavy boundary.

C3ca—16 to 18 inches; pale yellow (2.5Y 7/4) loam, light yellowish brown (2.5Y 6/4) moist; weak coarse

prismatic structure parting to moderate thin platy; very hard, friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline; clear wavy boundary.

C4r—18 inches; pale yellow (5Y 7/4) thin to medium platy siltstone and soft fine grained sandstone.

Depth to platy siltstone and sandstone ranges from 10 to 20 inches. About 5 to 25 percent, by volume, of any horizon can be siltstone and sandstone fragments. The soil is mildly or moderately alkaline.

Cargill series

The Cargill series consists of moderately deep, well drained soils formed in material weathered from interbedded siltstone, sandstone, and shale. These soils are on uplands at elevations of 3,200 to 4,300 feet. Slopes are 0 to 10 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous silty clay loam about 6 inches thick. The subsoil is pale brown, calcareous silty clay loam 11 inches thick. The substratum is light gray and pale yellow, calcareous silty clay loam. Below 30 inches is light brownish gray, calcareous siltstone and shale.

Permeability is moderately slow. The available water capacity is low or moderate. Reaction is moderately alkaline to a depth of 17 inches and strongly alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Cargill silty clay loam, 0 to 4 percent slopes, in cropland, 400 feet west and 360 feet north of southeast corner NE1/4 sec. 24, T. 22 N., R. 1 E.

Ap—0 to 6 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; hard, very friable, sticky, slightly plastic; common fine and very fine roots; weakly effervescent; moderately alkaline; abrupt smooth boundary.

B2—6 to 13 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to weak medium and coarse blocky; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; clear wavy boundary.

B3ca—13 to 17 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to weak medium and coarse blocky; very hard, friable, sticky, plastic; common fine and very fine roots; many fine

and very fine pores; common medium soft masses of segregated lime; few angular sandstone pebbles with lime crusts and pendants on undersides; violently effervescent; moderately alkaline; clear wavy boundary.

C1ca—17 to 25 inches; light gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; common coarse masses of segregated lime; few small angular sandstone fragments; violently effervescent; strongly alkaline; clear wavy boundary.

C2ca—25 to 30 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; massive in upper part and platy in lower part; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; 10 percent of brownish yellow (10YR 6/6) shale fragments; few coarse soft masses of segregated lime; violently effervescent; strongly alkaline; gradual wavy boundary.

IIC3r—30 inches; light brownish gray (2.5Y 6/2) platy siltstones and shales.

The A horizon is silty clay loam or silt loam. Depth to the interbedded siltstone, sandstone, and shale ranges from 20 to 40 inches but is generally between 30 and 40 inches. Reaction in the A horizon is mildly or moderately alkaline.

35—Cargill silty clay loam, 0 to 4 percent slopes.

This nearly level and undulating soil is on sedimentary uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is silt loam and a few small areas where slopes are more than 4 percent. Small areas of Cabbart and Abor soils are also included.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-2 dryland; windbreak suitability group 2M; not assigned to a range site.

36—Cargill-Cabbart complex, 4 to 10 percent slopes. This map unit consists of gently rolling and strongly rolling soils on sedimentary uplands. It is about 50 percent Cargill silty clay loam and 30 percent Cabbart loam. The Cabbart loam occupies the convex sideslopes, ridges, and knolls. About 20 percent of the unit is included areas of Yawdim and Abor soils.

Surface runoff is medium from the Cargill soils and rapid from the Cabbart soils. The erosion hazard is moderate from wind and is severe from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIVe-3 dryland; not assigned to a range site. Cargill soil in windbreak

suitability group 2M; Cabbart soil in windbreak suitability group 4-1.

Castner series

The Castner series consists of shallow, well drained soils formed in material weathered from shattered sandstone and igneous bedrock. These soils are on uplands at elevations of 3,350 to 4,600 feet. Slopes are 0 to 60 percent. The native vegetation is mainly bluebunch wheatgrass, rough fescue, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 105 to 135 days.

In a representative profile the surface layer is about 6 inches of dark grayish brown channery sandy loam and 4 inches of brown, calcareous very channery loam. The underlying material is pale brown, calcareous extremely channery loam 6 inches thick. Below 16 inches is calcareous sandstone.

Permeability is moderate. The available water capacity is very low. Reaction is neutral or mildly alkaline in the upper 10 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Castner channery loam, in an area of Castner-Reeder complex, 4 to 35 percent slopes, in native grass, 300 feet west and 1,030 feet south of northeast corner sec. 18, T. 20 N., R. 3 W.

A11—0 to 6 inches; dark grayish brown (10YR 4/2) channery sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable, slightly sticky, nonplastic; 25 percent sandstone fragments mainly smaller than 6 inches but with some flagstones; neutral; clear smooth boundary.

A12—6 to 10 inches; (10YR 4/3) very channery loam, very dark grayish brown, (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky, nonplastic; many fine and very fine roots and pores; 50 percent sandstone fragments of flagstone size and smaller; lime crusts on undersides of some fragments; slightly effervescent; mildly alkaline; clear smooth boundary.

Cca—10 to 16 inches; pale brown (10YR 6/3) extremely channery loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots with a root mat at 16 inches; 75 percent sandstone fragments of flagstone size and smaller; thick lime crusts and pendants; strongly effervescent; moderately alkaline; abrupt wavy boundary.

R—16 inches; layered shattered calcareous sandstone with lime crusts at the contact of fractures.

The A horizon is loamy fine sand, channery sandy loam, channery, cobbly and stony loam, or very channery loam. Depth to bedrock ranges from 10 to 20 inches. The soil and bedrock are generally calcareous but in some places lime is absent throughout the soil. The A horizon is neutral or mildly alkaline, and the C horizon is mildly or moderately alkaline.

37—Castner loamy fine sand, 0 to 3 percent slopes. This nearly level and undulating soil is on sedimentary uplands. It has a profile similar to the one described as typical of the series, but the surface layer is a loamy fine sand. Included in mapping are small areas of Ervide and Castner soils.

Surface runoff is slow. The erosion hazard is severe from wind and is slight from water.

This soil is well suited to range. Capability unit VIs-1 dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

38—Castner complex, 2 to 15 percent slopes. This map unit consists of undulating to strongly rolling soils on sedimentary uplands. It is about 65 percent Castner channery loam and 15 percent Sinnigam very stony loam. Castner channery loam occupies bench edges and convex areas. Sinnigam very stony loam is on smooth slopes. About 20 percent of the unit is included areas of Absarokee, Roy, and Reeder soils and a few areas of Castner very stony loams. The Castner soil in this unit has a profile similar to the one described as typical of the series, but it has a channery loam surface layer.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is slight or moderate from water.

This unit is used for range. Capability unit VIs-1 dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

39—Castner-Perma-Rock outcrop complex, 10 to 60 percent slopes. This map unit consists of strongly sloping to very steep soils on foot slopes and uplands. It is about 40 percent Castner cobbly loam and 40 percent Perma very cobbly loam, and 15 percent areas of igneous rock outcrop. Castner cobbly loam occupies convex slopes, ridges, and knolls. Perma very cobbly loam is on foot slopes and fans. About 5 percent of the unit is included areas of Hilger and Loberg soils. The Loberg soil is mainly on north facing slopes. Also included are small areas where slope is less than 10 percent.

The Castner soil in this complex has a profile similar to the one described as typical of the series, but it formed in material weathered from igneous bedrock. The Perma soil has the profile described as typical of the Perma series.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is moderate or severe from water.

This unit is mostly native pasture. Some areas are woodland. Forested areas are mainly on the Loberg,

warm, soil, or on similar soils, where slope is 5 to 30 percent. See the description of map unit 134, Loberg stony loam, warm, for woodland interpretations. Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Castner soil in Shallow range site, 15- to 19-inch precipitation zone. Perma soil in Silty range site, 15- to 19-inch precipitation zone.

40—Castner-Reeder complex, 4 to 35 percent slopes. This map unit consists of gently rolling to steep soils on sedimentary uplands. It is about 45 percent Castner stony loam and 40 percent Reeder loam. The Castner stony loam is on convex slopes, ridges, and knolls. The Reeder loam occupies smooth slopes and slightly concave areas. About 15 percent of the unit is included areas of Dast and Yawdim soils.

The Castner soil has the profile described as typical of the series. The Reeder soil has a profile similar to the one described as typical of the Reeder series.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is moderate or severe from water.

This unit is used for range. Capability unit VIe-1 dryland. Castner soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1. Reeder soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M if slope is less than 15 percent, group 4-0 if more than 15 percent.

Cheadle series

The Cheadle series consists of shallow, well drained soils formed in material weathered from fractured sandstone and igneous bedrock. These soils are on uplands. They are only 8 to 20 inches deep over bedrock. Slopes are 2 to 70 percent. The elevation is 4,600 to 6,500 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, Idaho fescue, and forbs and shrubs. The mean annual precipitation is 16 to 20 inches. The mean annual air temperature is 38 to 44 degrees F. The growing season is 60 to 105 days.

Typically the surface layer is dark grayish brown stony loam and grayish brown very stony loam about 10 inches thick. Below 10 inches is fractured sandstone.

Permeability is moderate. The available water capacity is very low. Reaction is neutral.

These soils are used for range.

Typical profile of Cheadle stony loam, in native grass, 1,320 feet south and 800 feet east of northwest corner NE1/4 sec. 15, T. 17 N., R. 7 E.

A11—0 to 5 inches; dark grayish brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; few medium roots; 35 percent stone fragments by volume; neutral; clear wavy boundary.

A12—5 to 10 inches; grayish brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky, nonplastic; many fine and very fine roots; few medium roots; 65 percent stone fragments by volume; neutral; gradual wavy boundary.

R—10 inches; fractured sandstone.

The A11 horizon is stony loam or channery loam. The A horizon is 6 to 12 inches thick. Depth to bedrock ranges from 10 to 20 inches. The soil is noncalcareous in areas where the bedrock is within a depth of 12 inches. Calcareous very stony loams are generally above the bedrock in areas where the soil is 12 to 20 inches deep over sandstone. The volume of rock fragments ranges from 35 to 60 percent. The A horizon is neutral or mildly alkaline. The C horizon, where present, is moderately alkaline.

41—Cheadle stony loam, 2 to 15 percent slopes.

This undulating to strongly rolling soil is on uplands. Included in mapping are small areas of sandstone outcrop on ridges and knolls and small areas of Loggert soils.

Surface runoff is slow or medium. The wind erosion hazard is slight, and the water erosion hazard is slight or moderate.

This soil is used for range. Capability unit VIs-1 dryland; Shallow range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-1.

42—Cheadle-Hilger complex, 10 to 60 percent slopes. This map unit consists of strongly rolling to very steep soils on foot slopes and uplands. It is about 45 percent Cheadle stony loams and about 35 percent Hilger very stony loams. The Cheadle stony loams occupy convex slopes, ridges, and knolls. The Hilger very stony loams are on foot slopes. About 5 percent of the unit is included areas of igneous rock outcrop, and 15 percent is areas of Perma and Loberg soils. Also included are small areas where the slope is less than 10 percent.

The Cheadle soil in this unit has a profile similar to the one described as typical of the series, but it formed in material weathered from igneous bedrock. The Hilger soil has a profile similar to the one described as typical of the Hilger series, but the summer soil temperature is somewhat cooler than typical for the series.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

This unit is mainly native pasture. Some areas are woodland. Forested areas are mainly on the Loberg and similar soils where slopes are 5 to 30 percent. See the description of map unit 135, Loberg-Cheadle complex, for the woodland interpretations. Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Cheadle soil in

Shallow range site, 15- to 19-inch precipitation zone. Hilger soil in Silty range site, 15- to 19-inch precipitation zone.

43—Cheadle-Loggert complex, 15 to 70 percent slopes. This map unit consists of hilly to very steep soils on sedimentary uplands. It is about 50 percent Cheadle stony loam and 40 percent Loggert extremely stony loam. Cheadle stony loam is mainly in the convex areas. About 10 percent of the unit is included areas of Tigreron stony loam and outcrops of sandstone.

The Cheadle soil in this unit has the profile described as typical of the series. The Loggert soil has a profile similar to the one described as typical of the Loggert series.

Surface runoff is medium. The wind erosion hazard is slight, and the water erosion hazard is slight or moderate.

This soil is mainly used for native pasture. Some areas are woodland. Forest in this unit is mainly in areas of Tigreron soils and similar included soils where slopes are 15 to 30 percent. See the description of map unit 200, the Tigreron-Loggert complex, for woodland interpretations. Capability unit VIIs-1 dryland; windbreak suitability group 4-0. Cheadle soil in Shallow range site, 20- to 24-inch precipitation zone. Loggert soil in Stony range site, 20- to 24-inch precipitation zone.

Crago series

The Crago series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,100 feet. Slopes are 0 to 45 percent. The native vegetation is mainly bluebunch wheatgrass, western wheatgrass, needleandthread, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous very cobbly loam about 3 inches thick. Below this is light brownish gray, calcareous very gravelly loam 6 inches thick. The substratum is white and pale brown, calcareous extremely gravelly sandy loam.

Permeability is moderately slow to a depth of about 36 inches and moderately rapid below. The available water capacity is low. Reaction is moderately alkaline.

These soils are used mainly for dryland crops or range. Some areas are used for irrigated crops.

Typical profile of Crago very cobbly loam, in native grass, 1,200 feet north and 380 feet west of southeast corner sec. 12, T. 21 N., R. 2 W.

A1—0 to 3 inches; grayish brown (10YR 5/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure, soft, very friable, slightly sticky, slightly plastic; many fine

and very fine roots; 50 percent by volume coarse fragments; slightly effervescent; moderately alkaline; clear wavy boundary.

AC—3 to 9 inches; light brownish gray (10YR 6/2) very gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure parting to moderate fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; 50 percent gravel and 5 percent cobbles; pendants of lime on undersides of pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

C1ca—9 to 36 inches; white (10YR 8/2) extremely gravelly sandy loam, light brownish gray (10YR 6/2) moist; massive; hard, very friable, nonsticky, nonplastic; few fine and very fine roots; common fine and very fine pores; 60 percent gravel and 10 percent cobbles with lime coating on fragments and weak cementation between pebbles; violently effervescent; moderately alkaline; gradual wavy boundary.

C2—36 to 60 inches; pale brown (10YR 6/3) extremely gravelly sandy loam, brown (10YR 5/3) moist; massive; soft, very friable, nonsticky, nonplastic; 70 percent gravel; strongly effervescent; moderately alkaline.

The A horizon is very cobbly loam or gravelly loam. The C horizon is very limy, very gravelly or extremely gravelly loam or sandy loam to a depth of about 36 inches and grades to very or extremely gravelly loamy sand or sandy loam below. The A horizon is mildly or moderately alkaline.

44—Crago gravelly loam, 0 to 2 percent slopes. This nearly level soil is on terraces. Included in mapping are small narrow convex areas where cemented gravel is at a depth of about 15 inches. Also included are small areas of Binna and Rothiemay soils.

Surface runoff is medium. The erosion hazard is slight from wind and water.

Under dryland management, this soil is suited to range. Under irrigation it is suited to wheat, barley, hay, and pasture. Capability unit VIs-1 dryland, IVs-2 irrigated; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

45—Crago very cobbly loam, 0 to 15 percent slopes. This nearly level to strongly rolling soil is on terraces, fans, and foot slopes. Included in mapping are small narrow convex areas where cemented gravel is at a depth of about 15 inches. Also included are small areas of Binna soils.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is best suited to range. Small areas are used for hay and pasture under dryland management and

under irrigation. Capability unit VIs-1 dryland; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

46—Crago-Yawdim complex, 15 to 45 percent slopes. This map unit consists of hilly and steep soils on gravel capped terrace edges. It is underlain by shale. It is about 35 percent Crago very cobbly loam, 35 percent Yawdim clay loam, and 30 percent minor soils. These minor soils are Abor, Binna, and Lisam soils and small areas of soils that have a gravelly clay loam surface layer. Crago very cobbly loam occupies the terrace edges and upper slopes. Yawdim clay loam occupies steep slopes below the rim of gravel mantles. The included soils occupy terrace edges and foot slopes. Also included are a few small areas of nearly barren shale and sandstone outcrops that make up less than 1 percent of the unit and small areas where the slope is less than 15 percent or more than 45 percent.

The Crago soil has the profile described as typical of the series. The Yawdim soil has a profile similar to the one described as typical of the Yawdim series, but the surface layer has more coarse fragments than is typical.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

This unit is suited to range. Capability unit VIle-1 dryland; windbreak suitability group 4-0. Crago soil in Shallow to Gravel range site, 10- to 14-inch precipitation zone. Yawdim soil in Shallow range site, 10- to 14-inch precipitation zone.

Danvers series

The Danvers series consists of deep, well drained soils formed in alluvium. These soils are on terraces at elevations of 3,500 to 4,200 feet. Slopes are 0 to 2 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 16 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is brown silty clay and pale brown silty clay loam about 13 inches thick. The substratum is very pale brown, calcareous silty clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is neutral to a depth of 14 inches, mildly alkaline to 18 inches, and moderately alkaline to 60 inches.

These soils are mainly used for dryland crops.

Typical profile of Danvers silty clay loam, in cropland, 980 feet west and 1,800 feet north of southeast corner sec. 15, T. 19 N., R. 6 E.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; mod-

erate very fine granular structure; hard, friable, sticky and plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

- B2t—5 to 14 inches; brown (10YR 5/3) silty clay, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong fine and very fine blocky; very hard, friable, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on ped surfaces; neutral; clear wavy boundary.
- B3—14 to 18 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate fine and very fine blocky; very hard, friable, sticky and plastic; common fine and very fine roots; many fine and very fine pores; slightly effervescent; mildly alkaline; clear irregular boundary.
- C1ca—18 to 30 inches; very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; moderate fine blocky structure; very hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; many fine soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.
- C2ca—30 to 40 inches; very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) moist; weak coarse platy structure; hard, friable, sticky, plastic; few very fine roots; many fine and very fine pores; many medium and large soft masses of segregated lime; violently effervescent; moderately alkaline; diffuse boundary.
- C3—40 to 60 inches; very pale brown (10YR 7/3) silty clay loam, light yellowish brown (10YR 6/4) moist; massive; hard, friable, sticky, plastic; common fine and very fine pores; common fine and medium masses of segregated lime; violently effervescent; moderately alkaline.

The B horizon is silty clay loam or silty clay. The noncalcareous part of the soil ranges from 10 to 16 inches in thickness. The A and B horizons are neutral or mildly alkaline.

47—Danvers silty clay loam, 0 to 2 percent slopes.

This nearly level soil is on terraces. It has the profile described as typical of the series. Included in mapping are a few small areas where slopes are more than 2 percent and some small areas of Judith soil.

Surface runoff is slow. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIc-3 dryland; windbreak suitability group 1; not assigned to a range site.

Darret series

The Darret series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over interbedded shale and sandstone. Slopes are 2 to 20 percent. The elevation is 3,300 to 4,800 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 13 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark reddish gray silty clay loam about 7 inches thick. The subsoil is reddish brown silty clay and clay loam about 11 inches thick. The substratum is reddish brown, calcareous clay loam about 10 inches thick. Below 28 inches is dark reddish brown, calcareous shale and sandstone.

Permeability is slow. The available water capacity is low. Reaction is neutral in the upper 7 inches and mildly or moderately alkaline below.

These soils are used for either dryland crops or range.

Typical profile of Darret silty clay loam, in cropland, 1,320 feet north and 1,050 feet west of southeast corner SW1/4 sec. 16, T. 18 N., R. 6 E.

- Ap—0 to 7 inches; dark reddish gray (5YR 4/2) silty clay loam, dark reddish brown (5YR 2/2) moist; moderate fine granular structure; slightly hard, friable, sticky, plastic; common fine and very fine roots; many very fine and fine pores; neutral; abrupt smooth boundary.
- B2t—7 to 11 inches; reddish brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; moderate medium prismatic structure parting to strong fine blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on ped faces; dark reddish brown (5YR 2/2) moist; organic stains on prism faces; mildly alkaline; clear wavy boundary.
- B3—11 to 18 inches; reddish brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; strong fine blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin patchy clay films on ped faces; slightly effervescent; moderately alkaline; gradual wavy boundary.
- C1ca—18 to 28 inches; reddish brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate medium blocky structure; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; common medium and coarse soft masses of lime; 10 percent shale and sandstone; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2r—28 inches; dark reddish brown (2.5YR 3/4) calcareous interbedded shale and sandstone.

The B2t horizon is silty clay loam or silty clay. Depth to bedrock is 20 to 40 inches.

48—Darret silty clay loam, 8 to 20 percent slopes.

This strongly rolling and hilly soil is on sedimentary uplands. It has the profile described as typical of the series. Included in mapping are small areas of Big Timber and Castner soils on ridges and knolls.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to dryland wheat, barley, hay, and pasture. It is also used for range. Capability unit IVe-4 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M if slope is less than 15 percent, group 4-0 if more than 15 percent.

49—Darret-Castner complex, 2 to 8 percent slopes.

This map unit consists of undulating and gently rolling soils on sedimentary uplands. It is about 60 percent Darret silty clay loam and 25 percent Castner channery loam. The Darret silty clay loam is on smooth slopes over reddish colored shale beds. The Castner channery loam is on the convex slopes, ridges, and knolls. About 15 percent of the unit is included areas of Big Timber and Sinnigam soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IIIe-9 dryland. Darret soil in Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Castner soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

50—Darret-Castner complex, 8 to 20 percent slopes. This strongly rolling and hilly map unit is on sedimentary uplands. It is about 65 percent Darret silty clay loam and 25 percent Castner channery loam. The Darret silty clay loam is on smooth side slopes that are underlain by reddish shale beds. The Castner channery loam is on the convex sideslopes, ridges, and knolls. About 10 percent of the unit is included areas of Big Timber and Timberg soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is used mainly for range. Capability unit VIe-1 dryland. Darret soils in Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Castner soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

Dast series

The Dast series consists of moderately deep, well drained soils formed in weakly consolidated sandstone. These soils are on uplands. They are only 20 to 40 inches deep over sandstone bedrock. Slopes are 2 to 20 percent. The elevation is 3,500 to 4,500 feet. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, and forbs and shrubs. The mean annual precipitation is 13 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous fine sandy loam about 6 inches thick. The underlying material is light brownish gray and light gray, calcareous fine sandy loam about 24 inches thick. Below 30 inches is light gray, calcareous sandstone.

Permeability is moderately rapid. The available water capacity is low or moderate. Reaction is mildly alkaline in the upper 6 inches and moderately alkaline to 30 inches.

These soils are mainly used for range.

Typical profile of Dast fine sandy loam, in native grass, 1,460 feet east and 30 feet south of northwest corner of sec. 32, T. 22 N., R. 3 W.

A1—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine and very fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky, nonplastic; common fine and few medium roots; strongly effervescent; mildly alkaline; clear smooth boundary.

C1—6 to 21 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure; soft, very friable, nonsticky, nonplastic; common fine and few medium roots; many fine and very fine pores; few fine sandstone fragments; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C2—21 to 30 inches; light gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, nonsticky, nonplastic; few fine and very fine roots; many fine and very fine pores; 5 percent by volume of sandstone fragments; violently effervescent; moderately alkaline; diffuse wavy boundary.

C3r—30 inches; light gray (2.5Y 7/2) soft and hard interbedded sandstone; strongly effervescent.

Depth to weakly consolidated sandstone is 20 to 40 inches. The C horizon is fine sandy loam or sandy loam. The A horizon is mildly alkaline.

51—Dast-Rentsac complex, 2 to 20 percent slopes. This map unit consists of undulating to hilly soils on sandstone uplands. It is about 60 percent Dast fine sandy loam and 25 percent Rentsac very channery sandy loam. The Dast fine sandy loam is in the concave

and plane sloping areas. The Rentsac very channery sandy loam occupies convex areas, ridges, and knolls. About 15 percent of the unit is included areas of Yamac soils and sandstone outcrops.

The Dast soil in this unit has the profile described as typical of the series. The Rentsac soil has a profile similar to the one described as typical of the Rentsac series, but it has a very channery sandy loam surface layer.

Surface runoff is slow or medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This unit is used mainly for range. Capability unit Vle-1 dryland. Dast soil in Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M if slope is less than 15 percent, group 4-0 if more than 15 percent. Rentsac soil in Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-1.

Delpoint series

The Delpoint series consists of moderately deep, well drained soils formed in material weathered from interbedded siltstone and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over interbedded siltstone and sandstone. Slopes are 4 to 20 percent. The elevation is 3,500 to 4,500 feet. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

In a representative profile the surface layer is grayish brown, calcareous loam about 3 inches thick. The subsoil is light brownish gray, calcareous loam about 14 inches thick. The substratum is light gray, calcareous loam about 11 inches thick. Light gray siltstone is below 28 inches.

Permeability is moderate. The available water capacity is low. Reaction is moderately alkaline to a depth of 17 inches and strongly alkaline below.

These soils are mainly used for range.

Typical profile of Delpoint loam in native grass, 330 feet east and 900 feet south of northwest corner of SW1/4 sec. 18, T. 20 N., R. 3 W.

A1—0 to 3 inches; grayish brown (10YR 5/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate very thin platy structure; slightly hard, very friable, sticky, plastic; common fine and very fine roots, few medium roots; many fine and very fine pores; few medium pores; weakly effervescent; moderately alkaline; clear smooth boundary.

B2—3 to 17 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to weak medium blocky; hard, very friable, sticky, plastic; common fine and

very fine roots; few medium roots; many fine and very fine pores, few medium pores; moderately effervescent; moderately alkaline; clear wavy boundary.

C1—17 to 28 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; moderately effervescent; strongly alkaline; gradual wavy boundary.

C2r—28 inches; light gray (2.5Y 7/2) siltstone.

Depth to interbedded siltstone and sandstone ranges from 20 to 40 inches. The texture of the soil profile ranges from loam to silty clay loam. The A horizon is mildly or moderately alkaline and the C horizon is moderately or strongly alkaline.

52—Delpoint loam, 4 to 20 percent slopes. This gently rolling to hilly soil is on uplands. It has the profile described as typical of the series. Included in mapping are Abor, Cabbart, and Yamac soils. Also included are small areas below gravel benches where the surface layer is gravelly loam.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is used for range. Capability unit Vle-1 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M if slope is less than 15 percent, group 4-0 if more than 15 percent.

Dooley series

The Dooley series consists of deep, well drained soils formed in alluvium or eolian sands over glacial till. These soils occupy uplands and terraces at elevations of 3,300 to 4,100 feet. Slopes are 0 to 15 percent. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, and forbs and shrubs. The mean annual precipitation is 12 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is brown and grayish brown sandy clay loam about 16 inches thick. The substratum is grayish brown, calcareous clay loam to a depth of 44 inches and light brownish gray, calcareous clay to 60 inches or more.

Permeability is slow. The available water capacity is moderate. Reaction is neutral or mildly alkaline in the upper 10 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Dooley sandy loam in native grass, 1,600 feet east and 100 feet south of northwest corner SW1/4 sec. 17, T. 20 N., R. 4 E.

- A1—0 to 4 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; few medium roots; neutral; clear wavy boundary.
- B21t—4 to 10 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and medium blocky; hard, very friable, sticky, plastic; common fine and very fine roots; few medium roots; many fine and very fine pores; thin continuous clay films on faces of peds; mildly alkaline; clear wavy boundary.
- B22t—10 to 12 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to moderate medium and fine subangular blocky; hard, very friable, sticky, slightly plastic; common fine and very fine roots; few medium roots; many fine and very fine pores; thin continuous clay films on vertical surfaces; slightly effervescent; moderately alkaline; clear wavy boundary.
- B3ca—13 to 20 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; common fine soft lime masses; slightly effervescent; moderately alkaline; clear wavy boundary.
- IIC1ca—20 to 32 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; many medium and fine soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.
- IIC2—32 to 44 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium blocky structure; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; few fine masses of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.
- IIC3—44 to 60 inches; light brownish gray (2.5Y 6/2) clay; dark grayish brown (2.5Y 4/2) moist; strong fine and very fine platy structure; very hard, very firm, sticky, very plastic; slightly effervescent; moderately alkaline.

The A and B horizons combined range from 18 to 24 inches in thickness. Depth to the clay loam glacial till ranges from 20 to 36 inches. The A horizon is neutral to moderately alkaline. The B horizon is mildly or moderately alkaline.

53—Dooley sandy loam, 0 to 4 percent slopes. This nearly level and undulating soil occupies terraces and

uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where slopes are more than 4 percent and small areas where the surface layer is sandy clay loam and the subsoil is clay loam. Small areas of Azaar and Ipano soils occupy convex positions.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management. It is also well suited to range. Capability unit IIIe-1 dryland; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

54—Dooley sandy loam, 4 to 8 percent slopes. This gently rolling or moderately sloping soil is on uplands and terraces. Included in mapping are a few small areas where the slope is less than 4 percent or more than 8 percent. Small areas of Azaar and Ipano soils occupy some convex positions.

Surface runoff is slow. The erosion hazard is moderate from wind and water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management. It is suited to range. Capability unit IIIe-1 dryland; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

55—Dooley sandy loam, 8 to 15 percent slopes. This strongly rolling soil is on uplands. Included in mapping are a few small areas where slope is less than 8 percent. Small areas of Azaar and Ipano soils occupy some convex positions.

Surface runoff is slow. The erosion hazard is moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-2 dryland; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

Dutton series

The Dutton series consists of moderately deep, well drained soils formed in material weathered from interbedded shale and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over interbedded shale and sandstone. Slopes are 0 to 8 percent. The elevation is 3,600 to 4,300 feet. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is brown and grayish brown silty clay about 21 inches thick. The substratum is grayish brown very channery loam and clay to

a depth of 36 inches. Below this is grayish brown, interbedded shale and sandstone.

Permeability is slow. The available water capacity is low. Reaction is neutral to a depth of 14 inches, mildly or moderately alkaline to 27 inches, and strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Dutton silty clay loam, in cropland, 320 feet west and 1,520 feet north of the southeast corner SW1/4 sec. 20, T. 22 N., R. 2 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; hard, friable, sticky, plastic; many unstained sand and silt grains; neutral; abrupt smooth boundary.

B2t—6 to 14 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; grayish brown (10YR 5/2) coats, very dark grayish brown (10YR 3/2) moist; strong fine and medium prismatic structure parting to strong fine and very subangular blocky; extremely hard, firm, sticky, very plastic; many very fine roots; many fine and very fine and few medium tubular pores; neutral; clear wavy boundary.

B31—14 to 17 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong fine and very fine angular and subangular blocky; extremely hard, friable, sticky, plastic; many very fine roots; many fine and very fine and few medium tubular pores; few fine lime coated sandstone pebbles that leave a pocket of lime if removed; slightly effervescent; mildly alkaline; clear wavy boundary.

B32ca—17 to 27 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to moderate fine and medium blocky; extremely hard, friable, sticky, plastic; many very fine roots; many fine and very fine and few medium tubular pores; few very dark grayish brown (2.5Y 3/2) coatings on faces of prisms; common fine and medium masses of segregated lime; few very fine lime coated sandstone pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

IIC1ca—27 to 30 inches; grayish brown (2.5Y 5/2) very channery loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, nonsticky, nonplastic; many very fine roots; many fine and very fine and few medium tubular pores; 55 percent by volume sandstone fragments; lime coatings on rock fragments; strongly effervescent; strongly alkaline; clear wavy boundary.

IIIC2ca—30 to 36 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, firm, sticky, plastic; few very fine roots; common fine and very tubular pores; 10 percent

gray (N 5/0), platy shale fragments, many very fine masses of segregated lime; strongly effervescent; strongly alkaline; gradual wavy boundary.

IIIC3r—36 inches; grayish brown (2.5Y 5/2) platy shale interbedded with 1- to 3-inch layers of hard sandstone.

Thickness of the noncalcareous A and B horizons ranges from 10 to 18 inches. Depth to interbedded shale and sandstone ranges from 20 to 40 inches. The A horizon is neutral or mildly alkaline. The B horizon is neutral to moderately alkaline.

56—Dutton silty clay loam, 0 to 2 percent slopes.

This nearly level soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of Acel and Pylon soils.

Surface runoff is medium. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIc-1 dryland; windbreak suitability group 2M; not assigned to a range site.

57—Dutton silty clay loam, 2 to 8 percent slopes.

This undulating and gently rolling soil is on uplands. Included in mapping are a few small areas of Pylon and Acel soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-7 dryland; windbreak suitability group 2M; not assigned to a range site.

Eltzac series

The Eltsac series consists of moderately deep, well drained soils formed from shale. These soils are on uplands. They are only 20 to 40 inches deep over shale. Slopes are 4 to 70 percent. The elevation is 3,500 to 4,600 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 90 to 125 days.

Typically the surface layer is grayish brown, calcareous clay about 6 inches thick. The underlying material is grayish brown, calcareous clay 20 inches thick. Below 26 inches is light brownish gray clay shale.

Permeability is very slow. The available water capacity is low. Reaction is mildly alkaline in the upper 6 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Eltsac clay, in cropland, 1,900 feet west and 600 feet south of northeast corner sec. 17, T. 20 N., R. 7 E.

Ap—0 to 6 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong fine and very fine granular structure; very hard, friable, sticky, very plastic; common very fine and fine roots; common very fine pores; very slightly effervescent; mildly alkaline; abrupt wavy boundary.

C1—6 to 14 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and medium subangular blocky structure; extremely hard, firm, sticky, very plastic; well expressed pressure and stress cutans with some intersecting slickensides; cracks are 2 to 5 centimeters wide; common fine and very fine roots; common very fine pores; very slightly effervescent; moderately alkaline; clear wavy boundary.

C2cacs—14 to 26 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and medium blocky structure; extremely hard, firm, sticky, very plastic; distinct pressure and stress cutans and intersecting slickensides; common very fine and fine roots; common very fine pores; common seams of gypsum and few masses of segregated lime; slightly effervescent; moderately alkaline; gradual wavy boundary.

C3r—26 inches; light brownish gray (2.5Y 6/2) clay shale.

Depth to clay shale ranges from 20 to 40 inches. The soil is mainly more than 60 percent clay throughout. Reaction is mildly or moderately alkaline in the A horizon.

58—Eltzac clay, 4 to 8 percent slopes. This gently rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are small areas of Lisam and Shane soils. Also included are small areas where slope is less than 4 percent.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IIIe-9 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

59—Eltzac clay, 8 to 15 percent slopes. This strongly rolling soil is on uplands. Included in mapping are small areas of Lisam and Shane soils. Also included are small areas where slope is less than 8 percent.

Surface runoff is rapid. The erosion hazard is moderate from wind and is moderate or severe from water.

This soil is well suited to range. Capability unit VIe-1 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

60—Eltzac-Lisam clays, 10 to 70 percent slopes.

This map unit is a complex consisting of strongly rolling to very steep soils on uplands. It is about 65 percent Eltsac clay and 25 percent Lisam clay. The Eltsac clay is on the smooth and slightly concave slopes, and the Lisam clay is in the convex areas and on the steeper slopes bordering drainageways. About 10 percent of the unit is included areas of Shane and Timberg soils.

The Eltsac soil has a profile similar to the one described as typical of the series. The Lisam soil has the profile described as typical of the Lisam series.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

This unit is used for range. Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Eltsac soil in Clayey range site, 15- to 19-inch precipitation zone. Lisam soil in Shallow Clay range site, 15- to 19-inch precipitation zone.

Ernem series

The Ernem series consists of shallow, well drained soils formed in material weathered from sandstone of mixed mineralogy. These soils are on uplands. They are only 10 to 20 inches deep over hard sandstone. Slopes are 0 to 15 percent. The elevation is 3,300 to 4,200 feet. The native vegetation is mainly bluebunch wheatgrass, western wheatgrass, needleandthread, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown very stony loam about 3 inches thick. The subsoil, about 12 inches thick, is grayish brown, brown, and light gray very stony clay loam. Below 15 inches is hard sandstone.

Permeability is moderate. The available water capacity is very low. Reaction is neutral or mildly alkaline to a depth of 12 inches and moderately alkaline below.

These soils are used mainly for range.

Typical profile of Ernem very stony loam, 0 to 15 percent slopes, in native grass, 100 feet west and 10 feet south of northeast corner sec. 36, T. 22 N., R. 1 E.

A1—0 to 3 inches; grayish brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, sticky, plastic; many fine roots; many fine pores; 20 percent stones, 15 percent cobbles; mildly alkaline; clear wavy boundary.

B21t—3 to 7 inches; grayish brown (10YR 5/2) very stony clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong very fine blocky; hard, friable, sticky, very plastic;

many fine roots; many fine pores; 25 percent stones, 10 percent cobbles; mildly alkaline; clear wavy boundary.

B22t—7 to 12 inches; brown (10YR 5/3) very stony clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong very fine blocky; hard, friable, sticky, very plastic; thin continuous clay films on faces of peds; many fine roots; many fine pores; 25 percent stones, 10 percent cobbles; 10 percent gravel; mildly alkaline; abrupt irregular boundary.

B3ca—12 to 15 inches; light gray (10YR 7/2) very stony clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, friable, sticky, plastic; common fine roots; many fine pores, common fine and medium soft masses of lime; 25 percent stones and 10 percent cobbles; strongly effervescent; moderately alkaline; abrupt wavy boundary.

R—15 inches; indurated sandstone.

The A horizon is very stony loam or loam. In cultivated areas the loam horizon is 5 to 7 inches thick. The thickness of the noncalcareous solum ranges from 10 to 14 inches. The B and C horizons are 35 to 55 percent coarse fragments, by volume. The A horizon is neutral or mildly alkaline. The B horizon is mildly or moderately alkaline. Depth to hard sandstone is 10 to 20 inches.

61—Ernem loam, 0 to 4 percent slopes. This nearly level or undulating soil is on uplands. It has a profile similar to the one described as typical of the series, but the surface layer is loam. Included in mapping are a few small areas where the surface layer is stony loam and small areas of Castner and Marmarth soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVs-2 dryland; Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

62—Ernem very stony loam, 0 to 15 percent slopes. This nearly level to strongly rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of sandstone outcrop. Also included are small areas of Rentsac and Tanna soils.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is used for range. Capability unit VI s-1 dryland; Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-1.

Ervide series

The Ervide series consists of moderately deep, well drained soils formed in alluvium or eolian sands over sandstone. These soils are on uplands. They are only 20 to 40 inches deep over hard sandstone. Slopes are 0 to 8 percent. The elevation is 3,400 to 4,300 feet. The native vegetation is mainly prairie sandreed, Indian ricegrass, bluebunch wheatgrass, and forbs and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown and grayish brown loamy fine sand about 17 inches thick. The underlying material is grayish brown loamy fine sand in the upper 6 inches and light gray, calcareous gravelly loam in the lower 9 inches. Below 32 inches is sandstone.

Permeability is moderately rapid to 23 inches. The available water capacity is low. Reaction is mildly alkaline to a depth of 17 inches and moderately alkaline below.

These soils are used mainly for dryland crops and range.

Typical profile of Ervide loamy fine sand in cropland, 1,300 feet east and 600 feet south of northwest corner SW1/4 sec. 27, T. 19 N., R. 2 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak coarse blocky structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots and pores; mildly alkaline; clear wavy boundary.

A12—9 to 17 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots; many fine and very fine pores; mildly alkaline; diffuse wavy boundary.

C1—17 to 23 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; soft, very friable, nonsticky, nonplastic; common fine roots; common fine pores; few fine lime-coated sandstone fragments; moderately alkaline; gradual wavy boundary.

IIC2—23 to 32 inches; light gray (10YR 7/2) gravelly loam, grayish brown (10YR 5/2) moist; massive; very hard, friable, slightly sticky, slightly plastic; common fine roots; common to few fine pores; 20 percent lime-coated sandstone fragments; strongly effervescent; moderately alkaline; clear smooth boundary.

IIR—32 inches; fractured sandstone.

The A horizon is loamy fine sand or fine sandy loam. The A and C horizons combined are 20 to 40 inches

thick over the sandstone. The IIC2 horizon is loam, silt loam, or silty clay loam. It is 5 to 25 percent, by volume, sandstone fragments. The A horizon is neutral to mildly alkaline.

63—Ervide loamy fine sand, 0 to 8 percent slopes.

This nearly level to gently rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is fine sandy loam. Small areas of shallow loamy fine sand over sandstone and areas of Lihen soils are also included.

Surface runoff is slow. The erosion hazard is severe from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-1 dryland; Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

64—Ervide fine sandy loam, 0 to 4 percent slopes.

This nearly level and undulating soil is on uplands. It has a profile similar to the one described as typical of the series but is fine sandy loam. Included in mapping are a few small areas of Azaar and Castner soils.

Surface runoff is slow. The erosion hazard is severe from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVe-2 dryland; windbreak suitability group 2M; not assigned to a range site.

Ethridge series

The Ethridge series consists of deep, well drained soils formed in alluvium. They are on terraces, fans, and foot slopes at elevations of 3,400 to 4,000 feet. Slopes are 0 to 15 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silty clay loam about 7 inches thick. The subsoil is brown and light brownish gray silty clay and silty clay loam 13 inches thick. The substratum is light brownish gray and grayish brown silty clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is neutral in the upper 7 inches, mildly alkaline to 16 inches, and moderately alkaline to 60 inches.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Ethridge silty clay loam, in cropland, 1,000 feet west and 1,200 feet south of northeast corner sec. 34, T. 22 N., R. 3 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; hard, very friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt wavy boundary.

B2t—7 to 16 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and very fine blocky; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; thin continuous clay films on ped surfaces; mildly alkaline; gradual irregular boundary.

B3ca—16 to 20 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium blocky; very hard, very friable, sticky, plastic; many fine roots; many fine and very fine pores; common fine soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—20 to 30 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium and coarse prismatic structure parting to weak medium and coarse subangular blocky; very hard, very friable, sticky, plastic; common fine roots; common fine pores; common fine and medium soft masses of segregated lime; violently effervescent; moderately alkaline; diffuse boundary.

C2ca—30 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, very friable, sticky, plastic; common to few roots; few pores; common fine soft masses and threads of segregated lime; violently effervescent; moderately alkaline.

The A horizon is silty clay loam or clay loam. The B2t horizon is silty clay loam or silty clay. Depth to the calcareous B horizon ranges from 10 to 18 inches. The C horizon is dominantly silty clay loam or silt loam. The A horizon is neutral or mildly alkaline. The B horizon is mildly or moderately alkaline.

65—Ethridge silty clay loam, 0 to 2 percent slopes.

This nearly level soil occupies terraces and fans. Included in mapping are a few small areas of Kevin and Scobey soils occupying slightly convex positions and small areas of Linnet soils in some concave positions. Also included are a few small areas where slopes are more than 2 percent.

Surface runoff is slow or medium. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIs-2 dryland, IIIs-1 irrigated; windbreak suitability group 1; not assigned to a range site.

66—Ethrige silty clay loam, 2 to 4 percent slopes.

This gently sloping soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Kobar and Kevin soils occupying slightly convex positions and small areas of Acel and Linnet soils in some concave positions. Also included are a few small areas where slopes are more than 4 percent.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-2 dryland, IIIe-2 irrigated; windbreak suitability group 1; not assigned to a range site.

67—Ethrige-Kobar silty clay loams, 0 to 2 percent slopes.

This map unit of nearly level soils is on terraces and fans. It is about 65 percent Ethrige silty clay loam and about 25 percent Kobar silty clay loam. The Ethrige silty clay loam is on smooth or slightly concave slopes, and the Kobar silty clay loam is in convex areas. About 10 percent of the unit is included areas of Marias soils. Also included are a few small areas where slopes are more than 2 percent.

Surface runoff is slow or medium. The erosion hazard is slight from wind and water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management and irrigation. Capability unit IIIs-2 dryland, IIIs-1 irrigated; windbreak suitability group 1; not assigned to a range site.

68—Ethrige-Kobar silty clay loams, 2 to 8 percent slopes.

This map unit of undulating and moderately sloping soils is on terraces and fans. It is about 60 percent Ethrige silty clay loam and about 30 percent Kobar silty clay loam. The Ethrige silty clay loam is on smooth and slightly concave slopes, and the Kobar silty clay loam is in convex areas. About 10 percent of the unit is included areas of Marias soils. Also included are a few small areas where slopes are less than 2 percent or more than 8 percent.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-8 dryland; IIIe-1 irrigated; windbreak suitability group 1; not assigned to a range site.

Evanston series

The Evanston series consists of deep, well drained soils formed in alluvium. These soils occupy foot slopes, terraces, and fans at elevations of 3,300 to 4,000 feet. Slopes are 0 to 10 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air tem-

perature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown loam about 8 inches thick. The subsoil is brown, pale brown, and light brownish gray clay loam 19 inches thick. The substratum is light brownish gray loam, gravelly sandy loam, and clay loam to a depth of 60 inches or more. The soil is calcareous below 15 inches.

Permeability is moderate. The available water capacity is high. Reaction is mildly alkaline to a depth of 15 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland and irrigated crops and range.

Typical profile of Evanston loam, in cropland, 1,600 feet west and 120 feet south of the center of sec. 17, T. 22 N., R. 5 E.

Ap—0 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; strong very fine and fine granular structure; slightly hard, very friable, sticky, plastic; many fine and very fine roots; many fine pores; mildly alkaline; abrupt wavy boundary.

B2t—8 to 15 inches; brown (10YR 5/3) clay loam; dark yellowish brown (10YR 4/4) moist; strong medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; common medium pores; thin continuous clay films on ped faces; few pebbles; mildly alkaline; abrupt irregular boundary.

B31ca—15 to 19 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; common medium pores; few pebbles with lime coatings on lower sides; strongly effervescent; moderately alkaline; clear irregular boundary.

B32ca—19 to 27 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak medium and coarse prismatic structure parting to weak medium and fine subangular blocky; very hard, very friable, sticky, plastic; many fine roots; many fine and very fine pores; few medium pores; many fine and medium soft masses of segregated lime; few lime coated pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—27 to 35 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak medium and fine subangular blocky structure; very hard, very friable, sticky, plastic; many fine roots; many fine and very fine pores; many fine and medium soft masses of segregated lime; few lime coated pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

C2—35 to 40 inches; light brownish gray (2.5Y 6/2) gravelly sandy loam, dark grayish brown (2.5Y 4/2) moist; single grained; loose, very friable, nonsticky, nonplastic; common fine roots; common fine pores; 20 percent fine pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

C3—40 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; very hard, friable, sticky, plastic; few fine roots; few fine pores; few threads and masses of gypsum; few fine and medium pebbles; few lignite chips; strongly effervescent; strongly alkaline.

The A horizon is loam, clay loam, or cobbly clay loam. The noncalcareous portion of the solum is 10 to 25 inches thick. The B2t horizon is loam or clay loam that ranges from 20 to 35 percent clay. The B horizon is mildly or moderately alkaline.

69—Evanston loam, 2 to 4 percent slopes. This undulating soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas where slopes are less than 2 percent or more than 4 percent. Also included are small areas where the surface layer is clay loam and small areas of Floweree and Rothiemay soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-2 dryland, IIe-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

70—Evanston loam, 4 to 8 percent slopes. This moderately sloping soil occupies foot slopes and fans. Included in mapping are a few small areas where slopes are less than 4 percent or more than 8 percent. Also included are small areas of Assinniboine and Hillon soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-3 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

71—Evanston clay loam, 0 to 2 percent slopes. This nearly level soil is on terraces. It has a profile similar to the one described as typical of the series, but the surface layer is clay loam. Included in mapping, in convex positions, are a few narrow areas where cemented gravel is at a depth of about 15 inches. Also included are a few small areas of Binna, Crago, and Rothiemay soils.

Surface runoff is medium. The erosion hazard is slight from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIc-2 dryland, IIc-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

72—Evanston cobbly clay loam, 4 to 10 percent slopes. This gently rolling and strongly sloping soil occupies fans and foot slopes. It has a profile similar to the one described as typical of the series, but the surface layer is a cobbly clay loam. Included in mapping are small areas of Crago soils in some convex positions. Also included are small areas of Ethridge and Kobar soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-3 dryland, IIIe-2 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

Fairfield series

The Fairfield series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and fans at elevations of 3,600 to 4,500 feet. Slopes are 0 to 8 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark gray clay loam about 7 inches thick. The subsoil is brown and pale brown silty clay loam about 7 inches thick. The substratum is very pale brown, calcareous silty clay loam to a depth of 60 inches or more.

Permeability is moderately slow. The available water capacity is high. Reaction is neutral in the upper 7 inches, mildly or moderately alkaline to a depth of 14 inches, and strongly alkaline below.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Fairfield clay loam, in cropland, 300 feet west and 1,620 feet north of southeast corner sec. 27, T. 19 N., R. 6 E.

Ap—0 to 7 inches; dark gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) moist; strong fine and very fine granular structure; very hard, friable, sticky, plastic; many fine and very fine roots; many fine pores; neutral; abrupt wavy boundary.

B2t—7 to 9 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine and very fine subangular blocky; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and

very fine pores; thin continuous clay films on all ped surfaces; mildly alkaline; clear wavy boundary.

B3ca—9 to 14 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent with few soft masses of segregated lime; few lime coated pebbles; moderately alkaline; gradual wavy boundary.

C1ca—14 to 36 inches; very pale brown (10YR 7/3) silty clay loam, light yellowish brown (10YR 6/4) moist; moderate fine and very fine blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; violently effervescent with common medium and few coarse soft masses of segregated lime; few lime coated pebbles; strongly alkaline; diffuse wavy boundary.

C2ca—36 to 60 inches; very pale brown (10YR 7/3) silty clay loam, yellowish brown (10YR 5/4) moist; massive; very hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; violently effervescent; few lime coated pebbles; strongly alkaline.

The thickness of the Ap horizon ranges from 5 to 8 inches. The A horizon is clay loam or loam. Depth to carbonates is 8 to 10 inches. The B horizon is mildly alkaline or moderately alkaline.

73—Fairfield loam, 4 to 8 percent slopes. This moderately sloping soil is on valley foot slopes and fans. It has a profile similar to the one described as typical of the series, but the surface layer is loam. Included in mapping are a few small areas where slopes are less than 4 percent or more than 8 percent. Small areas of Farnuf and Reeder soils are also included.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

74—Fairfield clay loam, 0 to 4 percent slopes. This nearly level and undulating soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is loam and small areas of Turner and Judith soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-1 dryland, IIe-1 irrigated; windbreak suitability group 1; not assigned to a range site.

Farnuf series

The Farnuf series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and fans at elevations of 3,400 to 4,800 feet. Slopes are 0 to 8 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is brown clay loam and pale brown, calcareous loam 17 inches thick. The substratum is calcareous, light gray loam in the upper part and very pale brown loam and sandy clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is high. Reaction is neutral in the upper 7 inches, mildly or moderately alkaline to a depth of 36 inches, and strongly alkaline below.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Farnuf loam, in native grass, 1,600 feet west and 1,240 feet south of northeast corner sec. 36, T. 18 N., R. 6 E.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate very thin platy structure in the upper part and moderate medium prismatic structure in lower part with plates and prisms parting to moderate very fine granules; hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many very fine and fine pores; neutral; clear smooth boundary.

B2t—7 to 15 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; strong medium prismatic structure parting to strong fine and moderate medium subangular blocky; very hard, friable, sticky, plastic; thin continuous clay films on ped faces; many fine and very fine roots; many fine and very fine and few medium pores; peds coated with dark grayish brown (10YR 4/2); mildly alkaline; clear wavy boundary.

B3ca—15 to 24 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to weak medium and fine blocky; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine and few medium pores; few soft masses of segregated lime; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C1ca—24 to 36 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; weak coarse blocky structure; hard, friable, sticky, slightly plastic; common fine and very fine roots; common fine and very fine pores; common soft masses of segregated lime and few small lime-coated pebbles; strongly

effervescent; moderately alkaline; diffuse wavy boundary.

C2—36 to 60 inches; very pale brown (10YR 7/3) loam stratified with sandy clay loam and fine sandy loam, brown (10YR 5/3) moist; massive; hard, very friable, sticky, slightly plastic; few fine and very fine roots; common fine and very fine pores; strongly effervescent; strongly alkaline.

Thickness of the noncalcareous parts of the soil ranges from 11 to 18 inches. The C horizon below 40 inches is mainly loam but ranges from sandy loam to clay loam. The A horizon is neutral or mildly alkaline. The B horizon is mildly or moderately alkaline.

75—Farnuf loam, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. Included in mapping are a few small areas of Fairfield and Tally soils.

Surface runoff is medium. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-3 dryland, IIc-1 irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

76—Farnuf loam, 2 to 4 percent slopes. This gently sloping soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Fairfield clay loams and Tally loams.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-1 dryland, IIe-1 irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

77—Farnuf loam, 4 to 8 percent slopes. This moderately sloping soil occupies foot slopes and fans. Included in mapping are a few small areas where slopes are less than 4 percent or more than 8 percent. Small areas of Fairfield and Work soils are also included.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-4 dryland, IIIe-1 irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

Fergus series

The Fergus series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and fans at elevations of 3,300 to 4,500 feet. Slopes are 0 to 8

percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and some forbs and shrubs. The mean annual precipitation is 15 to 18 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is brown silty clay loam 24 inches thick. The substratum is brown silty clay loam in the upper 12 inches and pinkish gray silt loam and silty clay loam in the lower part to a depth of 60 inches or more.

Permeability is moderately slow. The available water capacity is high. Reaction is neutral to a depth of 6 inches, mildly alkaline to 25 inches, moderately alkaline to 42 inches, and strongly alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Fergus silty clay loam, in cropland, 1,320 feet west and 1,850 feet north of southeast corner sec. 27, T. 20 N., R. 4 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; hard, friable, sticky, plastic; many very fine and fine roots; many very fine and fine pores; neutral; abrupt smooth boundary.

B21t—6 to 10 inches; brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; strong medium prismatic structure parting to strong fine blocky; hard, friable, sticky, plastic; many very fine roots; many very fine pores; mildly alkaline; clear wavy boundary.

B22t—10 to 14 inches; brown (7.5YR 4/2) silty clay, dark reddish brown (5YR 3/3) moist; strong medium prismatic structure parting to strong fine blocky; hard, friable, sticky, plastic; many very fine roots; many very fine pores; thick, continuous, dark brown (7.5YR 3/2) moist clay films on faces of peds; mildly alkaline; clear wavy boundary.

B23t—14 to 25 inches; brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 4/4) moist; strong medium prismatic structure parting to strong medium blocky; hard, friable, sticky, plastic; many very fine roots; many very fine pores; moderately thick continuous and patchy dark brown (7.5Y 3/2) moist clay films on faces of peds; slightly effervescent; mildly alkaline; gradual wavy boundary.

B3—25 to 30 inches; brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 4/2) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, friable, sticky, plastic; common very fine roots; common very fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—30 to 42 inches; brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 4/2) moist; moderate medium blocky structure; hard, friable, sticky, plastic; common very fine roots; common very fine pores;

few medium and fine soft masses of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2—42 to 60 inches; pinkish gray (7.5YR 6/2) stratified silt loam and silty clay loam, dark brown (7.5YR 4/2) moist; massive; hard, friable, slightly sticky or sticky, slightly plastic or plastic; common to few fine and very fine roots; common fine pores; few medium and fine soft masses of lime; strongly effervescent; strongly alkaline.

The Ap horizon is a clay loam or silty clay loam. The B horizon is silty clay loam or silty clay and mildly or moderately alkaline. The C horizon is moderately or strongly alkaline.

78—Fergus clay loam, 2 to 4 percent slopes. This gently sloping soil occupies fans and terraces. Included in mapping are small areas of Twin Creek soils. Also included are a few small areas where slopes are less than 2 percent or more than 4 percent.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 1; not assigned to a range site.

79—Fergus clay loam, 4 to 8 percent slopes. This moderately sloping soil is on fans. Included in mapping are small areas of Twin Creek and Darret soils. The areas of Darret soil are on the upper part of the slope. Also included are a few small areas where slope is less than 4 percent or more than 8 percent.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 1; not assigned to a range site.

80—Fergus silty clay loam, 0 to 2 percent slopes. This nearly level soil is on terraces. It has the profile described as typical of the series. Included in mapping are areas of Twin Creek soils.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 1; not assigned to a range site.

81—Fergus-Absher silty clay loams, 0 to 2 percent slopes. This map unit consists of nearly level soils on terraces and fans. It is about 70 percent Fergus silty clay loam and about 20 percent Absher silty clay loam. The Fergus silty clay loam occupies the fans and slightly

elevated areas on terraces, and the Absher soil is in the depressional areas. About 10 percent of the unit is included areas of Twin Creek soil.

The Fergus soil in this unit has a profile similar to the one described as typical of the series. The Absher soil has a profile similar to the one described as typical of the series, but the surface layer is silty clay loam.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This unit is used mainly for wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; not assigned to a range site. Fergus soil in windbreak suitability group 1. Absher soil in windbreak suitability group 3S.

Floweree series

The Floweree series consists of deep, well drained soils formed in alluvium. These soils occupy fans and terraces at elevations of 3,300 to 3,600 feet. Slopes are 0 to 8 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silt loam about 6 inches thick. The subsoil is grayish brown and light yellowish brown silty clay loam about 14 inches thick. The substratum is light brownish gray silty clay loam with silt loam strata in the lower part. It extends to a depth of 60 inches or more. The soil is calcareous below 8 inches.

Permeability is moderately slow. The available water capacity is high. Reaction is mildly alkaline to a depth of 8 inches, moderately alkaline to 20 inches, and strongly alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Floweree silt loam, in an area of Floweree complex, 0 to 4 percent slopes, in cropland, 840 feet north and 50 feet east of southwest corner sec. 10, T. 22 N., R. 5 E.

Ap—0 to 6 inches; grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; moderate fine and very fine granular structure; hard, friable, sticky, plastic; many very fine roots; many very fine and fine pores; mildly alkaline; clear smooth boundary.

B21—6 to 8 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; strong medium prismatic structure parting to moderate medium blocky; hard, friable, sticky, plastic; many very fine roots; many very fine pores; very dark grayish brown (10YR 3/2) moist coatings on faces of prisms; mildly alkaline; clear smooth boundary.

B22—8 to 13 inches; light yellowish brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; strong medium prismatic structure; hard, friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; dark grayish brown (2.5Y 4/2) moist coatings on faces of prisms; slightly effervescent; moderately alkaline; gradual smooth boundary.

B23ca—13 to 20 inches; light yellowish brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure parting to moderate coarse blocky; hard, friable, sticky, plastic; common very fine roots; common very fine pores; few soft masses of lime, strongly effervescent; moderately alkaline; gradual smooth boundary.

C1ca—20 to 36 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse blocky; hard, very friable, sticky, plastic; common very fine roots; common very fine pores; common soft masses and threads of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2ca—36 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam stratified with silt loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, very friable, slightly sticky, slightly plastic; few roots; few pores; few seams of gypsum; strongly effervescent; moderately alkaline.

The Ap horizon is neutral or mildly alkaline. The B horizon is mildly or moderately alkaline and the C horizon is moderately or strongly alkaline. The depth to the Bca and Cca horizons ranges from 10 to 16 inches.

82—Floweree complex, 0 to 4 percent slopes. This map unit consists of nearly level and undulating soils on terraces and fans. It is about 85 percent Floweree silt loam. The Floweree silt loam is on smooth and slightly concave areas. There are areas of Floweree silt loam where the surface layer is light brownish gray. About 10 percent of the unit is included areas of Lambeth, Ethridge, and Kobar soils. Also included are a few small areas where slopes are more than 4 percent. The Floweree soil has the profile described as typical of the series.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-2 dryland; windbreak suitability group 1; not assigned to a range site.

83—Fluventic Haplaquolls, nearly level. This map unit consists of deep, poorly drained, loamy and clayey soils. Slopes are 0 to 2 percent. These soils occupy terraces, fans, and bottom lands along drainageways. They are subject to flooding in spring. A water table is

within a depth of 3 feet in spring and summer. Included in mapping are a few small areas of soils that are underlain at shallow depths by sand and gravel.

Surface runoff is slow. The erosion hazard is slight from wind and water.

These soils are used mostly for pasture and range. Small areas are used for hay. Some areas support trees. Capability unit VIw-1 dryland; Subirrigated range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

84—Fluventic Haploborolls, nearly level. This map unit consists of deep, well drained loams and clay loams. Slopes are 0 to 2 percent. These soils occupy bottom lands and fans in narrow valleys. These narrow valley bottom lands are dissected by water channels and are subject to overflow from valley sides and to occasional stream overflow. Included in mapping are small areas of wet and saline soils.

Surface runoff is medium. The erosion hazard is slight from wind and is severe from water.

These soils are used mostly for pasture and range. Small areas are used for hay. Some areas support trees. Capability unit VIe-1 dryland; Overflow range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

Gerber series

The Gerber series consists of deep, well drained soils formed in glacial till and glaciolacustrine material. These soils occupy terraces and fans at elevations of 3,300 to 4,100 feet. Slopes are 0 to 15 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

In a representative profile the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is brown, grayish brown, and light brownish gray silty clay and silty clay loam 25 inches thick. The substratum is grayish brown clay loam to a depth of 60 inches or more. The soil is calcareous below 14 inches. When dry, this soil has 1/2-inch to 3/4-inch cracks that extend to a depth of 20 inches or more.

Permeability is slow. The available water capacity is high. Reaction is neutral in the upper 7 inches, mildly alkaline to 14 inches, and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Gerber silty clay loam, 0 to 4 percent slopes, in cropland, 900 feet east and 100 feet north of southwest corner NW1/4 sec. 24, T. 20 N., R. 5 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong fine and very fine granular structure

which becomes cloddy when cultivated; hard, friable, sticky, plastic; common, fine and very fine roots; neutral; abrupt wavy boundary.

B21t—7 to 11 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine and very fine subangular blocky; very hard, friable, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; thin continuous clay films on ped surfaces; very dark grayish brown (10YR 3/2) moist coatings along prism surfaces; mildly alkaline; clear wavy boundary.

B22t—11 to 14 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and very fine subangular blocky; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores, few medium pores; thin continuous clay films on ped surfaces; very dark grayish brown (10YR 3/2) moist coating along prism surfaces; common intersecting slickensides; mildly alkaline; clear wavy boundary.

B31ca—14 to 24 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium and coarse prismatic structure parting to moderate fine and medium blocky; extremely hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; few medium pores; common soft masses of segregated lime; strongly effervescent; moderately alkaline; diffuse boundary.

B32ca—24 to 32 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse prismatic structure parting to weak coarse and very coarse plates in lower part; very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores, few medium pores; common soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—32 to 46 inches; grayish brown (2.5Y 5/2) clay loam glacial till, dark grayish brown (2.5Y 4/2) moist; weak coarse and very coarse platy structure; extremely hard, firm, sticky, plastic; common fine and very fine pores; few soft masses of segregated lime; few pebbles, shale and lignite chips; strongly effervescent; moderately alkaline; diffuse boundary.

C2—46 to 60 inches; grayish brown (2.5Y 5/2) clay loam glacial till, dark grayish brown (2.5Y 4/2) moist; weak coarse and very coarse platy structure; extremely hard, firm, sticky, plastic; few pebbles; shale and lignite chips; slightly effervescent; moderately alkaline.

The A horizon is silty clay loam or silty clay. The thickness of the noncalcareous soil ranges from 8 to 18 inches. Reaction of the A horizon is neutral or mildly

alkaline, the B horizon is mildly or moderately alkaline, and the C horizon is moderately or strongly alkaline.

85—Gerber silty clay loam, 0 to 4 percent slopes.

This nearly level and undulating soil is on terraces. It has the profile described as typical of the series. Included in mapping are areas where the surface layer is silty clay, and a few small areas where bedrock is at a depth of 20 to 40 inches. Also included are small areas of Acel and Lawther soils. The Acel soil occupies nearly level or concave positions, and the Lawther soil is in some convex areas.

Surface runoff is slow or medium. The erosion hazard is slight or moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 1; not assigned to a range site.

86—Gerber-Acel silty clay loams, 2 to 8 percent slopes.

This map unit is a complex of undulating and gently rolling soils on terraces. It is about 60 percent Gerber silty clay loam and about 30 percent Acel silty clay loam. The Gerber silty clay loam occupies the smooth slopes and some slightly convex positions. The Acel silty clay loam occupies level or concave positions. About 10 percent of the unit is included areas of Lawther soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-10 dryland; windbreak suitability group 1; not assigned to a range site.

87—Gerber-Lawther silty clays, 0 to 4 percent slopes.

This map unit consists of nearly level and undulating soils on terraces. It is about 60 percent Gerber silty clay and about 30 percent Lawther silty clay. The Gerber silty clay occupies the smooth slopes and some concave positions, and the Lawther silty clay occupies convex positions. About 10 percent of the unit is included areas of Acel soils in concave positions.

Both the Gerber and Lawther soils in this complex have a profile similar to the one described as typical of the respective series, but the surface layer of the Gerber soil is silty clay.

Surface runoff is slow or medium. The erosion hazard is moderate from wind and is slight from water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-9 dryland; windbreak suitability group 1; not assigned to a range site.

88—Gerber-Lawther silty clays, 4 to 8 percent slopes.

This map unit consists of gently rolling soils on terraces and fans. It is about 55 percent Gerber silty clay

and about 35 percent Lawther silty clay. The Gerber silty clay occupies the smooth slopes and some concave positions, and the Lawther silty clay occupies convex positions. About 10 percent of the unit is included areas of Acel soils. Also included in mapping are a few small areas where slopes are more than 8 percent.

Both Gerber and Lawther soils in this complex have a profile similar to that described as typical for the series, but the surface layer of the Gerber soil is silty clay.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-9 dryland; windbreak suitability group 1; not assigned to a range site.

Glendive series

The Glendive series consists of deep, well drained soils formed in alluvium. These soils are on terraces at elevations of 3,300 to 3,500 feet. Slopes are 0 to 2 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous loam about 5 inches thick. The underlying material is calcareous, grayish brown loam, light brownish gray silt loam and light brownish gray fine sandy loam to a depth of 60 inches or more.

Permeability is moderately rapid. The available water capacity is moderate or high. Reaction is moderately alkaline to a depth of 10 inches and strongly alkaline below.

These soils are mainly used for dryland crops. Some areas are used for irrigated crops and woodland.

Typical profile of Glendive loam, in cropland, 650 feet east and 100 feet north of the center of sec. 34, T. 21 N., R. 2 E.

Ap—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; very hard, friable, slightly sticky, slightly plastic; many very fine roots; strongly effervescent; moderately alkaline; clear smooth boundary.

C1—5 to 10 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10R 4/2) moist; weak medium subangular blocky structure; very hard, friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—10 to 16 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky, slightly plastic; common very fine

roots; common very fine pores; strongly effervescent; strongly alkaline; gradual wavy boundary.

C3—16 to 60 inches; light brownish gray (10YR 6/2) fine sandy loam stratified with lenses of loam, silt loam, and loamy fine sand, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; common to few fine roots; common fine pores; strongly effervescent; strongly alkaline.

The A horizon is moderately or strongly alkaline. The C horizon is dominantly fine sandy loam or sandy loam stratified with lenses of loam, silt loam, and loamy fine sand.

89—Glendive loam. This nearly level soil occupies terraces. It has the profile described as typical of the series. Included in mapping are a few small areas of gravelly loams and small areas of Korent and Havre soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are used for native pasture and for woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, equipment limitation, seedling mortality, and windthrow hazard are slight. Plant competition is moderate.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than boxelder and other associated species.

This unit supports dense stands of understory vegetation. Cottonwood seedlings withstand competition poorly. Reducing the amount of plant competition is sometimes needed for good seedling survival and rapid regeneration.

Capability unit IIIe-2 dryland, IIc-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Hanson series

The Hanson series consists of deep, well drained soils formed in alluvium. These soils occupy fans and foot slopes at elevations of 4,500 to 5,500 feet. Slopes are 4 to 45 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, and forbs and shrubs. The mean annual precipitation is 18 to

22 inches. The mean annual air temperature is 40 to 42 degrees F. The frost-free season is 60 to 100 days.

Typically the surface layer is dark gray and dark grayish brown loam about 14 inches thick. The underlying material is very pale brown and pale yellow, calcareous very cobbly and extremely cobbly loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is moderate. Reaction is neutral to a depth of 14 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Hanson loam, in cropland, 790 feet south and 260 feet west of the center of sec. 15, T. 17 N., R. 7 E.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, slightly sticky, slightly plastic; many very fine roots; 5 percent gravel; neutral; gradual smooth boundary.

A12—8 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to weak subangular blocky; slightly hard, very friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; 10 percent limestone gravel; strongly effervescent; mildly alkaline; clear smooth boundary.

IIC1ca—14 to 26 inches; very pale brown (10YR 8/3) very cobbly loam; pale brown (10YR 6/3) moist; weak fine blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; 50 percent cobbles, 10 percent gravel; many soft masses of lime, lime crusts on cobbles and gravel; strongly effervescent; mildly alkaline; diffuse smooth boundary.

IIC2ca—26 to 42 inches; pale yellow (2.5Y 8/4) extremely cobbly loam, light yellowish brown (2.5Y 6/4) moist; moderate fine blocky structure; slightly hard, very friable; few fine roots; 55 percent cobbles, 25 percent gravel; violently effervescent with many soft masses of lime, lime crusts on cobbles and gravel; moderately alkaline; gradual wavy boundary.

IIC3—42 to 60 inches; pale yellow (2.5Y 7/4) extremely cobbly loam, light yellowish brown (2.5Y 6/4) moist; weak fine blocky structure; slightly hard, very friable; 55 percent cobbles; 10 percent gravel; lime coating on cobbles and gravel; violently effervescent; moderately alkaline.

The A horizon is loam or stony loam. The C horizon is mildly alkaline or moderately alkaline.

90—Hanson loam, 4 to 15 percent slopes. This gently sloping to strongly sloping soil occupies fans and foot slopes. It has the profile described as typical of the series. Included in mapping are areas of soils that have

a surface layer of stony loam. They occupy steeper convex ridges or knobs throughout the map unit. Also included are a few small areas with random stones and gravel on the surface and a few small areas where slopes are less than 4 percent.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVe-5 dryland; windbreak suitability group 2M; not assigned to a range site.

91—Hanson-Sheege complex, 4 to 15 percent slopes. This map unit consists of gently rolling and strongly rolling soils on foot slopes and uplands. It is about 50 percent Hanson loam and about 35 percent Sheege stony loam. The Hanson loam occupies smooth slopes and swales, and the Sheege stony loam occupies convex slopes and ridges. About 15 percent of the unit is included areas of Skaggs stony loam. Also included are small areas where slopes are less than 4 percent or more than 15 percent.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is slight or moderate from water.

This unit is used mainly for range. Capability unit VI-1 dryland. Hanson soil in Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 2M. Sheege soil in Shallow range site, 20- to 24-inch precipitation zone; windbreak suitability group 3M.

92—Hanson-Sheege complex, 15 to 40 percent slopes. This map unit consists of hilly and steep soils on foot slopes and uplands. It is about 45 percent Hanson loam and about 35 percent Sheege stony loam. The Hanson loam occupies plane slopes and swales, and the Sheege stony loam occupies convex slopes and ridges. About 15 percent of the unit is included areas of Skaggs or Whitore soil, and about 5 percent is limestone outcrops. Also included are small areas where slopes are less than 15 percent or more than 40 percent.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is moderate or severe from water.

Soils in this complex are used for native pasture. Small areas are used for woodland. Small areas of deep, well drained soils on dominantly north-facing foot slopes produce mainly Douglas-fir and ponderosa pine. The forested areas in this map unit are mainly on the included areas of Whitore soils where slopes are 15 to 30 percent. See map unit 216, Whitore silty clay loam, for the woodland interpretations. Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Hanson soil in Silty range site, 20- to 24-inch precipitation zone; Sheege soil in Shallow range site, 20- to 24-inch precipitation zone.

93—Hanson-Skaggs association, steep. This map unit is about 55 percent Hanson stony loam in areas where slopes are 15 to 25 percent and about 35 percent

Skaggs stony loam where slopes are 20 to 40 percent. The Hanson soils occupy foot slopes, swales, and some smooth slopes. The Skaggs soils are on convex slopes and ridges. About 10 percent of the unit is included areas of other soils, mainly Sheege and Woosley soils.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is moderate from water.

This unit is used for range. Capability unit VIIe-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-0.

Harlem series

The Harlem series consists of deep, well drained soils formed in alluvium. These soils are on terraces at elevations of 3,300 to 3,500 feet. Slopes are 0 to 2 percent. The native vegetation is mainly green needlegrass, blue-bunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous silty clay loam about 8 inches thick. The underlying material is calcareous, light brownish gray and grayish brown silty clay loam and silty clay about 32 inches thick. Below this is light brownish gray, stratified clay loam and loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is moderately alkaline.

These soils are mainly used for dryland and irrigated crops. Some areas are used for range and woodland.

Typical profile of Harlem silty clay loam, in cropland, 900 feet south and 300 feet west of northeast corner sec. 6, T. 20 N., R. 1 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; very hard, friable, sticky, plastic; common fine and very fine roots; strongly effervescent; moderately alkaline; clear wavy boundary.

C1—8 to 18 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; clear wavy boundary.

C2—18 to 30 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; very hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; many worm casts; strongly effervescent; moderately alkaline; clear smooth boundary.

C3—30 to 40 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard, friable, sticky, plastic; few fine

and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

IIC4—40 to 60 inches; light brownish gray (2.5Y 6/2) stratified clay loam and loam, grayish brown (2.5Y 5/2) moist; common fine distinct mottles of yellowish brown (10YR 5/4) moist; massive; hard, very friable, sticky, plastic; common fine and very fine pores; strongly effervescent; moderately alkaline.

The A horizon is mainly silty clay loam or silty clay. Texture of the C horizon ranges from silty clay loam to silty clay. Thin layers of clay loam or loam generally occur below 40 inches. The A horizon is mildly alkaline or moderately alkaline. The C horizon is moderately alkaline to 40 inches and moderately or strongly alkaline below.

94—Harlem silty clay loam. This nearly level soil is on terraces. It has the profile described as typical of the series. Included in mapping are a few small areas of Havre soils. Also included are a few small areas where sand and gravel are at a depth of 24 to 40 inches.

Surface runoff is slow. The erosion hazard is slight from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are used for native pasture and for woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, seedling mortality, and windthrow hazard are slight. The equipment limitation and plant competition are moderate. The equipment limitation is moderate because of the limited trafficability and the potential for compaction by equipment when the soil is wet.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than boxelder and other associated species.

This unit generally supports moderately dense to dense stands of understory vegetation. Cottonwood seedlings withstand competition poorly. Reducing the amount of plant competition is sometimes needed for good seedling survival and rapid regeneration.

Capability unit IIIs-1 dryland, IIs-3 irrigated; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

95—Harlem silty clay. This nearly level soil is on terraces. It has a profile similar to the one described as

typical of the series, but the surface layer is silty clay. Included in mapping are a few small areas of Lallie soil.

Surface runoff is slow. The erosion hazard is slight or moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Timely tillage is needed to prepare the seedbed and insure seedling emergence. Capability unit IIIs-6 dryland, IIs-1 irrigated; windbreak suitability group 1; not assigned to a range site.

Havre series

The Havre series consists of deep, well drained soils formed in alluvium. These soils are on terraces at elevations of 3,300 to 3,500 feet. Slopes are 0 to 4 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

In a representative profile the surface layer is a grayish brown, calcareous loam about 8 inches thick. The underlying material is light brownish gray, calcareous loam stratified with very fine sandy loam, sandy loam, silt loam, and silty clay loam.

Permeability is moderate. The available water capacity is high. Reaction is moderately alkaline.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops and woodland.

Typical profile of Havre loam, in cropland, 2,300 feet west and 500 feet north of southeast corner sec. 13, T. 21 N., R. 1 E.

Ap—0 to 8 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure which becomes cloddy when cultivated; slightly hard, very friable, sticky, plastic; many fine and very fine roots; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C1—8 to 17 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, very friable, sticky, plastic; stratified with thin layers of very fine sandy loam; many very fine roots, many very fine and fine pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C2—17 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, very friable, sticky, plastic; stratified layers of very fine sandy loam, sandy loam, silt loam and silty clay loam; common very fine roots; common very fine pores; few fine threads of lime and gypsum, strongly effervescent; moderately alkaline.

The C horizon has indistinct to distinct thin to thick lenses of loamy fine sands to clay. When it is mixed the

average texture is loam. The A horizon is mildly alkaline or moderately alkaline. Threads of lime and seams of gypsum are few or common in the lower part of the C horizon.

96—Havre loam. This nearly level soil occupies terraces. It has the profile described as typical of the series. Included in mapping are a few small areas of Korent and Rivra soils and a few small areas where sand and gravel are at depths of 24 to 40 inches.

Surface runoff is slow. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are used for native pasture and for woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, equipment limitation, seedling mortality, and windthrow hazard are slight. Plant competition is moderate.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than boxelder and other associated species.

This unit supports dense stands of understory vegetation. Cottonwood seedlings withstand competition poorly. Reducing the amount of plant competition is sometimes needed for good seedling survival and rapid regeneration.

Capability unit IIIc-1 dryland, IIc-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

97—Havre loam, channeled. This nearly level and gently sloping soil occupies terraces and fans. The terraces and fans are dissected by numerous abandoned river channels and oxbows. Included in mapping are small areas of Rivra and Glendive soils.

Surface runoff is slow. The erosion hazard is moderate from wind but is severe from water because of flooding.

This soil is suited to pasture or range. Capability unit VIe-1 dryland; Overflow range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

98—Havre loam, saline. This nearly level soil occupies terraces. It has a profile similar to the one described as typical of the Havre series, but the seasonal high water table is between 4 and 5 feet in summer, the underlying material is mottled with reddish and yellowish brown, and the profile contains accumulations of soluble salts. Included in mapping are concave areas of clay loams and silty clays. Also included are slightly convex

areas of the nearly level Glendive loams along stream-banks.

Surface runoff is slow. The hazard of wind and water erosion is slight.

If irrigated, this soil is suited to wheat, barley, hay, and pasture. Some areas are used for native pasture and for woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, equipment limitation, seedling mortality, and windthrow hazard are slight. Plant competition is moderate.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than boxelder and other associated species.

This unit supports dense stands of understory vegetation. Cottonwood seedlings withstand competition poorly. Reducing the amount of plant competition is sometimes needed for good seedling survival and rapid regeneration.

Capability unit IIIw-1 irrigated; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 3W.

Hilger series

The Hilger series consists of deep, well drained soils formed in alluvium. These soils occupy fans and foot slopes at elevations of 3,600 to 4,800 feet. Slopes are 2 to 50 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is very dark grayish brown very stony loam about 5 inches thick. The subsoil is brown very cobbly and extremely cobbly clay loam and light brownish gray extremely cobbly loam about 14 inches thick. The substratum is light gray and light yellowish brown, calcareous extremely cobbly loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is low. Reaction is mildly alkaline to a depth of 5 inches, mildly alkaline or moderately alkaline to 19 inches, and moderately alkaline below.

These soils are mainly used for range.

Typical profile of Hilger very stony loam, in native grass, 260 feet north and 1,050 feet east of southwest corner sec. 5, T. 18 N., R. 2 W.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) very stony loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots; 10 percent stones; 20 percent cobbles; 15 percent gravel; mildly alkaline; clear wavy boundary.

B21t—5 to 9 inches; brown (10YR 5/3) very cobbly clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine subangular blocky; hard, firm, sticky, plastic; many very fine roots and pores; 5 percent stones, 25 percent cobbles, 15 percent gravel; thin clay film on faces of peds and rock fragments; mildly alkaline; clear wavy boundary.

B22t—9 to 15 inches; brown (10YR 5/3) extremely cobbly clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong very fine subangular blocky; hard, firm, sticky, plastic; many very fine roots and pores; thin clay films on faces of peds and coarse fragments, 5 percent stones, 35 percent cobbles, 25 percent gravel; mildly alkaline; clear wavy boundary.

B3ca—15 to 19 inches; light brownish gray (2.5Y 6/2) extremely cobbly loam, grayish brown (2.5Y 5/2) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few very fine roots and pores; 5 percent stones, 30 percent cobbles, 25 percent gravel; few large soft masses of lime and lime crust on coarse fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—19 to 24 inches; light gray (2.5Y 7/2) extremely cobbly loam, grayish brown (2.5Y 5/2) moist; moderate very fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; 10 percent stones, 45 percent cobbles, 10 percent gravel; common soft masses and threads of lime and lime crusts on coarse fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—24 to 60 inches; light yellowish brown (2.5Y 6/4) extremely cobbly loam, olive brown (2.5Y 4/4) moist; massive; hard, very friable; 20 percent stones, 30 percent cobbles, 20 percent gravel; strongly effervescent; moderately alkaline.

The depth to the lime ranges from 13 to 22 inches. The A1 horizon is stony loam or very stony loam that is 15 to 50 percent, by volume, coarse fragments. Reaction is neutral or mildly alkaline. The B and C horizons are 35 to 80 percent, by volume, coarse fragments. The B horizon is mildly or moderately alkaline, and the C horizon is moderately alkaline.

99—Hilger very stony loam, 2 to 15 percent slopes. This undulating to strongly sloping soil occupies fans and

foot slopes. Included in mapping are a few small areas of Perma and Work soils.

Surface runoff is medium. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is used for range. Capability unit VIs-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

100—Hilger very stony loam, 15 to 50 percent slopes. This moderately steep and steep soil is on fans and foot slopes below uplands. It has the profile described as typical of the series. Included in mapping are small areas where the slope is less than 15 percent, narrow igneous dikes in convex areas, and small areas of Castner and Perma soils. Where mapped with Cheadle and Bridger soils in the southwest corner of the survey area, this soil has a cooler temperature in summer and a slightly higher precipitation zone than is typical.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is moderate or severe from water.

This soil is used for native pasture. Small areas of deep, well drained soils on dominantly north facing foot slopes produce mainly ponderosa pine and an understory of grasses, forbs, and shrubs.

Forested areas are chiefly on north facing foot slopes of 15 to 50 percent slopes. The following interpretations are for Hilger very stony loams of 5 to 50 percent slopes.

Ponderosa pine is the only suitable species. Unless the stand is overstocked, it can be expected to reach a height of 57 to 65 feet at 100 years of age. The estimated volume per acre in a fully stocked stand at 100 years ranges from 10,500 to 14,500 board feet or from 3,700 to 4,300 cubic feet.

The erosion hazard and the equipment limitation are slight if slopes are 5 to 30 percent and moderate if 30 to 60 percent. The windthrow hazard is slight. Seedling mortality is moderate because of the moderate available water capacity, the 15- to 19-inch rainfall, and the warm environment. Plant competition is moderate because of the moderate available water capacity, the rhizomatous plants, the warm environment, and the 15- to 19-inch rainfall.

Shelterwood and selective harvest can be adapted. Where stands are drastically opened up, for example, in clearcutting or in the seed tree system of harvest, regeneration of the stand is often very slow. Ponderosa pine is the best suited species for planting.

The dominant understory plants are bluebunch wheatgrass, Idaho fescue, rough fescue, pinegrass, elk sedge, heartleaf arnica, arrowleaf balsamroot, snowberry, white spirea, kinnikinnick, and common juniper. Many of these plants have a fair to good forage value for cattle, deer, or elk. The forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants are determined not only by soil properties and variations in climate but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shade. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing on this site are bluebunch wheatgrass, rough fescue, and elk sedge. The other plants mentioned are increasers.

The following tabulation shows the estimated average annual air-dry yield in pounds per acre of understory plants, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total annual yield:

10-30.....	1,250
30-50.....	900
50-70.....	470

It is estimated that 80 percent of the yield is potential feed for grazing animals.

Capability unit VIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

101—Hilger-Castner complex, 15 to 60 percent slopes. This map unit consists of moderately steep to very steep soils on fans, foot slopes, and uplands. It is about 60 percent Hilger stony loam and about 25 percent Castner channery loam. The Hilger stony loam occupies the fans and foot slopes. The Castner channery loam occupies convex slopes, ridges, and knolls. Included in mapping are small areas where slopes are less than 15 percent. About 5 percent of the unit is included areas of igneous rock outcrop and about 10 percent is areas of Shawa and Perma soils.

The Hilger soil in this unit has a profile similar to the one described as typical of the series. The Castner soil has a profile similar to the one described as typical of the Castner series, but it formed in material weathered from igneous bedrock.

In areas where this unit is mapped with Cheadle and Bridger soils in the southwest corner of the survey area, the summer soil temperature is cooler and the precipitation zone is slightly higher than is typical.

Surface runoff is medium or rapid. The erosion hazard is slight from wind but is moderate or high from water.

This soil is used mainly for native pasture. Some areas are woodland. Small areas of deep, well drained soils on dominantly north facing foot slopes produce mainly ponderosa pine and an understory of grasses, forbs, and shrubs.

Forested areas on this unit are mainly on the Hilger soil on north facing foot slopes where slope is 15 to 30 percent. See map unit 100, Hilger very stony loam, for woodland interpretations. Capability unit VIe-1 dryland; windbreak suitability group 4-0. Hilger soil in Silty range

site, 15- to 19-inch precipitation zone. Castner soil in Shallow range site, 15- to 19-inch precipitation zone.

Hillon series

The Hillon series consists of deep, well drained soils formed in glacial till. These soils are on uplands at elevations of 3,400 to 4,000 feet. Slopes are 0 to 45 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous clay loam about 5 inches thick. The underlying material is calcareous, light brownish gray and grayish brown clay loam and loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is mildly alkaline in the upper 5 inches and moderately alkaline below that depth.

These soils are mainly used for dryland crops and range.

Typical profile of Hillon clay loam, in an area of Kevin-Hillon clay loams, 8 to 15 percent slopes, in cropland, 290 feet north and 1,000 feet west of southeast corner SW1/4 sec. 8, T. 22 N., R. 5 E.

Ap—0 to 5 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, very friable, sticky, plastic; few fine and very fine roots; slightly effervescent; mildly alkaline; abrupt wavy boundary.

C1ca—5 to 12 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, very friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; few medium pores; few pebbles; common medium soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2ca—12 to 19 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, very friable, slightly sticky, slightly plastic; few fine and very fine roots; many fine and very fine pores; few medium pores; few pebbles and few lignite chips; common medium soft masses of segregated lime; strongly effervescent; moderately alkaline; clear smooth boundary.

C3ca—19 to 28 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine and medium blocky structure; hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores, few medium pores; 15 percent by volume coarse fragments with lime coatings; few lignite chips, common medium soft masses

of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C4—28 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; 10 percent coarse fragments; common medium prominent masses of gypsum; slightly effervescent; moderately alkaline.

The A horizon is mildly alkaline or moderately alkaline. The C horizon is moderately alkaline or strongly alkaline.

102—Hillon clay loam, 15 to 45 percent slopes.

This hilly and steep soil occupies terrace edges and foot slopes. Included in mapping are small areas where slopes are less than 15 percent or more than 45 percent. Also included are a few small areas of shale or sandstone outcrops occupying nearly vertical slopes along drainageways and small areas of Gerber or Scobey soils.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

This soil is used for range. Capability unit VIe-1 dryland; Thin Hilly range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

Ipano series

The Ipano series consists of moderately deep, well drained soils formed in alluvium or loess over sandstone. These soils are on uplands. They are only 20 to 40 inches deep over hard sandstone. Slopes are 0 to 15 percent. The elevation is 3,300 to 4,300 feet. The native vegetation is mainly rough fescue, bluebunch wheatgrass, Columbia needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous loam about 8 inches thick. The subsoil is light brownish gray and light gray, calcareous silt loam about 11 inches thick. The substratum is light brownish gray, calcareous gravelly loam and pale brown, calcareous channery loam about 15 inches thick. Below 34 inches is hard sandstone.

Permeability is moderate to 34 inches. The available water capacity is low or moderate. Reaction is mildly alkaline in the upper 8 inches and moderately alkaline below.

These soils are used mainly for dryland crops and range.

Typical profile of Ipano loam, in cropland, 460 feet west and 180 feet north of the center of sec. 28, T. 20 N., R. 3 E.

- Ap—0 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; slightly hard, very friable, sticky, plastic; slightly effervescent; mildly alkaline; abrupt wavy boundary.
- B2ca—8 to 13 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to weak medium and fine subangular blocky; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; common fine soft masses of lime; strongly effervescent; moderately alkaline; clear wavy boundary.
- B3ca—13 to 19 inches; light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; common soft masses and filaments of lime; few angular sandstone fragments; violently effervescent; moderately alkaline; clear wavy boundary.
- IIC1ca—19 to 24 inches; light brownish gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and few medium pores; common nodules of lime; 15 percent by volume of angular sandstone fragments; violently effervescent; moderately alkaline; gradual wavy boundary.
- IIC2ca—24 to 34 inches; pale brown (10YR 6/3) channery loam, brown (10YR 5/3) moist; hard, very friable, nonsticky, nonplastic; 30 percent by volume of sandstone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.
- IIR—34 inches; hard fractured sandstone.

Depth to bedrock ranges from 20 to 40 inches. The average volume of sandstone coarse fragments in the IICca horizon is 15 to 30 percent. Reaction of the A and B horizons ranges from mildly to moderately alkaline.

103—Ipano loam, 0 to 4 percent slopes. This nearly level and undulating soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where slopes are more than 4 percent. Also included are a few small areas of Azaar and Reeder soils.

Surface runoff is medium. The erosion hazard is moderate from wind and slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

104—Ipano-Castner complex, 8 to 15 percent slopes. This map unit consists of strongly rolling soils on

sedimentary uplands. It is about 50 percent Ipano loam and about 35 percent Castner channery loam. The Ipano loam occupies the smooth slopes and concave areas. The Castner channery loam occupies the convex slopes, ridges, and knolls. About 15 percent of the unit is included convex areas of Big Timber soils and some areas of Darret soils on some concave slopes. Also included are small areas where slopes are less than 8 percent or more than 15 percent.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-4 dryland. Ipano soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Castner soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

105—Ipano-Hillon complex, 0 to 4 percent slopes. This map unit consists of nearly level and undulating soils on uplands. It is about 50 percent Ipano loam and about 30 percent Hillon clay loam. The Ipano loam occupies smooth slopes, and the Hillon clay loam occupies slightly convex areas. About 20 percent of the unit is included areas of Ticell and Gerber soils. Also included are small areas of channery loam on some convex ridges and knolls.

The Ipano soil in this unit has a profile similar to the one described as typical of the series. The Hillon soil has a profile similar to the one described as typical for the Hillon series, but it has bedrock between depths of 40 and 60 inches in some places.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

106—Ipano-Hillon complex, 4 to 10 percent slopes. This map unit consists of gently rolling and strongly rolling soils on uplands and terraces. It is about 50 percent Ipano loam and about 30 percent Hillon clay loam. The Ipano loam occupies plane slopes, and the Hillon clay loam occupies slightly convex areas. About 20 percent of the unit is included areas of Ticell and Gerber soils. Also included are small areas of channery loam on some convex ridges and knolls.

The Ipano soil in this unit has a profile similar to the one described as typical of the series. The Hillon soil has a profile similar to the one described as typical of the Hillon series, but it has bedrock between 40 and 60 inches in some places.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

107—Ipano-Ticell loams, 0 to 4 percent slopes.

This map unit consists of nearly level and undulating soils on uplands. It is about 55 percent Ipano loam and about 20 percent Ticell loam. The Ipano loam occupies the plane slopes and concave areas, and the Ticell loam occupies convex areas and ridges. About 10 percent of the unit is included areas of Castner soils on some convex slopes and ridges, and about 15 percent is Absarokee and Work soils on some smooth slopes and in swales.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; not assigned to a range site. Ipano soil in windbreak suitability group 2M. Ticell soil in windbreak suitability group 3M.

108—Ipano-Ticell loams, 4 to 10 percent slopes.

This map unit consists of gently rolling and strongly rolling soils on uplands. It is about 55 percent Ipano loam and about 20 percent Ticell loam. The Ipano loam occupies the plane slopes and concave areas, and the Ticell loam occupies convex slopes and ridges. About 10 percent of the unit is included areas of Castner soils on convex slopes and ridges. About 15 percent is Absarokee and Work soils on smooth slopes and in swales.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-4 dryland. Ipano soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Ticell soil in Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

Judith series

The Judith series consists of deep, well drained soils formed in alluvium. These soils are on terraces and fans at elevations of 3,600 to 4,600 feet. Slopes are 0 to 8 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark gray, calcareous loam about 7 inches thick. The subsoil is light brownish gray, calcareous clay loam about 6 inches thick. The substratum is very pale brown, calcareous clay loam, gravelly loam, and very gravelly sandy loam to a depth of 60 inches or more.

Permeability is moderate to a depth of about 26 inches and is moderately rapid below. The available water capacity is low. Reaction is mildly alkaline to a depth of 7 inches, moderately alkaline to 22 inches, and strongly alkaline to 60 inches.

These soils are mainly used for dryland crops.

Typical profile of Judith loam, 0 to 4 percent slopes, in cropland, 300 feet north and 100 feet west of the center of sec. 35, T. 19 N., R. 6 E.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; moderate very fine granular structure; slightly hard, very friable, sticky, plastic; many fine and very fine roots; 10 percent gravel; slightly effervescent; mildly alkaline; abrupt wavy boundary.

B2ca—7 to 13 inches; light brownish gray (10YR 6/2) clay loam, pale brown (10YR 6/3) moist; weak fine subangular blocky structure; hard, friable, sticky, plastic; many very fine roots; many very fine pores; 10 percent gravel; violently effervescent; moderately alkaline; clear wavy boundary.

C1ca—13 to 22 inches; very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) moist; massive; hard, friable, sticky, plastic; common very fine roots; common very fine pores; 15 percent gravel with lime crust on surface; violently effervescent; moderately alkaline; gradual wavy boundary.

C2ca—22 to 26 inches; very pale brown (10YR 8/3) gravelly loam, pale brown (10YR 6/3) moist; massive; hard, friable, slightly sticky, slightly plastic; few roots; 30 percent gravel with lime crust on surface; violently effervescent; strongly alkaline; gradual wavy boundary.

IIC3ca—26 to 60 inches; very pale brown (10YR 7/3) very gravelly sandy loam; pale brown (10YR 6/3) moist; massive; hard, very friable, slightly sticky; no roots; 60 percent gravel with thick lime crust on surface; violently effervescent; strongly alkaline.

The depth to the IIC horizon is 24 to 30 inches. The calcium carbonate equivalent is estimated to range from 35 to 45 percent below the Ap horizon. The coarse fragments, which are mainly limestone, make up from 35 to 70 percent of the material below 26 inches. The A horizon is mildly or moderately alkaline. The C horizon ranges from moderately to strongly alkaline.

109—Judith loam, 0 to 4 percent slopes. This nearly level and undulating soil is on terraces. It has the profile described as typical of the series. Included in mapping, on convex positions, are a few small areas where cemented gravel is at a depth of about 15 inches and the surface layer is gravelly loam. Also included are a few small areas of Fairfield soil in concave swales and along shallow drainageways.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

110—Judith loam, 4 to 8 percent slopes. This moderately sloping soil occupies terraces and fans. Included in mapping are areas of gravelly and cobbly loam on sharp convex ridges and along the edges of terraces and fans.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

111—Judith loam, sandstone substratum, 0 to 4 percent slopes. This nearly level and undulating soil occupies terraces and uplands. It has a profile similar to the one described as typical of the series, but it is underlain at a depth of 40 to 60 inches by hard fractured sandstone. Included in mapping are a few small areas of Azaar and Ipano soils.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; windbreak suitability group 2M; not assigned to a range site.

Kevin series

The Kevin series consists of deep, well drained soils formed in glacial till. These soils are on uplands at elevations of 3,500 to 4,100 feet. Slopes are 0 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown clay loam about 7 inches thick. The subsoil is brown and grayish brown clay loam about 12 inches thick. It is calcareous below 9 inches. The substratum is grayish brown and light brownish gray, calcareous clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is mildly alkaline to a depth of 9 inches, moderately alkaline to 19 inches, and strongly or moderately alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Kevin clay loam, in an area of Scobey-Kevin clay loams, 0 to 5 percent slopes, in crop-

land, 1,400 feet north and 150 feet east of southwest corner sec. 11, T. 22 N., R. 4 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure which becomes cloddy when cultivated; hard, friable, sticky, plastic; many very fine roots; 5 percent gravel; mildly alkaline; abrupt smooth boundary.

B2t—7 to 9 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky, plastic; many very fine roots; many fine pores; moderately thick continuous grayish brown (10YR 5/2) and very dark grayish brown (10YR 3/2) moist clay films on faces of peds; 5 percent gravel; mildly alkaline; clear wavy boundary.

B3ca—9 to 19 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; very hard, friable, sticky, plastic; common very fine roots; many very fine pores; 5 percent gravel with lime crusts on surface; many very fine masses of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.

C1ca—19 to 30 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure; very hard, friable, sticky, plastic; common very fine roots; common very fine pores; 5 percent gravel with lime crust on surface; few lignite chips; common fine masses of lime; strongly effervescent; strongly alkaline; gradual smooth boundary.

C2—30 to 44 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; very hard, friable, sticky, plastic; few roots; 5 percent gravel; few fine masses of lime; strongly effervescent; strongly alkaline; clear smooth boundary.

C3—44 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive parting to weak coarse platy; very hard, firm, sticky, plastic; few roots; 5 percent gravel; few fine lignite chips; few fine masses of lime and few fine seams of gypsum; strongly effervescent; moderately alkaline.

The depth to lime ranges from 7 to 10 inches. The Ap horizon is neutral or mildly alkaline. The B2t horizon is mildly or moderately alkaline. The C horizon is moderately or strongly alkaline. The profile is 0 to 15 percent coarse fragments throughout. Seams of gypsum occur below 40 inches.

112—Kevin-Hillon clay loams, 8 to 15 percent slopes. This map unit consists of strongly rolling soils on uplands. It is about 60 percent Kevin clay loam and

about 30 percent Hillon clay loam. The Kevin clay loam is on plane slopes, and the Hillon clay loam is on convex slopes, ridges, and knolls. About 10 percent of the unit is included areas of Scobey soils. Also included are a few small areas where slopes are less than 8 percent or more than 15 percent and small areas where the surface layer is loam.

The Kevin soil has a profile similar to the one described as typical of the series. The Hillon soil has the profile described as typical of the Hillon series.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-3 dryland; Thin Hilly range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

113—Kevin-Scobey complex, 4 to 10 percent slopes. This map unit consists of gently rolling and strongly rolling soils on uplands. It is about 55 percent Kevin clay loam and about 30 percent Scobey clay loam. The Kevin clay loam occupies the upper slopes and crests of some ridges, and the Scobey clay loam occupies smooth slopes and concave positions. About 15 percent of the unit is included areas of Hillon soil occupying ridges and knolls. Also included in mapping are a few small areas where slopes are less than 4 percent or more than 10 percent.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-3 dryland; windbreak suitability group 1; not assigned to a range site.

Kobar series

The Kobar series consists of deep, well drained soils formed in alluvium and glaciolacustrine material. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,000 feet. Slopes are 0 to 8 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous silty clay loam 6 inches thick. The subsoil is light brownish gray and light yellowish brown, calcareous silty clay loam about 20 inches thick. The substratum is light brownish gray, calcareous silty clay and silty clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is moderate or high. Reaction is mildly or moderately alkaline.

These soils are mainly used for dryland crops and some irrigated crops.

Typical profile of Kobar silty clay loam, in an area of Kobar-Marias complex, 0 to 4 percent slopes, in cropland, 120 feet north and 300 feet east of the center of sec. 14, T. 22 N., R. 5 E.

Ap—0 to 6 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; hard, friable, sticky, plastic; common fine and very fine roots; slightly effervescent; mildly alkaline; clear wavy boundary.

B2—6 to 12 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; gradual irregular boundary.

B3ca—12 to 26 inches; light yellowish brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; weak medium and coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; common fine soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1cs—26 to 36 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; few fine distinct mottles of brownish yellow (10YR 6/6) dry; massive and very thinly stratified; very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; many medium and fine threads and masses of gypsum; slightly effervescent; mildly alkaline; diffuse wavy boundary.

C2—36 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; common fine distinct mottles of brownish yellow (10YR 6/6) dry; massive and very thinly stratified; very hard, friable, sticky, plastic; common fine and very fine pores; thin layers of silty clay and silt loam; few fine threads and masses of gypsum; slightly effervescent; moderately alkaline.

The texture of the B and C horizons is mainly silty clay loam with layers of silty clay or silt loam in the C horizon. Reaction throughout the soil is mildly alkaline or moderately alkaline.

114—Kobar silty clay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces, fans, and foot slopes. Included in mapping are a few small areas of Marias and Lawther soils.

Surface runoff is medium. The wind erosion hazard is moderate, and the water erosion hazard is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capabil-

ity unit IIIe-2 dryland, IIs-3 irrigated; windbreak suitability group 1; not assigned to a range site.

115—Kobar silty clay loam, 2 to 4 percent slopes. This gently sloping soil occupies terraces, fans, and foot slopes. Included in mapping are a few small areas where slopes are less than 2 percent. Small areas of Marias and Lawther soils are also included.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-2 dryland, IIe-2 irrigated; windbreak suitability group 1; not assigned to a range site.

116—Kobar silty clay loam, 4 to 8 percent slopes. This moderately sloping soil occupies fans and foot slopes. Included in mapping are a few small areas where slopes are more than 8 percent. Also included are areas of Yamac loam or light silty clay loam on some convex fans and along drainages, and a few small areas where gravel, cobbles, and stones are on the surface.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-3 dryland, IIIe-1 irrigated; windbreak suitability group 1; not assigned to a range site.

117—Kobar-Marias complex, 0 to 4 percent slopes. This map unit consists of nearly level and undulating soils on terraces and fans. It is about 55 percent Kobar silty clay loam and about 35 percent Marias silty clay. The Kobar silty clay loam occupies smooth slopes and slightly convex positions. The Marias silty clay occupies concave slopes and swales. About 10 percent of the unit is included areas of Linnet and Hillon soils.

The Kobar soil has the profile described as typical of the series. The Marias soil has the profile similar to the one described as typical of the Marias series.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-5 dryland; windbreak suitability group 1; not assigned to a range site.

Korent series

The Korent series consists of deep, well drained soils formed in alluvium. These soils are on terraces at elevations of 3,300 to 3,500 feet. Slopes are 0 to 2 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous loam about 9 inches thick. The underlying material is light brownish gray, gray, and grayish brown, calcareous loam, silt loam, and fine sandy loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is moderate or high. Reaction is moderately alkaline.

These soils are mainly used for dryland crops. Some areas are used for irrigated crops, range, and woodland.

Typical profile of Korent loam, in cropland, 880 feet east and 1,540 feet south of northwest corner sec. 10, T. 20 N., R. 3 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; slightly effervescent; moderately alkaline; abrupt wavy boundary.

C1—9 to 24 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (2.5Y 4/2) moist; very weak coarse prismatic structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

A1b—24 to 26 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; massive; hard, very friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C1b—26 to 41 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; few fine mottles of brownish yellow (10YR 6/6) dry; massive; soft, friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2b—41 to 60 inches; grayish brown (2.5Y 5/2) stratified fine sandy loam and loamy sand, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable; few fine roots; slightly effervescent; moderately alkaline.

The C horizon is loam, silt loam, and very fine sandy loam stratified with thin layers of silty clay loam to loamy sand. The A horizon is mildly alkaline or moderately alkaline. The C horizon is moderately alkaline or strongly alkaline.

118—Korent loam. This nearly level soil is on terraces. It has the profile described as typical of the series. Included in mapping are a few small areas of Glendive and Harlem soils.

Surface runoff is slow. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are used for native pasture and for woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, equipment limitation, seedling mortality, and windthrow hazard are slight. Plant competition is moderate.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than boxelder and other associated species.

This unit supports dense stands of understory vegetation. Cottonwood seedlings withstand competition poorly. Reducing the amount of plant competition is sometimes needed for good seedling survival and rapid regeneration. Capability unit IIIc-1 dryland, IIc-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

Lallie series

The Lallie series consists of deep, poorly drained soils formed in alluvium. These soils are on terraces at elevations of 3,300 to 3,500 feet. Slopes are 0 to 2 percent. The native vegetation is mainly alkali cordgrass, alkali sacaton, Nuttall alkaligrass, forbs, and shrubs. Mean annual precipitation is 12 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous silty clay loam about 2 inches thick. The underlying material is gray and light gray, calcareous silty clay and clay loam to a depth of 50 inches. Below 50 inches is light gray, calcareous very gravelly sand to 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is strongly alkaline in the upper 2 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range. Some areas are irrigated.

Typical profile of Lallie silty clay loam, in grassland, 600 feet west and 150 feet south of northeast corner sec. 35, T. 21 N., R. 1 W.

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

C1g—2 to 12 inches; gray (N 6/) silty clay, gray, (N 5/) moist; common fine to medium prominent mottles of dark yellowish brown (10YR 4/4) moist; strong very fine subangular blocky structure; extremely hard, firm, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; many very fine masses of gypsum; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2g—12 to 45 inches; light gray (N 7/) silty clay, gray (N 5/) and greenish gray (5GY 6/1) moist; many fine to coarse prominent mottles of olive brown (2.5Y 4/4) moist; massive; extremely hard, firm, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

C3g—45 to 50 inches; gray (N 6/) clay loam, gray (N 5/) moist; few fine and medium distinct mottles of dark gray (N 4/) moist; massive; extremely hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC4—50 to 60 inches; light gray (5Y 6/1) very gravelly sand, dark gray (5Y 4/1) moist; single grain; loose, nonsticky, nonplastic; strongly effervescent; moderately alkaline.

The A horizon is silty clay loam or clay loam. The C horizon is mainly silty clay, silty clay loam, or clay loam to a depth of 40 inches. Contrasting coarser textures of very gravelly sand to very gravelly sandy loam are stratified with sandy loam and clay loam. Reaction is moderately alkaline or strongly alkaline throughout the soil.

119—Lallie silty clay loam. This nearly level soil is on terraces. It has the profile described as typical of the series. It is subject to flooding in spring, and the water table is within 3 feet of the surface during the growing season. If cultivated, the surface layer is cloddy and preparing a seedbed is difficult. Included in mapping are small areas where the surface layer is clay loam. Also included are a few small areas of Benz and Marvan soils and areas between terrace levels where slopes are more than 2 percent.

Surface runoff is very slow. The erosion hazard is slight from both wind and water.

This soil is best suited to irrigated hay and pasture and to limited small grain production. Capability unit VIw-1 dryland, IVw-1 irrigated; Subirrigated range site, 15- to 19-inch precipitation zone; windbreak suitability group 3W.

Lambeth series

The Lambeth series consists of deep, well drained soils formed in glacial outwash and glaciolacustrine material. These soils occupy terraces and uplands at elevations of 3,300 to 3,800 feet. Slopes are 0 to 60 percent.

The native vegetation is mainly bluebunch wheatgrass, needleandthread, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 13 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light yellowish brown calcareous silt loam about 4 inches thick. The underlying material is light yellowish brown and pale yellow, calcareous silt loam to a depth of 66 inches or more.

Permeability is moderately slow. The available water capacity is moderate or high. Reaction is moderately alkaline.

These soils are mainly used for dryland crops and range.

Typical profile of Lambeth silt loam in an area of Lambeth and Lothair soils, in cropland, 640 feet east and 250 feet north of southwest corner NW1/4 sec. 10, T. 22 N., R. 5 E.

A1—0 to 4 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; weak thin platy structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

C1cs—4 to 12 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; hard, very friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; many fine seams and masses of gypsum; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C2cs—12 to 66 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; hard, very friable, slightly sticky, slightly plastic; few roots; few pores; yellowish brown (10YR 5/4) and reddish brown (5YR 3/3) mottles; few fine seams and masses of gypsum; strongly effervescent; moderately alkaline.

The depth to the cs horizon is 2 to 4 inches. The C horizon has thin stratifications of silt loam, silty clay loam, and very fine sandy loam. It is moderately alkaline.

120—Lambeth-Floweree silt loam, 2 to 8 percent slopes. This map unit consists of undulating and moderately sloping soils on terraces, fans, and uplands. It is about 65 percent Lambeth silt loam and 25 percent Floweree silt loam. Lambeth silt loam is on convex slopes, ridges, and knolls. Floweree silt loam is on smooth and concave slopes. About 10 percent of this unit is included areas of Ethridge and Kobar soils and a few small areas where the slope is more than 8 percent.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range.

Capability unit IIIe-3 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

121—Lambeth and Lothair soils, 25 to 60 percent slopes. This map unit consists of steep and very steep Lambeth silt loam and Lothair silty clay loam. It occupies highly dissected terrace edges and valley walls. Both soils have the profile described as typical of their respective series. Included in mapping are a few small areas where the slope is steeper than typical, small areas of Hillon and Havre soils, and small areas of shale outcrop on the very steep slopes and sides of deep drainageways.

Surface runoff is rapid. The erosion hazard is slight from wind but is severe from water.

This unit is used as rangeland. Capability unit VIIe-1 dryland; Thin Hilly range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

Lawther series

The Lawther series consists of deep, well drained and moderately well drained soils formed in alluvium and lacustrine deposits. These soils occupy terraces and fans at elevations of 3,300 to 3,800 feet. Slopes are 0 to 15 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown, calcareous silty clay about 6 inches thick. The subsoil is grayish brown, calcareous silty clay about 24 inches thick. The substratum is grayish brown and light brownish gray, calcareous clay and clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is moderate or high. Reaction is mildly alkaline in the upper 6 inches and moderately alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Lawther silty clay, in cropland, 1,300 feet east and 435 feet south of northwest corner SW1/4 sec. 17, T. 20 N., R. 6 E.

Ap—0 to 6 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; strong very fine granular structure; hard, friable, sticky, very plastic; common fine and very fine roots; slightly effervescent; mildly alkaline; abrupt wavy boundary.

B2—6 to 16 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium and fine blocky structure; extremely hard, very firm, sticky, very plastic; common fine and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline; clear irregular boundary.

B3ca—16 to 30 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium and coarse blocky structure; extremely hard, very firm, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; well expressed slickensides that intersect at a 30 to 60 degree angle; few medium and coarse soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—30 to 35 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; very hard, firm, sticky, plastic; common fine and very fine pores; few fine soft masses of segregated lime; few fine gravel and lignite chips; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—35 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common fine strong brown (7.5YR 5/6) mottles; massive, very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; many medium and coarse threads and masses of gypsum; slightly effervescent; moderately alkaline.

The thickness of the A and B horizons ranges from 20 to 40 inches. The soil is mainly calcareous throughout, but in some areas the surface layer is noncalcareous. The A and B horizons are mildly alkaline or moderately alkaline.

122—Lawther silty clay, 0 to 4 percent slopes. This nearly level and undulating soil is on terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Gerber soil.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-9 dryland; windbreak suitability group 1; not assigned to a range site.

123—Lawther clay. This nearly level soil is in swales. Included in mapping are small areas of Gerber and McKenzie soils.

Surface runoff is slow. The erosion hazard is slight from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. However, crops are sometimes damaged by ponding, or planting is delayed because of wetness. Capability unit IIIw-1 dryland; windbreak suitability group 4-2; not assigned to a range site.

124—Lawther-Gerber complex, 8 to 15 percent slopes. This map unit consists of strongly rolling soils on terraces. It is about 65 percent Lawther silty clay and 25 percent Gerber silty clay loam. Lawther silty clay occupies convex areas and smooth slopes. Gerber silty clay

loam occupies concave slopes. About 10 percent of this unit is included areas of Hillon soils, which occupy ridges and knolls.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-7 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

Lenep series

The Lenep series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,200 to 4,000 feet. Slopes are 2 to 10 percent. The native vegetation is mainly western wheatgrass, needleandthread, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 16 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

In a representative profile the surface layer is grayish brown sandy loam and loam about 6 inches thick. The subsoil is grayish brown clay loam and clay about 18 inches thick. The substratum is pale olive sandy clay and sandy clay loam to a depth of 60 inches or more. The soil is calcareous below 20 inches.

Permeability is slow. The available water capacity is moderate. Reaction is neutral or mildly alkaline in the upper 6 inches, moderately alkaline to a depth of 9 inches, strongly alkaline to 40 inches, and very strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Lenep loam, in native grass, 1,420 feet east and 30 feet south of northwest corner sec. 31, T. 20 N., R. 3 W.

A11—0 to 3 inches; grayish brown (2.5Y 5/2) sandy loam, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots; many fine and very fine pores; neutral; clear smooth boundary.

A12—3 to 6 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; mildly alkaline; clear smooth boundary.

B1t—6 to 9 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; strong very fine blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; continuous clean silt and fine sand coatings on vertical faces of peds; discontinuous

thin clay films on ped faces; moderately alkaline; clear wavy boundary.

B2t—9 to 20 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong medium blocky; extremely hard, firm, sticky, very plastic; common fine and very fine roots; common fine and very fine pores; thin clay films on ped faces; strongly alkaline; clear irregular boundary.

B3ca—20 to 24 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong medium blocky; extremely hard, firm, sticky, and very plastic; common fine and very fine roots; common fine and very fine pores; few medium distinct lime masses; few lime coated sandstone fragments; strongly effervescent; strongly alkaline; gradual wavy boundary.

C1ca—24 to 40 inches; pale olive (5Y 6/3) sandy clay, olive (5Y 5/4) moist; moderate medium and coarse prismatic structure parting to moderate medium and coarse blocky; extremely hard, firm, sticky, and plastic; few fine and very fine roots; common fine and very fine pores; common fine and medium lime masses; strongly effervescent; strongly alkaline; gradual wavy boundary.

C2—40 to 60 inches; pale olive (5Y 6/3) sandy clay loam, olive (5Y 5/3) moist; massive; extremely hard, firm, sticky, plastic; few very fine roots; common fine and very fine pores; common fine lime masses and threads; few gypsum seams; slightly effervescent; very strongly alkaline.

If mixed by plowing, the A horizon is loam. The thickness of the solum ranges from 20 to 30 inches. The A horizon is neutral or mildly alkaline. The B horizon is moderately to strongly alkaline. The C horizon is strongly to very strongly alkaline.

125—Lennep-Nobe complex, 2 to 10 percent slopes. This map unit consists of undulating to strongly sloping soils on terraces, foot slopes, and fans. It is about 65 percent Lennep loam and 20 percent Nobe clay loam. Lennep loam occupies the smooth slopes and slightly elevated areas, and Nobe clay loam is in the nearly barren depressions. About 15 percent of the unit is included areas of Absher soils. Also included are areas where the slope is less than 2 percent.

The Lennep soil in this unit has the profile described as typical of the series. The Nobe soil has a profile similar to the one described as typical of the Nobe series.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVs-3 dryland. Lennep soil in Silty range site, 10- to 14-inch precipitation zone; windbreak suitability

ity group 3S. Nobe soil in Saline Uplands range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-5.

Libeg series

The Libeg series consists of deep, well drained soils formed in material weathered from sandstone fragments and stony alluvium. These soils occupy foot slopes, fans, and uplands at elevations of 4,600 to 5,500 feet. Slopes are 2 to 45 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, forbs, and shrubs. The mean annual precipitation is 19 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the surface layer is dark grayish brown stony loam about 6 inches thick. The upper part of the subsoil is brown channery loam, brown very channery clay loam, and reddish brown very channery sandy clay loam about 24 inches thick. The lower part of the subsoil is light reddish brown extremely stony sandy loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is low. Reaction is slightly acid to a depth of 60 inches.

These soils are mainly used for range.

Typical profile of Libeg stony loam in native grass, 1,900 feet west and 360 feet north of southeast corner NE1/4 sec. 16, T. 17 N., R. 6 E.

A1—0 to 6 inches; dark grayish brown (10YR 4/2) stony loam; very dark brown (10YR 2/2) moist; weak fine platy structure parting to moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; 25 percent sandstone fragments; slightly acid; clear wavy boundary.

B21t—6 to 11 inches; brown (10YR 5/3) very channery loam, dark brown (10YR 3/3) moist; strong very fine subangular blocky structure; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; pale brown (10YR 6/3) dry fine sand coating on blocky structure; 35 percent sandstone fragments; slightly acid; clear wavy boundary.

B22t—11 to 16 inches; brown (7.5YR 5/4) very channery clay loam, dark brown (7.5YR 4/4) moist; strong fine and very fine blocky structure; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; pale brown (10YR 6/3) dry fine sand coating sides of blocky structure; 40 percent sandstone fragments; slightly acid; clear wavy boundary.

B23t—16 to 30 inches; reddish brown (5YR 5/4) very channery sandy clay loam, reddish brown (5YR 4/4) moist; strong fine and medium blocky structure; extremely hard, friable, sticky, plastic; common fine

and very fine roots; few coarse roots; many fine and very fine pores; few medium pores; thin continuous clay films on all ped faces and on coarse fragments; 60 percent sandstone fragments; slightly acid; gradual irregular boundary.

B3—30 to 60 inches; light reddish brown (5YR 6/4) extremely stony sandy loam, yellowish red (5YR 5/6) moist; weak medium and fine subangular blocky structure; very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; 80 percent sandstone fragments; slightly acid.

The control section is 35 to 60 percent coarse fragments by volume. The B22t horizon is a loam, sandy clay loam, or clay loam with coarse fragments. The A and B horizons are slightly acid to neutral.

126—Libeg stony loam, 2 to 15 percent slopes.

This undulating to strongly rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are small areas of Monad and Loggert soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is used for range. Capability unit VI_s-1 dryland, Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 3M.

Lihen series

The Lihen series consists of deep, well drained soils formed in alluvium and eolian sands. These soils occupy terraces, uplands, and fans at elevations of 3,300 to 4,300 feet. Slopes are 0 to 20 percent. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, forbs, and shrubs. The mean annual precipitation is 14 to 16 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown and dark gray loamy sand about 21 inches thick. The underlying material is grayish brown and light grayish brown, calcareous loamy sand and loamy fine sand to a depth of 60 inches or more.

Permeability is rapid. The available water capacity is low. Reaction is neutral to a depth of 21 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range. Some areas are irrigated.

Typical profile of Lihen loamy sand, in native grass, 1,050 feet west and 200 feet north of southeast corner sec. 6, T. 17 N., R. 1 E.

A11—0 to 3 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; single grain; soft, very friable; many fine and very

fine roots; few medium roots; neutral; clear smooth boundary.

A12—3 to 15 inches; dark gray (10YR 4/1) loamy sand, very dark brown (10YR 2/2) moist; weak medium and coarse subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; few medium roots; neutral; gradual wavy boundary.

A13—15 to 21 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable; common fine and very fine roots; few medium roots; many fine and very fine pores; neutral; clear wavy boundary.

C1—21 to 33 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; common fine and very fine roots; many fine and very fine pores; slightly effervescent; mildly alkaline; gradual wavy boundary.

C2ca—33 to 60 inches; light grayish brown (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; few fine and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline.

The texture is mainly loamy sand or loamy fine sand to a depth of 40 inches or more. The A horizon is noncalcareous to a depth of 10 to 25 inches. It is neutral or mildly alkaline. The C horizon is mildly alkaline or moderately alkaline.

127—Lihen loamy sand, 2 to 8 percent slopes. This undulating and gently rolling soil occupies fans, terraces, and uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the slope is less than 2 percent or more than 8 percent and small areas of Dooley and Yetull soils. Also included on uplands are a few small areas of Ervide soils.

Surface runoff is slow. The erosion hazard is severe from wind but is only slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IV_e-1 dryland, IV_e-1 irrigated; Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

128—Lihen loamy sand, 8 to 20 percent slopes. This strongly rolling and hilly soil occupies fans, terraces, and uplands. Included in mapping are small areas where the slope is less than 8 percent and small convex areas on uplands of Castner and Ervide soils. Also included are small areas of Yetull soils.

Surface runoff is slow or medium. The erosion hazard is severe from wind but is only slight or moderate from water.

This soil is suited to range. Capability unit VI_e-1 dryland; Sands range site, 15- to 19-inch precipitation zone;

windbreak suitability group 3M if slope is less than 15 percent, group 4-0 if slope is more than 15 percent.

Linnet series

The Linnet series consists of deep, well drained soils formed in alluvium and glaciolacustrine material. These soils occupy outwash terraces and uplands at elevations of 3,400 to 4,000 feet. Slopes are 0 to 8 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is brown and light brownish gray silty clay about 24 inches thick. The substratum is light brownish gray, calcareous silty clay loam and grayish brown and light brownish gray, calcareous clay loam to a depth of 66 inches or more.

Permeability is slow. The available water capacity is moderate or high. Reaction is neutral in the upper 15 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops.

Representative profile of Linnet silty clay loam, in cropland, 310 feet north and 525 feet east of southwest corner sec. 15, T. 22 N., R. 4 E.

Ap—0 to 6 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; strong fine and very fine granular structure; very hard, friable, sticky, plastic; common fine and very fine roots; common unstained sand grains in surface crust; neutral; abrupt wavy boundary.

B2t—6 to 15 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and very fine blocky; extremely hard, friable, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; thin continuous clay films on all ped surfaces; peds coated very dark grayish brown (10YR 3/2) moist; neutral; clear wavy boundary.

B3ca—15 to 30 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; extremely hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; thin discontinuous clay films on vertical faces of peds; few pebbles with lime crusts on undersides; few soft masses of segregated lime; strongly effervescent; mildly alkaline; clear wavy boundary.

C1ca—30 to 42 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak

medium and coarse blocky; very hard, very friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; few lime coated pebbles; few soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2cs—42 to 66 inches; grayish brown and light brownish gray (2.5Y 5/2 and 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak thick platy structure; extremely hard, firm, sticky, plastic; few fine pores; few fine pebbles and lignite chips; common nests and seams of gypsum; moderately alkaline.

The A horizon is silty clay loam or silty clay. The thickness of noncalcareous parts of the solum combined is 11 to 20 inches. The A horizon is slightly acid to neutral. The B horizon is neutral to moderately alkaline.

129—Linnet-Acel silty clay loams, 0 to 2 percent slopes. This map unit consists of nearly level soils on outwash terraces. It is about 65 percent Linnet silty clay loam and about 25 percent Acel silty clay loam. The Linnet silty clay loam occupies smooth slopes and slightly convex areas. The Acel silty clay loam occupies slightly concave and nearly flat areas. About 10 percent of the unit is included areas of Ethridge soils and soils that have a surface layer of silty clay. Both Linnet and Acel soils in this unit have the profile described as typical of their respective series.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is slight or moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIs-2 dryland; windbreak suitability group 1; not assigned to a range site.

130—Linnet-Acel silty clay loams, 2 to 8 percent slopes. This map unit is a complex of undulating and moderately sloping soils on outwash terraces. It is about 65 percent Linnet silty clay loam and about 25 percent Acel silty clay loam. The Linnet silty clay loam is on plane slopes and in slightly convex areas, and the Acel silty clay loam is on slightly concave slopes and in swales. About 10 percent of this unit is included areas of Ethridge and Scobey soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-7 dryland; windbreak suitability group 1; not assigned to a range site.

131—Linnet-Marias complex, 0 to 2 percent slopes. This map unit consists of nearly level soils on outwash terraces. It is about 65 percent Linnet silty clay and about 30 percent Marias silty clay. The Linnet silty clay is in concave and nearly flat areas. The Marias silty clay is

in slightly convex areas. About 5 percent of the unit is included areas of Ethridge soils.

The Linnet soil in this unit has a profile similar to the one described as typical of the series, but the surface layer is silty clay. The Marias soil has a profile similar to the one described as typical of the Marias series.

Surface runoff is slow or medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-5 dryland; windbreak suitability group 1; not assigned to a range site.

132—Linnet-Marias complex, 2 to 8 percent slopes.

This undulating and moderately sloping map unit is on outwash terraces. It is about 60 percent Linnet silty clay and about 35 percent Marias silty clay. The Linnet silty clay is on smooth slopes and ridges. About 5 percent of the unit is included areas of Acel soils.

The Linnet soil in this unit has a profile similar to the one described as typical of the series, but the surface layer is silty clay. The Marias soil has a profile similar to the one described as typical of the Marias series.

Surface runoff is medium. The erosion hazard is moderate from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-8 dryland; windbreak suitability group 1; not assigned to a range site.

Lisam series

The Lisam series consists of shallow, well drained soils formed in shale. These soils are on uplands. They are only 10 to 20 inches deep over shale. Slopes are 4 to 70 percent. The elevation is 3,600 to 4,600 feet. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 12 to 18 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous clay about 5 inches thick. The underlying material is light brownish gray and grayish brown, calcareous clay about 7 inches thick. From 12 to 18 inches is weathered clay shale. Below 18 inches is hard platy clay shale.

Permeability is very slow. The available water capacity is very low. Reaction is mildly alkaline in the upper 5 inches and moderately alkaline below.

These soils are mainly used for range.

Typical profile of Lisam clay, in an area of Eltsac-Lisam clays, 10 to 70 percent slopes, in native grass, 1,320 feet east and 260 feet south of northwest corner sec. 20, T. 19 N., R. 7 E.

A1—0 to 5 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to weak fine granular; very hard, firm, sticky, very plastic; common fine and very fine roots; few medium roots; slightly effervescent; mildly alkaline; clear wavy boundary.

C1—5 to 12 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium and coarse subangular blocky structure; extremely hard, firm, sticky, plastic; few fine and very fine roots; common fine and very fine pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

C2r—12 to 18 inches; grayish brown (2.5Y 5/2) and gray (N 5/0) weathered clay shale; few fine and very fine roots.

C3r—18 to 22 inches; hard platy clay shale.

Depth to platy shale is 10 to 20 inches. The A horizon is mildly alkaline or moderately alkaline.

133—Lisam-Rock outcrop complex, 4 to 50 percent slopes.

This map unit consists of gently rolling to very steep soils on sedimentary uplands. It is about 50 percent Lisam clay and about 40 percent nearly barren shale Rock outcrop. The Lisam clay is on smooth and concave slopes, and the shale Rock outcrop occupies very steep slopes and convex areas. About 10 percent of this unit is included areas of Thebo and Rentsac soils.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

This unit is used for range. Capability unit VIIe-1 dryland. Lisam soil in Shallow Clay range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

Loberg series

The Loberg series consists of deep, well drained soils formed in stony alluvium. These soils occupy foot slopes and fans at elevations of 4,600 to 6,000 feet. Slopes are 20 to 60 percent. The native vegetation is mainly Douglas-fir, ponderosa pine, and lodgepole pine. The mean annual precipitation is 18 to 24 inches. The mean annual air temperature is 39 to 42 degrees F. The growing season is 60 to 90 days.

Typically a thin layer of undecomposed needles and twigs and partially decomposed organic material is on the surface. The surface layer is light brownish gray and very pale brown stony loam 10 inches thick. The subsoil is very pale brown, yellowish brown, and light yellowish brown very stony clay and clay loam to a depth of 60 inches or more.

Permeability is slow. The available water capacity is low or moderate. Reaction is strongly acid to a depth of 16 inches and slightly acid below.

These soils are mainly used for woodland and range.

Typical profile of Loberg stony loam in an area of Loberg-Cheadle complex, 20 to 60 percent slopes, in forest, 1,810 feet west and 950 feet north of southeast corner sec. 14, T. 19 N., R. 8 E.

- O1—1 to 0 inches; undecomposed needles, twigs and partially decomposed organic material.
- A21—0 to 2 inches; light brownish gray (10YR 6/2) stony loam, dark grayish brown (10YR 4/2) moist; weak very thin platy structure parting to strong fine and very fine granular; slightly hard, very friable, slightly sticky, slightly plastic; many fine, medium and coarse roots; many fine and very fine pores; 10 percent stones, 5 percent cobbles; strongly acid; clear wavy boundary.
- A22—2 to 10 inches; very pale brown (10YR 7/3) stony loam, brown (10YR 4/3) moist; weak fine and medium platy structure parting to weak fine subangular blocky; hard, very friable, slightly sticky, slightly plastic; many fine, medium and coarse roots; many fine and very fine pores; few medium pores; 10 percent stones, 5 percent cobbles; strongly acid; clear wavy boundary.
- B1—10 to 16 inches; very pale brown (10YR 7/3) very stony clay loam; brown (10YR 4/3) moist; strong fine and medium subangular blocky structure; very hard, friable, sticky, plastic; many fine, medium and coarse roots; many fine and very fine pores; few medium pores; 15 percent stones, 10 percent cobbles, 15 percent pebbles; strongly acid; gradual wavy boundary.
- B21t—16 to 30 inches; yellowish brown (10YR 5/4) very stony clay, dark brown (10YR 3/3) moist; strong medium and coarse prismatic structure parting to strong fine and medium blocky; extremely hard, firm, sticky, plastic; common fine, medium and coarse roots; many fine and very fine pores; few medium pores; 20 percent stones, 10 percent cobbles, 20 percent pebbles; slightly acid; gradual wavy boundary.
- B22t—30 to 60 inches; light yellowish brown (10YR 6/4) very stony clay loam, brown (10YR 4/3) moist; strong fine and medium blocky structure; very hard, friable, sticky, plastic; common fine medium and coarse roots; many fine and very fine pores, few medium pores; 20 percent stones, 15 percent cobbles, 20 percent pebbles; slightly acid.

The soil is 35 to 60 percent rock fragments below a 10-inch depth. The B22t horizon is mainly a clay loam or light clay with rock fragments. The A horizon is strongly acid or medium acid. The B horizon is strongly acid to neutral.

134—Loberg stony loam, warm, 20 to 60 percent slopes. This moderately steep to very steep soil occupies foot slopes and uplands. It has a profile similar to

the one described as typical of the series, but the soil temperature in summer is somewhat warmer than is typical. Included in mapping are a few small areas of igneous rock outcrop, small areas of Castner and Hilger soils, and small areas where slopes are less than 20 percent.

Surface runoff is medium or rapid. The erosion hazard is slight from wind but is severe from water.

This soil is used for range and woodland. Forested areas are chiefly on the Loberg stony loams, warm. The following woodland interpretations are for a slope range of 5 to 60 percent.

The desirable wood-producing species are ponderosa pine and Douglas-fir. Ponderosa pine, the most common, is the only species that can regenerate at the lower elevations in the unit.

Unless the stand is overstocked, ponderosa pine can be expected to reach a height of 60 to 66 feet at 100 years of age and Douglas-fir 35 to 40 feet at 50 years. The estimated volume at 100 years in a fully stocked stand of ponderosa pine ranges from 12,000 to 15,500 board feet per acre or from 3,900 to 5,100 cubic feet.

The erosion hazard is moderate if slopes are 5 to 15 percent but severe if 15 to 60 percent. The equipment limitation is slight if slopes are 5 to 30 percent but moderate if 30 to 60 percent. Seedling mortality and plant competition are moderate. The windthrow hazard is slight.

Shelterwood and selective harvest are well adapted if stands are young and healthy. In areas where both ponderosa pine and Douglas-fir are adapted, the shelterwood or seed-tree system of harvest or clearcutting favors the regeneration of ponderosa pine. Seed-tree harvest and clearcutting are not desirable, however, for the stands of ponderosa pine at low elevations. Douglas-fir is more tolerant of competition than ponderosa pine and will replace it unless harvesting opens up the stands enough to favor the regeneration of ponderosa pine. Only ponderosa pine should be planted at the lower elevations. Both species are adapted at the higher elevations.

The erosion hazard is moderate to severe because of the slow soil permeability and the moderately sloping to very steep slopes. The equipment limitation is moderate. Seedling mortality is moderate because of the moderate available water capacity, the 15- to 19-inch rainfall, and the warm environments. Plant competition is moderate because of the moderate available water capacity, the competitive rhizomatous plants, the warm environment, and the 15- to 19-inch rainfall.

The understory plants are bluebunch wheatgrass, Idaho fescue, rough fescue, pinegrass, elk sedge, heart-leaf arnica, arrowleaf balsamroot, snowberry, white spirea, kinnikinnick, and common juniper. Many of these plants can have fair to good forage value for cattle, deer, or elk. The forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants on these Loberg stony loams, warm, are determined not only by soil properties and variations in climate, but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading by overstory trees. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, the most preferred plants, are bluebunch wheatgrass, rough fescue, and elk sedge. The other plants mentioned are increasers, but they too can be expected to decrease under continued heavy grazing.

The following tabulation shows the estimated average annual air-dry yield in pounds per acre of understory plants, under limited grazing impact or other disturbance under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total annual yield.

10-30.....	1,250
30-50.....	900
50-70.....	470

It is estimated that 80 percent of the above yields is potential feed for grazing animals.

Capability unit VIIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

135—Loberg-Cheadle complex, 20 to 60 percent slopes. This map unit consists of hilly to very steep soils on foot slopes and uplands. It is about 60 percent Loberg stony loam and 25 percent Cheadle stony loam. Loberg stony loam occupies foot slopes. Cheadle stony loam occupies convex slopes, ridges, and knolls. About 15 percent of the unit is included areas of Libeg and Loggert soils. Small areas of Rock outcrop and small areas where slopes are less than 20 percent are also included.

The Loberg soil in this unit has the profile described as typical of the series. The Cheadle soil has a profile similar to the one described as typical of the series, but it formed in material weathered mostly from igneous rock.

Surface runoff is medium or rapid. The erosion hazard is slight from wind. It is moderate or severe from water.

This unit is used for range and woodland. Forested areas are mainly on the Loberg stony loams. The following interpretations are for those soils.

Stands are commonly lodgepole pine, Douglas-fir, and Engelmann spruce. All three are desirable wood-producing species. Lodgepole pine is dominant.

Unless the stand is overstocked, lodgepole pine can be expected to reach a height of 66 to 75 feet at 100 years of age and Douglas-fir a height of 40 to 45 feet at 50 years. The estimated volume per acre in a fully stocked stand of lodgepole pine at 100 years is 15,500 to 23,500 board feet or 6,500 to 8,600 cubic feet.

The erosion hazard is severe because of the 20 to 60 percent slopes and the slow permeability. The equipment limitation is slight if slopes are 20 to 30 percent and moderate if 30 to 60 percent. Seedling mortality is slight. Plant competition is moderate because of the number of plants that quickly cover a site after disturbance and compete with seedlings. The windthrow hazard is moderate because the soil is moist for a long period.

The clearcut, seed tree, or shelterwood systems in harvesting can be adapted. All favor the regeneration of lodgepole pine or Douglas-fir over the subalpine fir at the higher elevations. Selective harvesting favors Engelmann spruce. Lodgepole pine, Douglas-fir, and Engelmann spruce are suitable for planting.

The dominant understory plants are pinegrass, Kentucky bluegrass, elk sedge, heartleaf arnica, broadleaf arnica, twinflower, white spirea, snowberry, russet buffaloberry, rose, grouse whartleberry, blue huckleberry, kinnikinnick, and common juniper. Elk sedge and snowberry have high forage value for cattle, deer, or elk. The other plants mentioned, the increasers, have low to fair forage value. The forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants are determined not only by soil properties and variations in climate but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading by the overstory. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing on this site are elk sedge, blue huckleberry, snowberry, russet buffaloberry, and grouse whartleberry. The other plants mentioned, the increasers, can also be expected to decrease under continued heavy grazing.

The following tabulation shows the estimated average annual air-dry yield in pounds per acre of understory plants, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total annual yield.

10-30.....	2,000
30-50.....	1,200
50-70.....	625

It is estimated that 60 percent of the yield is potential feed for grazing animals.

Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Loberg soil in Silty range site, 20- to 24-inch precipitation zone. Cheadle soil in Shallow range site, 20- to 24-inch precipitation zone.

Loggert series

The Loggert series consists of deep, well drained soils formed in material weathered from shattered sandstone. These soils are on uplands at elevations of 4,600 to 5,500 feet. Slopes are 2 to 50 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass,

Idaho fescue, forbs, and shrubs. The mean annual precipitation is 18 to 24 inches. The mean annual air temperature is 39 to 42 degrees F. The growing season is 60 to 100 days.

Typically the surface layer is very dark grayish brown extremely stony loam about 7 inches thick. The subsurface layer is pinkish gray extremely stony loam 12 inches thick. The subsoil is brown and reddish brown extremely stony sandy clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is very low or low. Reaction is medium acid or slightly acid.

These soils are mainly used for range.

Typical profile of Loggert extremely stony loam in native grass, 1,280 feet south and 50 feet east of northwest corner sec. 16, T. 17 N., R. 6 E.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) extremely stony loam, very dark brown (10YR 2/2) moist; weak coarse granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; 60 percent stones and cobbles; slightly acid; clear wavy boundary.

A2—7 to 19 inches; pinkish gray (7.5YR 7/2) extremely stony loam, brown (7.5YR 4/2) moist; strong fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine roots; many very fine pores; 70 percent stones and cobbles; medium acid; diffuse wavy boundary.

A&B—19 to 27 inches; pinkish gray (7.5YR 7/2) extremely stony loam, brown (7.5YR 5/4) moist; 30 percent brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; sandy clay loam material is sticky and plastic; many very fine roots; many very fine pores; 75 percent stones, cobbles, and gravel; slightly acid; gradual wavy boundary.

B&A—27 to 40 inches; brown (7.5YR 5/4) extremely stony sandy clay loam, dark brown (7.5YR 4/4) moist; horizontal clay bands that part to moderate fine subangular blocky structure; very hard, friable, sticky, plastic; common very fine roots; common very fine pores; moderately thick, continuous pinkish gray (7.5YR 7/2) sandy loam, brown (7.5YR 5/4) moist coatings on the surface of horizontal clay bands, stones, cobbles, and gravel; 75 percent stones, cobbles and gravel; slightly acid; gradual wavy boundary.

B2t—40 to 60 inches; reddish brown (5YR 5/4) extremely stony sandy clay loam, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; very hard, firm, sticky, very plastic; few roots; discontinuous pinkish gray (7.5YR 7/2) brown (7.5YR 5/4) moist coatings on faces of peds; 80 percent stones, cobbles, and gravel; medium acid.

The volume of coarse fragments, mainly stone and gravel size, ranges from 50 to 80 percent throughout the soil. Reaction in the profile is medium acid or slightly acid.

136—Loggert extremely stony loam, 2 to 15 percent slopes. This undulating to strongly rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are small convex areas where sandstone bedrock is at a depth of less than 20 inches and small areas of Libeg and Monad soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is used for range. Capability unit VIIe-1 dryland; Stony range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-1.

137—Loggert extremely stony loam, 15 to 50 percent slopes. This hilly and steep soil is on uplands. Included in mapping are small areas of Cheadle soil on some convex slopes and ridges and areas of Monad soil on concave slopes.

Surface runoff is medium to rapid. The erosion hazard is slight from wind but is moderate or severe from water.

This soil is used for range. Capability unit VIIe-1 dryland; Stony range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-0.

Lothair series

The Lothair series consists of deep, well drained soils formed in alluvium and lacustrine deposits. These soils occupy terrace edges and steep fans at elevations of 3,300 to 3,800 feet. Slopes are 8 to 60 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous silty clay loam about 3 inches thick. The underlying material is light brownish gray, calcareous silty clay to a depth of 60 inches or more.

Permeability is slow. The available water capacity is high. Reaction is moderately alkaline.

These soils are mainly used for range.

Typical profile of Lothair silty clay loam in an area of Lambeth and Lothair soils, 25 to 60 percent slopes, in native grass, 400 feet east and 1,200 feet north of southwest corner sec. 12, T. 22 N., R. 5 E.

A1—0 to 3 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate fine granular structure; slightly hard, friable, sticky, plastic; many very fine roots; slightly effervescent; moderately alkaline; clear wavy boundary.

C1cs—3 to 14 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; common distinct reddish brown (5YR 5/4) and yellowish brown (10YR 5/6) mottles; moderate very fine blocky structure; very hard, friable, sticky, very plastic; common very fine roots; common very fine pores; many thin laminae of silty clay loam and silt loam; 3 percent gravel; many fine seams and soft masses of gypsum; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2cs—14 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common distinct reddish brown (5Y 5/4) and yellowish brown (10YR 5/6) mottles; weak thick platy structure; extremely hard, firm, sticky, very plastic; few very fine roots; few very fine pores; many thin laminae of silty clay loam and silt loam; 3 percent gravel; common seams, soft masses and a few large crystals of gypsum; slightly effervescent; moderately alkaline.

Reaction in the A horizon is mildly or moderately alkaline. The C horizon is silty clay or silty clay loam. The soil is 0 to 3 percent coarse fragments, which are mainly fine gravel.

138—Lothair silty clay loam, 8 to 25 percent slopes. This strongly rolling and hilly soil occupies terrace edges and foot slopes. Included in mapping are small areas where the slope is less than 8 percent or more than 25 percent. Also included are small areas of Hillon and Lambeth soils.

Surface runoff is medium to rapid. The erosion hazard is slight from wind but is severe from water.

This soil is used for range. Capability unit VIe-1 dryland; Thin Hilly range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

Marias series

The Marias series consists of deep, well drained soils formed in alluvium and lacustrine deposits. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,100 feet. Slopes are 0 to 8 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous silty clay about 8 inches thick. The underlying material is grayish brown and light brownish gray, calcareous silty clay to a depth of 60 inches or more.

Permeability is very slow. The available water capacity is moderate or high. Reaction is mildly alkaline to a depth of 16 inches and moderately alkaline below.

These soils are mainly used for dryland and irrigated crops.

Typical profile of Marias silty clay in cropland, 540 feet east and 1,220 feet north of southwest corner sec. 8, T. 21 N., R. 5 E.

Ap—0 to 8 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong fine and very fine granular structure; hard, friable, sticky, very plastic; very slightly effervescent; mildly alkaline; abrupt wavy boundary.

C1—8 to 16 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong fine and very fine blocky structure; very hard, firm, sticky, very plastic; common fine and very fine roots; common fine and very fine pores; slightly effervescent; mildly alkaline; clear wavy boundary.

C2—16 to 34 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium and fine blocky structure; extremely hard, firm, sticky, plastic; few fine and very fine roots; common fine and very fine pores; weakly expressed slickensides that intersect at 15 to 30 degrees from horizontal; few to common soft masses of segregated lime; slightly effervescent; moderately alkaline; clear wavy boundary.

C3cs—34 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, firm, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; few to many medium and coarse masses and threads of gypsum; slightly effervescent; moderately alkaline.

The soil is mainly silty clay throughout, but in some places, thin laminations of silty clay loam, silt loam, or clay occur below 30 inches.

139—Marias silty clay, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas where the slope is more than 2 percent and a few small areas of Linnet and Kobar soils.

Surface runoff is slow or medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-5 dryland, IIIs-1 irrigated; windbreak suitability group 1; not assigned to a range site.

140—Marias silty clay, 2 to 4 percent slopes. This gently sloping soil occupies terraces and fans. Included in mapping are a few small areas where the slope is less than 2 percent or more than 4 percent. Also included in mapping are a few small areas of Linnet and Kobar soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit Ille-5 dryland, Ille-3 irrigated; windbreak suitability group 1; not assigned to a range site.

141—Marias silty clay, 4 to 8 percent slopes. This moderately sloping soil occupies fans and foot slopes. Included in mapping are a few small areas where the slope is less than 4 percent and small areas of Abor and Kobar soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit Ille-8 dryland, IVe-3 irrigated; windbreak suitability group 1; not assigned to a range site.

Marmarth series

The Marmarth series consists of moderately deep, well drained soils formed in material weathered from interbedded sandstone and shale. These soils occupy uplands. They are only 20 to 40 inches deep over interbedded sandstone and shale. The elevation is 3,400 to 4,300 feet. Slopes are 0 to 4 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown clay loam about 7 inches thick. The subsoil is brown and pale brown clay loam about 14 inches thick. The substratum is light brownish gray very channery loam 3 inches thick. Below 24 inches is fractured sandstone interbedded with shale. The soil is calcareous below 10 inches.

Permeability is moderate. The available water capacity is very low or low. Reaction is mildly alkaline in the upper 10 inches and moderately alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Marmarth clay loam in cropland, 900 feet south and 700 feet west of northwest corner SW1/4 of sec. 10, T. 20 N., R. 1 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; slightly hard, friable, sticky, plastic; many fine and very fine roots; less than 2 percent sandstone fragments; mildly alkaline; abrupt wavy boundary.

B2t—7 to 10 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and medium blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few

medium pores; thin continuous clay films on ped surfaces; less than 2 percent sandstone fragments; mildly alkaline; clear irregular boundary.

B3ca—10 to 21 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; 5 percent sandstone fragments; common medium soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1—21 to 24 inches; light brownish gray (10YR 6/2) very channery loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; common fine and very fine pores; 40 percent sandstone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2r—24 to 38 inches; light brownish gray (10YR 6/2) fractured sandstone interbedded with gray (5Y 5/1) shale layers.

The B horizon is clay loam or loam. The thickness of the noncalcareous solum ranges from 11 to 17 inches thick. The depth to bedrock ranges from 20 to 40 inches.

142—Marmarth clay loam, 0 to 4 percent slopes.

This nearly level and undulating soil occupies sedimentary uplands. It has the profile described as typical of the series. Included in mapping are a few small concave areas of Tanna soil and small areas of Cabbart and Ernem soils in convex positions and at bench edges.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit Ille-2 dryland; windbreak suitability group 2M; not assigned to a range site.

Marvan series

The Marvan series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 3,800 feet. Slopes are 0 to 8 percent. The native vegetation is mainly alkali cordgrass, alkali sacaton, Nuttall alkaligrass, forbs, and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous clay about 4 inches thick. The underlying material is light brownish gray and grayish brown, calcareous clay to a depth of 60 inches or more.

Permeability is very slow. The available water capacity is moderate. Reaction is moderately alkaline.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Marvan clay, 0 to 2 percent slopes, in cropland, 2,640 feet south and 150 feet west of northeast corner sec. 8, T. 21 N., R. 2 E.

Ap—0 to 4 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate very fine granular structure which becomes cloddy when cultivated; very hard, friable, very sticky, very plastic; many fine and very fine roots; slightly effervescent; moderately alkaline; abrupt wavy boundary.

C1—4 to 11 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and very fine subangular blocky structure; extremely hard, firm, very sticky, very plastic; many fine and very fine roots; many fine and very fine pores; few medium pores; few slickensides along cracks; slightly effervescent; moderately alkaline; clear wavy boundary.

C2cs—11 to 35 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and medium subangular blocky structure; extremely hard, friable, very sticky, very plastic; common to few fine and very fine roots; many fine and very fine pores; many fine and medium masses of gypsum; few slickensides along cracks; slightly effervescent; moderately alkaline; diffuse boundary.

C3cs—35 to 60 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, firm, very sticky, very plastic; few fine and very fine roots; common fine and very fine pores; very thin stratifications of silty clay loam or silt loam; many fine masses of gypsum; slightly effervescent; moderately alkaline.

The C horizon is dominantly clay or heavy silty clay with thin layers of silty clay loam, clay loam, or silt loam. The depth to segregated gypsum masses is mainly 11 to 24 inches. The A horizon is moderately alkaline. The C horizon is moderately or strongly alkaline.

143—Marvan clay, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas where the slope is more than 2 percent. Also included are areas of Marias soil and areas of Absher and Vanda soils near drainageways.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVs-3 dryland; windbreak suitability group 3S; not assigned to a range site.

144—Marvan clay, 2 to 8 percent slopes. This gently sloping and moderately sloping soil occupies fans

and foot slopes. Included in mapping are a few small areas where the slope is more than 8 percent, small areas of Absher and Vanda soils near drainageways, and small areas of Marias soils on the lower parts of slopes.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-6 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 3S.

145—Marvan clay, wet, 0 to 2 percent slopes. This nearly level soil is on low terraces. It has a profile similar to the one described as typical of the series, but a seasonal high water table is at a depth of 30 to 60 inches during June, July, and August. The source of water is seepage from unlined canals and from irrigated land at higher elevations. Included in mapping are a few small areas of poorly drained and saline soil along drainageways and terrace edges, and small areas of Lallie and Marias soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is well suited to hay and pasture under irrigated management. It is suited to wheat, barley, and range. Capability unit IVw-1 irrigated; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-5.

McKenzie series

The McKenzie series consists of deep, poorly drained soils formed in alluvium. These soils occupy lake terraces and basins at elevations of 3,300 to 4,000 feet. Slopes are 0 to 2 percent. The native vegetation is mainly basin wildrye, green needlegrass, Canby bluegrass, forbs, and shrubs. The mean annual precipitation is 12 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is gray clay about 7 inches thick. The underlying material is gray and light gray clay to a depth of 60 inches or more.

Permeability is very slow. The available water capacity is high. Reaction is mildly or moderately alkaline. The soil is calcareous below 14 inches.

These soils are mainly used for dryland crops and range.

Typical profile of McKenzie clay in cropland, 150 feet east and 100 feet north of southwest corner sec. 3, T. 22 N., R. 2 E.

Ap—0 to 7 inches; gray (5Y 6/1) clay, dark gray (5Y 4/1) moist; common fine and medium prominent mottles of brownish yellow (10YR 6/6) dry; massive in upper 4 inches and moderate medium and fine blocky

structure in lower part; very hard, firm, sticky, very plastic; common fine and very fine roots; few medium roots; mildly alkaline; clear wavy boundary.

C1—7 to 14 inches; gray (5Y 5/1) clay, dark gray (5Y 4/1) moist; moderate medium and fine blocky structure; extremely hard, very firm, sticky, very plastic; few medium to very fine roots; common fine and very fine pores; mildly alkaline; gradual wavy boundary.

C2—14 to 60 inches; light gray (5Y 6/1) clay, gray (5Y 5/1) moist; few fine faint mottles of yellow (10YR 7/6) dry; weak medium and coarse blocky structure; extremely hard, very firm, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; slightly effervescent; moderately alkaline.

The Ap horizon is clay or silty clay loam. It tends to form a crust when dry. In some places the soil is calcareous in both the A and C horizons, and in others it is leached of lime in the upper horizons. Mottling of yellow, brownish yellow, or brown may be present in any horizon. The A horizon is mildly alkaline to strongly alkaline. The C horizon is mildly alkaline to strongly alkaline and has masses of gypsum and other salts in some pedons.

146—McKenzie silty clay loam. This nearly level soil is in closed basins. It is subject to flooding in spring. It has a profile similar to the one described as typical of the series, but the surface layer is silty clay loam. Water stands on the surface for shorter periods than is typical. Included in mapping are a few small areas of Acel soils that are not subject to flooding.

Surface runoff is ponded. There is little or no hazard of wind or water erosion.

This soil is suited to range. It is sometimes cultivated when runoff is low and when the surrounding upland soils are cultivated. Capability unit Vlw-1 dryland; Overflow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-2.

147—McKenzie clay. This nearly level soil occupies depressions and basins. It is subject to flooding in spring. It has the profile described as typical of the series. Included in mapping are small areas of Lawther and Pendroy soils.

Surface runoff is ponded. There is little or no erosion hazard from wind and water.

This soil is suited to range. Capability unit Vlw-1 dryland; Overflow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-2.

Monad series

The Monad series consists of deep, well drained soils formed in alluvium. These soils occupy uplands, foot slopes, and fans at elevations of 4,600 to 6,000 feet. Slopes are 2 to 45 percent. The native vegetation is

mainly rough fescue, Richardson needlegrass, mountain brome, forbs, and shrubs. The mean annual precipitation is 19 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 100 days.

Typically the surface layer is very dark gray loam 9 inches thick. The subsurface layer is grayish brown loam 5 inches thick. The subsoil is brown loam and pale brown clay loam 35 inches thick over very pale brown stony clay loam to a depth of 74 inches or more.

Permeability is moderately slow. The available water capacity is high. Reaction is medium acid to a depth of 49 inches and neutral below.

These soils are mainly used for dryland crops and range.

Typical profile of Monad loam, in native grass, 700 feet east and 1,340 feet south of northwest corner NE1/4 sec. 27, T. 17 N., R. 5 E.

A1—0 to 9 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium roots; 15 percent thin, flat rock fragments; medium acid; clear wavy boundary.

A3—9 to 14 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky structure; hard, friable, sticky, plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; few medium pores; very thin continuous coating of gray (10YR 6/1) dry sand grains on all ped surfaces; 15 percent rock fragments; medium acid; gradual wavy boundary.

B&A—14 to 21 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate fine subangular blocky; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; very thin continuous coating of gray (10YR 6/1) dry sand grains on all ped surfaces and as filling between peds; 10 percent sandstone rock fragments; about 80 percent B2 and 20 percent A2 by volume; medium acid; clear wavy boundary.

B21t—21 to 49 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate fine and medium blocky; extremely hard, firm, very sticky, plastic; few fine and very fine roots; many fine and very fine pores; few medium pores; very thin coatings of gray (10YR 6/1) sand grains on ped surfaces; 10 percent sandstone rock fragments; medium acid; gradual wavy boundary.

B22t—49 to 74 inches; very pale brown (10YR 7/4) stony clay loam, brown (7.5YR 5/4) moist; strong medium and fine blocky structure; extremely hard, firm, very sticky, plastic; many fine and very fine

pores; few medium pores; distinct clay films on ped surfaces; 25 percent cobble and stone sandstone fragments; neutral.

The A horizon is 10 to 15 inches thick. The soil is less than 35 percent sandstone rock fragments.

148—Monad loam, 2 to 10 percent slopes. This gently sloping and moderately sloping soil is on foot slopes, fans, and uplands. Included in mapping are small areas where the surface layer is stony loam and small areas of Bridger and Libeg soils on ridges and knolls.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1.

149—Monad loam, 10 to 20 percent slopes. This strongly sloping and strongly rolling soil is on foot slopes and uplands. It has the profile described as typical of the series. Included in mapping are small areas where the surface layer is stony loam and small areas of Bridger and Libeg soils on ridges and knolls.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1 if slope is less than 15 percent, group 4-0 if more than 15 percent.

150—Monad and Libeg soils, steep. This map unit consists of steep Monad loams and Libeg stony loams on foot slopes and uplands. Included in mapping are small areas of Loggert and Cheadle soils on ridges and knolls.

Surface runoff is medium or rapid. The erosion hazard is slight from wind but is moderate or severe from water.

This soil is well suited to range. Capability unit VIe-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-0.

Nobe series

The Nobe series consists of deep, moderately well drained soils formed in alluvium. These soils are on terraces, fans, and foot slopes at elevations of 3,300 to 4,300 feet. Slopes are 0 to 15 percent. The native vegetation is mainly inland saltgrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray loam about 1 inch thick. The subsoil is grayish brown silty clay

about 8 inches thick. The upper substratum is grayish brown silty clay to a depth of 25 inches. The lower substratum is light brownish gray stratified silty clay loam and silty clay to a depth of 60 inches or more.

Permeability is very slow. The available water capacity is low or moderate. Reaction is neutral to a depth of 1 inch, mildly alkaline to 4 inches, and strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Nobe silty clay in native grass, 50 feet east and 200 feet south of northwest corner sec. 22, T. 22 N., R. 1 W.

A2—0 to 1 inch; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; vesicular crust in upper part and weak very thin platy structure in lower part; slightly hard, very friable, slightly sticky, nonplastic; common fine and very fine roots; few medium roots; common fine and very fine pores; neutral; abrupt wavy boundary.

B2—1 to 4 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong fine and medium columnar structure parting to moderate fine and very fine subangular blocky; hard, firm, sticky, very plastic; common very fine roots; few medium roots; common fine and very fine pores; mildly alkaline; clear wavy boundary.

B3cs—4 to 9 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong very fine subangular blocky structure; hard, friable, sticky, very plastic; common fine and very fine roots; common fine and very fine pores; many fine seams and masses of gypsum; slightly effervescent; strongly alkaline; gradual wavy boundary.

C1cs,sa—9 to 25 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; granular (flocculated) structure; hard, friable, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; many seams and masses of gypsum and other soluble salts; strongly effervescent; strongly alkaline; diffuse boundary.

C2cs—25 to 60 inches; light brownish gray (2.5Y 6/2) stratified silty clay loam and silty clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, friable, sticky, plastic; few fine and very fine roots; common very fine pores; common seams and masses of gypsum; slightly effervescent; strongly alkaline.

If mixed by plowing, the surface layer is silty clay or clay loam. The noncalcareous part of the solum is 3 to 5 inches thick. The B and C horizons are silty clay loam or silty clay.

Pendroy series

The Pendroy series consists of deep, well drained soils formed in alluvium and lacustrine deposits. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 3,800 feet. Slopes are 0 to 15 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous clay about 7 inches thick. The underlying material is grayish brown, calcareous clay and silty clay to a depth of 70 inches or more.

Permeability is very slow. The available water capacity is high. Reaction is mildly alkaline to a depth of 30 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Pendroy clay, in native grass, 800 feet west and 110 feet north of southeast corner SW1/4 sec. 18, T. 22 N., R. 4 E.

A11—0 to 3 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and very fine granular structure; very hard, friable, sticky, very plastic; many very fine roots; many very fine pores; slightly effervescent; mildly alkaline; clear wavy boundary.

A12—3 to 7 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine blocky structure; extremely hard, firm, sticky, very plastic; many very fine roots; many very fine pores; 1- to 3-inch wide vertical cracks; well expressed slickensides; slightly effervescent; mildly alkaline; diffuse boundary.

C1—7 to 30 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse blocky structure; extremely hard, firm, sticky, very plastic; common very fine roots; few very fine pores; well expressed slickensides; slightly effervescent; mildly alkaline; diffuse boundary.

C2—30 to 42 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, sticky, plastic; few very fine roots; few very fine pores; few distinct gray (N 5/0) and dark gray (N 4/0) moist, clay laminae; well expressed slickensides; slightly effervescent; moderately alkaline; clear wavy boundary.

C3—42 to 70 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, sticky, plastic; gray (N 5/) and dark gray (N 4/) strata of clay below 50 inches; common coarse seams and masses of gypsum; slightly effervescent; moderately alkaline.

The A horizon is 5 to 12 inches thick. Reaction is mildly or moderately alkaline to a depth of 42 inches and moderately or strongly alkaline below. The C horizon is 60 to 75 percent clay that is dominantly montmorillonitic. When the soil is dry, surface cracks are 1 to 4 inches wide and 6 to 24 inches apart. Cracks extend to a depth of 30 inches or more. These cracks open and close once a year. Distinct slickensides are well expressed to depths of 20 to 40 inches.

151—Pendroy clay, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Lawther and Marias soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIs-6 dryland, IVs-3 irrigated; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

152—Pendroy clay, 2 to 8 percent slopes. This gently sloping and moderately sloping soil is on fans and foot slopes. In some areas the soil is underlain by bedded shales or varved lacustrine clays below a depth of 36 to 40 inches. Also included in mapping are a few small areas of Lawther and Marias soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-8 dryland, IVe-3 irrigated; windbreak suitability group 2M; not assigned to a range site.

153—Pendroy clay, 8 to 15 percent slopes. This strongly rolling soil occupies fans and foot slopes. Included in mapping are a few small areas of Marias soil.

Surface runoff is medium. The erosion hazard is moderate from wind but is severe from water.

This soil is mainly used for range, but it is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVe-6 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Perma series

The Perma series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,500 to 5,000 feet. Slopes are 2 to 60 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, forbs, and shrubs. The mean annual precipitation is 16 to 20 inches. The mean annual temperature is 38 to 42 degrees F. The growing season is 105 to 135

days. This is a longer growing season than is typical for Perma soils, but it does not affect the use and management of these soils.

Typically the surface layer is dark gray very cobbly loam about 11 inches thick. The subsoil is brown and pale brown very cobbly loam about 23 inches thick. The substratum is light brownish gray calcareous very cobbly sandy loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is low. The reaction is neutral to a depth of 34 inches and moderately alkaline to 60 inches.

These soils are mainly used for range. Small areas are used for woodland.

Typical profile of Perma very cobbly loam in native grass, 1,100 feet east and 1,850 feet north of southwest corner sec. 22, T. 20 N., R. 2 W.

A1—0 to 11 inches; dark gray (10YR 4/1) very cobbly loam, very dark brown (10YR 2/2) moist; moderate fine and very fine granular structure, soft, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium roots; 55 percent rock fragments; neutral; gradual wavy boundary.

B2—11 to 18 inches; brown (10YR 5/3) very cobbly loam, dark brown (10YR 4/3) moist; moderate medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; 30 percent cobbles and 20 percent gravel; neutral; clear irregular boundary.

B3—18 to 34 inches; pale brown (10YR 6/3) very cobbly loam, dark grayish brown (10YR 4/2) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine and very fine roots; few medium roots; many fine and very fine pores; 35 percent cobbles and 30 percent gravel; neutral; gradual wavy boundary.

C—34 to 60 inches; light brownish gray (10YR 6/2) very cobbly sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky, nonplastic; few fine and very fine roots; 30 percent cobbles and 35 percent gravel; slightly effervescent; moderately alkaline.

Thickness of the A horizon ranges from 11 to 15 inches. Percent of rock fragments ranges from 50 to 60 in the A horizon, 40 to 65 in the B horizon, and 50 to 80 in the C horizon. The A and B horizons range from slightly acid to mildly alkaline. The C horizon is mildly or moderately alkaline.

154—Perma very stony loam, 2 to 8 percent slopes. This undulating and moderately sloping soil occupies terraces and fans. It has a profile similar to the one described as typical of the series, but the surface layer is very stony loam about 15 inches thick. Included

in mapping are a few small areas of Shawa and Hilger soils.

Surface runoff is medium. The erosion hazard is slight from wind and slight or moderate from water.

This soil is used mostly for native pasture. Some areas are woodland.

Forested areas, commonly ponderosa pine, are mainly on the Perma very stony loams. The following woodland interpretations are for those soils.

Unless the stand is overstocked, ponderosa pine can be expected to reach a height of 43 to 50 feet at 100 years of age. The estimated volume per acre in a fully stocked stand at 100 years of age is 2,000 to 2,500 board feet or 2,900 to 3,400 cubic feet.

The erosion hazard is slight. Equipment limitation and windthrow hazard are slight. Seedling mortality is severe because of the low available water capacity of Perma soils, the 15- to 19-inch rainfall, and the warm environment. Plant competition is severe because of competitive grasses, the warm environment, and the 15- to 19-inch rainfall.

Shelterwood and selective harvest are adapted. If stands are drastically opened up, for example, in clear-cutting or in the seed-tree system of harvest, stand regeneration is often very slow. Ponderosa pine is the best species for planting.

Understory plants on Perma soils are bluebunch wheatgrass, Idaho fescue, rough fescue, and arrowleaf balsamroot. Many of these plants can have fair to good forage value for cattle, deer, or elk. Forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants are determined not only by soil properties and climatic variations but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, that is, the most preferred, are bluebunch wheatgrass and rough fescue. The other plants are increasers, but they too can be expected to decrease under continued heavy grazing.

The following tabulation shows the average annual air-dry yield, in pounds per acre, of understory plants on Perma soils, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total annual yield.

10-30.....	1,100
30-50.....	800
50-70.....	400

It is estimated that 80 percent of the yield is potential feed for grazing animals.

Capability unit VIs-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

Pylon series

The Pylon series consists of moderately deep, well drained soils formed in interbedded shale, sandstone, and alluvium over shale. These soils occupy uplands. They are only 20 to 40 inches deep over shale and sandstone. Slopes are 0 to 4 percent. The elevation is 3,400 to 3,800 feet. The native vegetation is mainly green needlegrass, western wheatgrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is brown and grayish brown silty clay 18 inches thick. The substratum is light brownish gray, calcareous silty clay 10 inches thick. Below 34 inches is calcareous platy clay shale.

Permeability is very slow. The available water capacity is very low or low. Reaction is neutral to a depth of 10 inches, mildly alkaline to 17 inches, and strongly alkaline to 34 inches.

These soils are mainly used for dryland crops.

Typical profile of Pylon silty clay loam, in cropland, 1,440 feet north and 50 feet west of southeast corner sec. 20, T. 22 N., R. 2 E.

Ap—0 to 6 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive with many vesicular pores; very hard, friable, sticky, plastic; neutral; abrupt wavy boundary.

B21t—6 to 10 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; strong fine and medium columnar structure parting to weak fine blocky; extremely hard, firm, sticky, very plastic; common fine and very fine pores; thin continuous clay films on ped surfaces; neutral; clear wavy boundary.

B22t—10 to 17 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; medium prismatic structure parting to strong fine and medium blocky; extremely hard, firm, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; thin continuous clay films on ped surfaces; mildly alkaline; clear irregular boundary.

B3ca—17 to 24 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong fine and medium blocky; extremely hard, friable, sticky, very plastic; few fine and very fine roots; common fine and very fine pores; few fine and medium soft masses of segregated lime; strongly effervescent; strongly alkaline; gradual wavy boundary.

C1ca—24 to 34 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse subangular blocky structure; extremely hard, friable, sticky, very plastic; few

fine and very fine roots; common fine and very fine pores; few masses of gypsum; few shale chips; few fine soft masses of segregated lime; strongly effervescent; strongly alkaline; gradual wavy boundary.
C2r—34 to 50 inches; light gray (N 6/) platy shale of clay texture, gray (N 5/) moist; clay shale with very thin hard sandstone layers; strongly effervescent.

The A horizon is 4 to 7 inches thick. If cultivated, it forms a hard durable crust when dry. Depth to lime is 12 to 18 inches. The A horizon is slightly acid to neutral. The C horizon is moderately alkaline or strongly alkaline. Depth to shale is 20 to 40 inches.

155—Pylon silty clay loam, 0 to 4 percent slopes.

This nearly level and gently sloping soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of Dutton and Linnet soils.

Surface runoff is ponded. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIs-2 dryland; windbreak suitability group 2M; not assigned to a range site.

Raynesford series

The Raynesford series consists of deep, well drained soils formed in alluvium. These soils occupy fans and foot slopes at elevations of 4,600 to 5,500 feet. Slopes are 4 to 40 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, forbs, and shrubs. The mean annual precipitation is 18 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 95 days.

Typically the surface layer is very dark gray and dark grayish brown loam 16 inches thick. The underlying material is white clay loam to 28 inches and very pale brown gravelly clay loam to a depth of 66 inches or more. The soil is calcareous below 12 inches.

Permeability is moderately slow. The available water capacity is moderate or high. Reaction is mildly alkaline to a depth of 12 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Raynesford loam, in native grass, 1,150 feet west and 160 feet south of northeast corner of SE1/4 sec. 4, T. 16 N., R. 5 E.

A11—0 to 12 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; strong fine and medium granular structure; slightly hard, very friable, slightly sticky, nonplastic; many fine roots; many fine and medium pores; 5 percent limestone gravel; mildly alkaline; clear wavy boundary.

A12—12 to 16 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; 5 percent limestone gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C1ca—16 to 28 inches; white (10YR 8/2) clay loam, light brownish gray (10YR 6/2) moist; weak to moderate fine subangular blocky structure; hard, very friable, sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; 5 percent limestone gravel, mainly less than 1 inch in diameter; lime diffused throughout mass and segregated as many soft masses and as thick crusts on gravel; violently effervescent; moderately alkaline; diffuse boundary.

IIC2ca—28 to 50 inches; very pale brown (10YR 8/3) gravelly clay loam, light brownish gray (10YR 6/2) moist; massive; very hard, very friable, sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; 25 percent limestone gravel, mainly less than 2 inches in diameter; lime diffused throughout mass and segregated as many fine to coarse soft masses and as thick crusts on pebbles; violently effervescent; moderately alkaline; diffuse boundary.

IIC3—50 to 66 inches; very pale brown (10YR 7/3) very gravelly clay loam, brown (10YR 5/3) moist; massive; hard, very friable, slightly sticky; 40 percent limestone gravel; lime crusts on pebbles; violently effervescent; moderately alkaline.

The depth to gravelly material ranges from 24 to 32 inches. The A horizon is 11 to 18 inches thick. Reaction is mildly to moderately alkaline in the A horizon. The C horizon is loam or clay loam that is 5 to 50 percent gravel.

156—Raynesford loam, 8 to 20 percent slopes. This strongly sloping and moderately steep soil occupies foot slopes and fans below uplands. Included in mapping are a few small areas where the slope is less than 8 percent and small areas of Hanson soil.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVe-5 dryland; windbreak suitability group 1 if slope is less than 15 percent, group 4-0 if more than 15 percent; not assigned to a range site.

157—Raynesford loam, 20 to 40 percent slopes. This moderately steep and steep soil occupies foot slopes and fans. It has the profile described as typical of the series. Included in mapping are small areas of

Skaggs soils occupying convex slopes and ridges and small areas of Adel and Hanson soils.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and is moderate or severe from water.

This soil is used mainly for range. Capability unit VIe-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-0.

158—Raynesford-Skaggs loams, 4 to 8 percent slopes. This map unit consists of gently rolling soils on foot slopes and uplands. It is about 60 percent Raynesford loam and about 25 percent Skaggs loam. Raynesford loam occupies smooth and slightly concave slopes, and Skaggs loam occupies convex areas. About 15 percent of the unit is areas of Hanson soil. Also included are a few small areas where the slope is less than 4 percent or more than 8 percent. A few stones are on the surface.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is slight or moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVc-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1.

159—Raynesford-Skaggs loams, 8 to 20 percent slopes. This map unit consists of strongly rolling soils on foot slopes and uplands. It is about 50 percent Raynesford loam and about 30 percent Skaggs clay loam. Raynesford loam occupies smooth and slightly concave slopes, and Skaggs loam is on mainly convex areas. About 10 percent of this unit is included areas of Sheege stony loam on convex slopes and ridges. About 10 percent is Hanson loam and stony loam on foot slopes and swales. Also included are a few small areas where the slope is less than 8 percent or more than 20 percent.

The Raynesford soil in this unit has a profile similar to the one described as typical of the series, but in small areas limestone or shale occurs between depths of 40 and 60 inches. The Skaggs soil has the profile described as typical of the Skaggs series.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1.

160—Raynesford-Sheege complex, 4 to 15 percent slopes. This map unit consists of gently rolling and strongly rolling soils on foot slopes and uplands. It is about 50 percent Raynesford loam and about 25 percent Sheege stony loam. Raynesford loam is on smooth and slightly concave slopes, and Sheege stony loam occupies convex slopes and ridges. About 15 percent of the unit is included areas of Skaggs loam, and 10 percent is areas of Hanson loam.

Surface runoff is slow or medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland. Raynesford soil in Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 1. Sheege soil in Shallow range site, 20- to 24-inch precipitation zone; windbreak suitability group 3M.

Reeder series

The Reeder series consists of moderately deep, well drained soils formed in material weathered from interbedded siltstone and sandstone. These soils are on uplands. They are only 20 to 40 inches deep over interbedded siltstone and sandstone. The elevation is 3,500 to 4,500 feet. Slopes are 0 to 35 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, forbs, and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown loam about 3 inches thick. The subsoil is brown and grayish brown clay loam about 13 inches thick. The substratum is light brownish gray clay loam 11 inches thick. Below 27 inches is weathered siltstone and sandstone. The soil is calcareous below 13 inches.

Permeability is moderate. The available water capacity is low or moderate. Reaction is neutral in the upper 8 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Reeder loam, in native grass, 1,750 feet north and 10 feet east of southwest corner sec. 31, T. 20 N., R. 3 W.

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

B21t—3 to 8 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; strong medium prismatic structure; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; thin continuous dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) moist clay films on faces of peds; neutral; clear wavy boundary.

B22t—8 to 13 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic structure parting to strong medium blocky; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; thin continuous very dark grayish brown (10YR 3/2)

moist clay films on faces of peds; mildly alkaline; abrupt irregular boundary.

B3tca—13 to 16 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; strong coarse prismatic structure parting to weak coarse blocky; very hard, friable, sticky, plastic; many very fine roots; many very fine pores; discontinuous patchy clay films on faces of peds; few threads of lime; strongly effervescent; moderately alkaline; clear irregular boundary.

C1ca—16 to 27 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse blocky; hard, friable, slightly sticky, plastic; common very fine roots; common very fine pores; common soft masses of lime; violently effervescent; moderately alkaline; diffuse boundary.

C2r—27 to 60 inches; light yellowish brown (2.5Y 6/4) weathered siltstone and interbedded sandstone.

The A horizon is loam or silt loam. The noncalcareous A and B horizons combined are 8 to 15 inches thick. Total thickness of the solum ranges from 16 to 25 inches. The B2t horizon is clay loam or loam. The A horizon is neutral or mildly alkaline. Depth to sandstone and siltstone is 20 to 40 inches.

161—Reeder loam, 2 to 8 percent slopes. This undulating and gently rolling soil is on sedimentary uplands. Included in mapping are a few small areas where the slope is more than 8 percent. Also included are small areas of Castner and Cabbart soils on ridges and knolls and small areas of Farnuf and Work soils on some lower slopes and in swales.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-3 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

162—Reeder loam, 8 to 25 percent slopes. This strongly rolling and hilly soil occupies sedimentary uplands. It has the profile described as typical of the series. Included in mapping are small areas where the slope is less than 8 percent and small areas of Castner, Cabbart, and Yawdim soils on convex slopes, ridges, and knolls. Also included are small areas of Farnuf and Winifred soils on smooth slopes and in swales.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to range. Capability unit VIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

Reeder variant

The Reeder variant consists of moderately deep, well drained soils formed in material weathered from sandstone. These soils occupy uplands at elevations of 3,500 to 4,500 feet. Slopes are 0 to 4 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, forbs, and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The frost-free season is 105 to 135 days.

Typically the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is brown and light gray silty clay loam 16 inches thick. The substratum is light brownish gray, calcareous silty clay loam in the upper 5 inches and pale brown, calcareous extremely flaggy loam in the lower 6 inches. Below 33 inches is hard sandstone.

Permeability is moderate. The available water capacity is low or moderate. Reaction is neutral to a depth of 15 inches and moderately alkaline below.

These soils are mainly used for dryland crops.

Typical profile of Reeder variant silt loam, in cropland, 1,800 feet east and 30 feet south of northwest corner sec. 7, T. 18 N., R. 3 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate fine and very fine granular structure; slightly hard, friable, sticky, plastic; many fine and very fine roots; neutral; abrupt wavy boundary.

B2t—6 to 15 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; few medium pores; thin continuous clay films on faces of peds; neutral; clear irregular boundary.

B3ca—15 to 22 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak fine subangular blocky structure; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; few medium pores; few lime coated pebbles; many fine and medium soft masses and threads of segregated lime; violently effervescent; moderately alkaline; clear wavy boundary.

C1—22 to 27 inches; light brownish gray (10YR 6/4) clay loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; 10 percent sandstone fragments; few medium soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2—27 to 33 inches; pale brown (10YR 6/3) extremely flaggy loam, brown (10YR 4/3) moist; massive; hard,

friable, sticky, plastic; common root matting over fragments; many fine and very fine pores; 80 percent sandstone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIR—33 inches; hard sandstone.

The A horizon is silt loam or loam. The noncalcareous A and B horizons combined are 11 to 18 inches thick. The B2t horizon is silty clay loam or clay loam. Reaction is slightly acid or neutral in the A horizon, neutral to moderately alkaline in the B horizon, and mildly or moderately alkaline in the C horizon. Depth to hard sandstone is 20 to 40 inches.

163—Reeder variant silt loam, 0 to 4 percent slopes. This nearly level and undulating soil is on uplands. It has the profile described as typical of the variant. Included in mapping are a few small areas of Ipano and Castner soils in convex positions. Also included are a few small areas where the slope is more than 4 percent.

Surface runoff is slow or medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 2M; not assigned to a range site.

Rentsac series

The Rentsac series consists of shallow, well drained soils formed in sandstone. These soils occupy uplands. They are only 10 to 20 inches deep over sandstone. The elevation is 3,400 to 4,500 feet. Slopes are 2 to 50 percent. The native vegetation is mainly bluebunch wheatgrass, prairie sandreed, green needlegrass, forbs, and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous channery loam about 2 inches thick. The underlying material is light brownish gray, calcareous channery loam and extremely channery loam. Indurated sandstone is at a depth of 18 inches.

Permeability is moderately rapid. The available water capacity is very low. Reaction is mildly alkaline to a depth of 2 inches and moderately alkaline below.

These soils are mainly used for range.

Typical profile of Rentsac channery loam in an area of Yawdim-Rentsac-Cabbart complex, 15 to 50 percent slopes, in native grass, 650 feet south and 60 feet east of northwest corner sec. 31, T. 20 N., R. 3 W.

A1—0 to 2 inches; grayish brown (10YR 5/2) channery loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable,

slightly sticky, nonplastic; many medium and fine roots; 15 percent sandstone rock fragments; slightly effervescent; mildly alkaline; clear wavy boundary.

C1—2 to 7 inches; light brownish gray (10YR 6/2) channery loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many medium and fine roots; many fine and very fine pores; 30 percent sandstone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—7 to 18 inches; light brownish gray (2.5Y 6/2) extremely channery loam, dark grayish brown (2.5Y 4/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common medium and fine roots; many fine and very fine pores, few medium pores; 70 percent sandstone fragments; strongly effervescent; moderately alkaline; abrupt wavy boundary.

R—18 inches; indurated calcareous sandstone with lime crust on lower side of fragments.

Depth to bedrock is between 10 and 20 inches. The control section is 40 to 70 percent coarse fragments, which are mainly flat angular pebbles and flagstones. The A horizon is neutral or mildly alkaline.

164—Rentsac-Ethridge complex, 2 to 25 percent slopes. This map unit consists of undulating to hilly soils on uplands and foot slopes. It is about 40 percent Rentsac very flaggy loam occupying convex slopes, ridges, and knolls. About 35 percent is Ethridge clay loam on foot slopes below sandstone ledges. About 25 percent of the unit is included areas of Ernem and Castner soils on convex or plane slopes.

The Rentsac soil in this unit has a profile similar to the one described as typical of the series, but the surface layer is very flaggy loam. The Ethridge soil has a profile similar to the one described as typical of the Ethridge series, but the surface layer is clay loam.

Surface runoff is medium. The erosion hazard is moderate from wind and is moderate or severe from water.

This unit is best suited to range, but some areas are used for wheat and barley under dryland management. Capability unit Vle-1 dryland. Rentsac soil in Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-1. Ethridge soil in Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 1 if slope is less than 15 percent, group 4-0 if more than 15 percent.

Rivra series

The Rivra series consists of deep, well drained soils formed in alluvium. These soils occupy flood plains and low terraces at elevations of 3,200 to 4,000 feet. Slopes are 0 to 2 percent. The native vegetation is mainly blue-

bunch wheatgrass, western wheatgrass, needleandthread, and forbs and shrubs. The mean annual precipitation is 11 to 16 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous gravelly sandy loam about 8 inches thick. The underlying material is grayish brown, calcareous very gravelly loamy coarse sand and extremely gravelly sand to a depth of 60 inches or more.

Permeability is very rapid. The available water capacity is very low. Reaction is neutral in the upper 8 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops and woodland.

Typical profile of Rivra gravelly sandy loam in native grass, 900 feet south and 720 feet east of northwest corner sec. 10, T. 20 N., R. 3 W.

A1—0 to 8 inches; light brownish gray (2.5Y 6/2) gravelly sandy loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, very friable, many very fine and fine roots; 20 percent pebbles; slightly effervescent; mildly alkaline; clear wavy boundary.

C1—8 to 32 inches; grayish brown (2.5Y 5/2) very gravelly loamy coarse sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; few fine and very fine roots; 50 percent gravel, 10 percent cobbles and stones; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C3—32 to 60 inches; grayish brown (2.5Y 5/2) extremely gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; few roots; 55 percent gravel, 15 percent cobbles; strongly effervescent; moderately alkaline.

The A horizon ranges from 3 to 10 inches in thickness. The volume of coarse fragments, mainly gravel, ranges from 0 to 35 percent. The C horizon is very gravelly loamy sand to extremely gravelly coarse sand. From 60 to 80 percent is coarse fragments, mainly gravel, but as much as 10 to 20 percent is cobble size and larger. Reaction is mild to moderately alkaline.

165—Rivra gravelly sandy loam. This nearly level soil occupies flood plains and low river terraces. It has the profile described as typical of the series. Included in mapping are small areas where the surface layer is loam or loamy sand, a few small areas of sand and gravel river deposits, and small areas of Glendive and Korent soils.

Surface runoff is slow. Flooding is a hazard in spring. The water table is within a depth of 5 feet.

This soil is mainly used for native pasture. Some areas are woodland.

Forested areas are mainly narrowleaf cottonwood and a sparse understory of grasses and shrubs. Narrowleaf cottonwood can be expected to reach a height of 20 to 30 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 2,000 to 7,000 board feet per acre or from 400 to 1,300 cubic feet.

Narrowleaf cottonwood is the only adapted species on this soil. Harvesting by clearcutting in small patches or by selectively removing the desired trees is suggested.

The erosion hazard is moderate because of sparse to moderate vegetative cover, the slow rate of vegetative recovery after disturbance, and the frequent flooding. The windthrow hazard is slight. The equipment limitation is slight, but equipment is limited during periods of flooding. Seedling mortality is severe because of the very low available water capacity and the frequent flooding. Plant competition is moderate as a result of the very low available moisture capacity of the soil and sparse to moderately dense stands of understory vegetation. Regeneration can be difficult in these areas because of the disturbance caused during flood periods and the very low available water capacity.

Capability unit Vlw-1 dryland; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Rothiemay series

The Rothiemay series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,400 to 4,100 feet. Slopes are 0 to 10 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous loam about 7 inches thick. The subsoil is pale brown and light brownish gray, calcareous loam 16 inches thick. The substratum is white, calcareous clay loam to a depth of 66 inches or more.

Permeability is slow. The available water capacity is high. Reaction is mildly alkaline to a depth of 7 inches, moderately alkaline to 31 inches, and strongly alkaline to 66 inches.

These soils are mainly used for dryland crops. Some areas are irrigated, and some are used for range.

Typical profile of Rothiemay loam, in cropland, 1,500 feet north and 100 feet west of southeast corner sec. 3, T. 21 N., R. 2 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine

and very fine roots; few pebbles; slightly effervescent; mildly alkaline; abrupt wavy boundary.

B2—7 to 17 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; few pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary.

B3ca—17 to 23 inches; light brownish gray (10YR 6/2) loam, brown (10YR 5/3) moist; weak medium and coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few pebbles; many fine and medium soft masses and threads of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—23 to 31 inches; white (10YR 8/2) clay loam, very pale brown (10YR 7/3) moist; massive; hard, friable, sticky, slightly plastic; common fine and very fine roots; common fine and very fine pores; 5 percent lime coated pebbles; disseminated lime; violently effervescent; moderately alkaline; diffuse wavy boundary.

C2ca—31 to 66 inches; white (10YR 8/2) clay loam, very pale brown (10YR 7/3) moist; massive; hard, friable, sticky, slightly plastic; few fine and very fine roots; common fine and very fine pores; pale brown (10YR 6/3) sandy loam pockets and discontinuous layers, brown (10YR 4/3) moist; 10 percent lime coated argillite and quartzite coarse fragments; disseminated lime; violently effervescent; strongly alkaline.

The A and B horizons combined are 12 to 24 inches thick. They are mildly alkaline or moderately alkaline.

166—Rothiemay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Crago gravelly and very gravelly loam on narrow convex ridges and small areas of Binna and Evanston soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit Ille-2 dryland, IIs-2 irrigated; windbreak suitability group 1; not assigned to a range site.

167—Rothiemay loam, wet, 2 to 8 percent slopes. This undulating and moderately sloping soil occupies fans and foot slopes that are adjacent to intermittent drainageways. It has a profile similar to the one described as typical of the series, but a seasonal high water table is at a depth of 30 inches and faint to distinct mottles occur in the underlying material. The source of

water is mainly seepage from unlined irrigated canals and from irrigated land at higher elevations. Included in mapping are a few small areas where the surface layer and subsoil are clay loam. Also included are small areas of Crago gravelly loam in convex areas and small areas where the surface layer is saline or strongly alkaline.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is best suited to hay and pasture under dryland management and under irrigation. Wheat and barley can be grown where water management lowers the seasonal high water table. The soil is well suited to range. Capability unit IVw-1 dryland, IVw-1 irrigated; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 3W.

168—Rothiemay clay loam, 0 to 2 percent slopes.

This nearly level soil occupies terraces and slightly concave positions adjacent to intermittent drainageways. Included in mapping are a few small areas where the surface layer is loam. Also included are small areas where the surface layer is saline or strongly alkaline.

Surface runoff is slow. The erosion hazard is slight or moderate from wind and is slight from water.

This soil is best suited to hay and pasture under dryland management and under irrigation. The soil is well suited to range. Capability unit IIIe-2 dryland, IIs-2 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3W.

169—Rothiemay-Binna loams, 2 to 4 percent slopes. This map unit consists of undulating soils on terraces and fans. It is about 55 percent Rothiemay loam and about 40 percent Binna loam. About 5 percent of this unit is included areas of Crago and Evanston soils. Rothiemay loam occupies smooth and slightly concave slopes, and Binna loam is in convex positions.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This unit is well suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-2 dryland, IIe-1 irrigated; windbreak suitability group 2M; not assigned to a range site.

170—Rothiemay-Binna loams, 4 to 10 percent slopes. This map unit is a complex of moderately sloping and strongly sloping soils on foot slopes and fans. It is about 50 percent Rothiemay loam and about 40 percent Binna loam. Rothiemay loam is on smooth and slightly concave slopes, and Binna loam occupies convex slopes and ridges. About 10 percent of this unit is included areas of Crago soils on convex slopes and knolls.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This unit is suited to wheat and barley under dryland management and under irrigation. Capability unit IIIe-3

dryland, IVe-2 irrigated; windbreak suitability group 2M; not assigned to a range site.

Roy series

The Roy series consists of deep, well drained soils formed in stony alluvium from hard sandstone bedrock. These soils occupy foot slopes, fans, and uplands at elevations of 3,500 to 5,000 feet. Slopes are 10 to 65 percent. The vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, some forbs, and some ponderosa pine. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 130 days.

Typically the surface layer is dark grayish brown stony loam about 6 inches thick. The subsoil is dark grayish brown and brown very stony clay loam about 26 inches thick. The substratum is light yellowish brown very stony sandy clay loam to a depth of 60 inches or more.

Permeability is moderately slow. The available water capacity is low. Reaction is neutral to 32 inches and mildly alkaline below.

These soils are used mainly for range.

Typical profile of Roy stony loam, in native grass, 1,320 feet east and 1,050 feet south of northwest corner sec. 19, T. 18 N., R. 6 E.

A1—0 to 6 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; slightly hard, very friable; many very fine and fine roots; many fine and very fine pores; 10 percent stones; 5 percent gravel; neutral; clear wavy boundary.

B21t—6 to 14 inches; dark grayish brown (10YR 4/2) very stony clay loam, dark brown (10YR 4/3) moist; strong very fine blocky structure; hard, friable, sticky, plastic; many very fine roots; many very fine pores; moderately thick continuous very dark grayish brown (10YR 3/2) moist clay films on faces of peds; 45 percent stones, cobbles, and gravel; neutral; diffuse boundary.

B22t—14 to 32 inches; brown (7.5Y 5/4) stony clay loam, dark brown (7.5YR 4/4) moist; strong very fine blocky structure; hard, firm, sticky, plastic; many very fine roots; many very fine pores; 50 percent stones, cobbles, and gravel; neutral; clear wavy boundary.

Cca—32 to 60 inches; light yellowish brown (10YR 6/4) stony sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky, slightly plastic; 50 percent stones, cobbles, and gravel; slightly effervescent; mildly alkaline.

The A horizon is 10 to 45 percent coarse fragments, mainly stones, cobbles, and gravel. The B and C horizons are 35 to 80 percent coarse fragments, mainly stones, cobbles, and gravel. The A horizon is slightly

acid or neutral. The B horizon is neutral or mildly alkaline. The C horizon is mildly to moderately alkaline.

Ryell series

The Ryell series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and flood plains at elevations of 3,200 to 3,500 feet. They are only 20 to 40 inches deep over sand and gravel. Slopes are 0 to 2 percent. The native vegetation is mainly needleandthread, western wheatgrass, and blue grama. The mean annual precipitation is 10 to 14 inches. The mean annual air temperature is 43 to 46 degrees F. The frost-free season is 105 to 135 days.

Typically the surface layer is a light brownish gray, calcareous loam about 8 inches thick. The underlying material is light brownish gray, calcareous very fine sandy loam over very gravelly loamy sand.

Permeability is moderate to a depth of about 28 inches and rapid below. The available water capacity is low or moderate. Reaction is moderately alkaline.

These soils are used for irrigated crops, dryland crops, pasture, and range.

Typical profile of Ryell loam, in a cultivated area, 1,800 feet east and 1,050 feet south of northwest corner sec. 36, T. 21 N., R. 1 W.

Ap—0 to 8 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C1—8 to 28 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

IIC2—28 to 60 inches; light brownish gray (10YR 6/2) very gravelly loamy sand, dark grayish brown (10YR 4/2) moist, single grain; loose; about 65 percent coarser than 2 millimeters; strongly effervescent; moderately alkaline.

Depth to the sand and gravel material ranges from 20 to 40 inches. The A and C horizons range from loam and silt loam to very fine sandy loam.

171—Ryell loam. This nearly level soil occupies river terraces. It has the profile described as typical of the series. The slope is 0 to 2 percent. Included in mapping are small slightly concave areas and narrow convex stringers of Rivra loam and Rivra very gravelly loam.

Surface runoff is slow. The erosion hazard is moderate from wind and slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are used for range and woodland.

Forested areas are mainly plains cottonwood. Some narrowleaf cottonwood grows in the areas of Rivra soils. There are a few stands of boxelder.

Plains cottonwood on the Ryell soil can be expected to reach a height of 60 to 70 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 14,500 to 22,500 board feet per acre or from 2,800 to 4,300 cubic feet.

The erosion hazard, equipment limitation, and windthrow hazard are slight. Seedling mortality is moderate because of the low to moderate available water capacity of the Ryell soil. Plant competition is moderate because the soils of this unit generally support moderately dense stands of understory vegetation and have low to moderate available water capacity. In addition, cottonwood seedlings withstand competition poorly.

Clearcutting small patches favors the regeneration of plains cottonwood over boxelder. Cottonwood tolerates very little competition. Plains cottonwood grows much faster on this Ryell soil than associated species, such as box elder.

Capability unit I1s-1 dryland, I1s-2 irrigated; Silty range site, 10- to 14- inch precipitation zone; windbreak suitability group 3M.

172—Ryell-Rivra complex. This map unit consists of nearly level soils on river terraces and flood plains. It is about 45 percent Ryell loam and 35 percent Rivra gravelly sandy loam. Ryell loam occupies slightly concave and level terraces. Rivra gravelly sandy loam occupies slightly convex positions on flood plains. About 20 percent of the unit is included areas of Havre and Glendive soils. The Ryell and Rivra soils have profiles similar to those described as typical of their respective series.

Surface runoff is slow. The erosion hazard is moderate from both wind and water. The Rivra soil is near the river and is therefore subject to overflow. The water table is within 5 feet of the surface late in spring and in summer.

This unit is well suited to hay, pasture, and native pasture. If irrigated, it is suited to wheat and barley. Some areas are suited to woodland.

Forested areas are mainly narrowleaf cottonwood on the Rivra soil and plains cottonwood on the Ryell loam. There are a few stands of boxelder.

Narrowleaf cottonwood on Rivra soil can be expected to reach a height of 20 to 30 feet at 30 years of age. Plains cottonwood on the Ryell soil can be expected to reach a height of 60 to 70 feet at 30 years. The estimated volume per acre at 70 years in a fully stocked stand ranges from 2,000 to 7,000 board feet or from 400 to 5,200 cubic feet on the Rivra soil and from 14,500 to 22,500 board feet or from 2,800 to 4,300 cubic feet on the Ryell soil.

The erosion hazard is moderate on the Rivra soil. The equipment limitation and windthrow hazard are slight. Seedling mortality is severe. Plant competition is moderate.

The erosion hazard is slight on the Ryell soil. The equipment limitation and windthrow hazard are slight. Seedling mortality is moderate. Plant competition is moderate.

The erosion hazard is moderate on the Rivra soil because of the sparse to moderately dense plant cover, the slow rate of vegetative recovery after disturbance, and the frequent flooding. The equipment limitation is slight on both soils, but equipment is restricted during periods of flooding. Seedling mortality is severe on the Rivra soil because of the very low available water capacity and the frequent flooding. It is moderate on the Ryell soil because of the low to moderate available water capacity. Plant competition is moderate on both soils because of the very low to moderate available moisture capacity, the sparse to moderately dense stands of understory vegetation, and the inability of cottonwood seedlings to withstand competition.

The narrowleaf cottonwood on the Rivra soil can be harvested selectively or on a patch-cut basis. Clearcutting of small patches of plains cottonwood on the Ryell soil favors the regeneration of this species over boxelder. Cottonwood can tolerate very little shade competition. Plains cottonwood grows much faster on the Ryell soil than associated species, such as boxelder.

Regeneration in areas of the Rivra soil may be difficult because of the frequent soil disturbance caused by spring floods and the low available water capacity.

Capability unit VIe-1 dryland, IVs-2 irrigated; windbreak suitability group 3M; Rivra soil in Shallow to Gravel range site, 10- to 14-inch precipitation zone, Ryell soil in Silty range site, 10- to 14-inch precipitation zone.

Scobey series

The Scobey series consists of deep, well drained soils formed in glacial till. These soils occupy uplands at elevations of 3,400 to 4,000 feet. Slopes are 0 to 10 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, forbs, and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown clay loam about 7 inches thick. The subsoil is brown, grayish brown, and light brownish gray clay and clay loam about 33 inches thick, and it is calcareous in the lower part. The substratum is light brownish gray, calcareous clay loam to 60 inches.

Permeability is slow. The available water capacity is high. Reaction is slightly acid to a depth of 7 inches, neutral to 16 inches, and moderately alkaline to 60 inches.

These soils are mainly used for dryland crops.

Typical profile of Scobey clay loam, in cropland, 350 feet south and 680 feet west of northeast corner sec. 10, T. 22 N., R. 7 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong fine and very fine granular structure; hard, very friable, sticky, plastic; common fine and very fine roots; few pebbles; slightly acid; abrupt wavy boundary.

B2t—7 to 16 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong fine and very fine subangular blocky; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; thin continuous clay films; few pebbles; neutral; clear wavy boundary.

B31—16 to 22 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium blocky; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; few pebbles less than 3 inches in size; lime coating on underside of pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

B32ca—22 to 40 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure; very hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores, few medium pores; about 5 percent lime coated coarse fragments; few lignite chips; many fine and medium soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—40 to 48 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; extremely hard, friable, sticky, plastic; few very fine roots; common fine and very fine pores; about 5 percent coarse fragments; common fine threads and masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and very coarse platy structure; extremely hard, friable, sticky, plastic; common fine and very fine pores; less than 5 percent coarse fragments; gypsum accumulated as masses and threads and as bands between plates and as films in vertical cracks; slightly effervescent; moderately alkaline.

The noncalcareous A and B horizons combined are 10 to 16 inches thick. The B horizon is clay loam or clay. The volume of rock fragments ranges from a trace to 15 percent throughout the soil. The A horizon is slightly acid

or neutral, the B horizon is neutral to moderately alkaline, and the C horizon is moderately alkaline.

173—Scobey clay loam, 0 to 2 percent slopes. This nearly level soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of Kevin, Linnet, and Acel soils and a few small areas where the slope is more than 2 percent.

Surface runoff is medium. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIc-2 dryland; windbreak suitability group 1; not assigned to a range site.

174—Scobey-Kevin clay loams, 0 to 5 percent slopes. This map unit consists of nearly level to gently rolling soils on uplands. It is about 60 percent Scobey clay loam and about 30 percent Kevin clay loam. The Scobey clay loam is on smooth and slightly concave slopes, and the Kevin clay loam is in convex positions. About 10 percent of the unit is included areas of Hillon clay loam in convex positions. A few small areas of Acel and McKenzie soils in concave positions and a few small areas where the slope is more than 5 percent are also included.

The Scobey soil in this unit has a profile similar to the one described as typical of the series. The Kevin soil has the profile described as typical of the Kevin series.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

Soils in this unit are well suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-2 dryland; windbreak suitability group 1; not assigned to a range site.

Shane series

The Shane series consists of moderately deep, well drained soils formed in shale. These soils occupy uplands. They are only 20 to 40 inches deep over shale. The elevation is 4,000 to 4,800 feet. Slopes are 2 to 15 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, forbs, and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown silty clay loam about 6 inches thick. It forms a hard crust when dry. The subsoil is brown and grayish brown clay 26 inches thick. Below 32 inches is calcareous shale.

Permeability is very slow. The available water capacity is low or very low. Reaction is medium acid in the upper 6 inches, neutral to moderately alkaline in the subsoil, and mildly alkaline in the underlying material.

These soils are mainly used for dryland crops and range.

Typical profile of Shane silty clay loam, in cropland, 530 feet west and 40 feet north of southeast corner NE1/4 sec. 20, T. 19 N., R. 7 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate very fine and fine granular structure which becomes cloddy when cultivated; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; medium acid; abrupt wavy boundary.

B21t—6 to 14 inches; brown (10YR 5/3) clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to strong very fine and fine subangular blocky; extremely hard, firm, very sticky, very plastic; many fine and very fine roots; many fine and very fine pores; common clay films; neutral; clear wavy boundary.

B22t—14 to 25 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; strong fine and medium blocky structure; extremely hard, firm, very sticky, very plastic; common fine and very fine roots; many fine and very fine pores; many well expressed slickensides; common clay films; few fine and medium soft masses of segregated lime; slightly effervescent; mildly alkaline; gradual wavy boundary.

B3—25 to 32 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; strong medium and coarse angular blocky structure; extremely hard, firm, very sticky, very plastic; common fine and very fine roots; many fine and very fine pores; few fine soft masses of segregated lime; moderately alkaline; gradual wavy boundary.

C1r—32 to 38 inches; dark gray (N 4/0) weathered shale; very dark gray (N 3/0) moist; extremely hard, firm, sticky, plastic; few fine and very fine roots along fracture planes; common fine masses and threads of gypsum; mildly effervescent; mildly alkaline; diffuse boundary.

C2r—38 to 60 inches; dark gray (N 4/0) shale.

Depth to unweathered shale is 20 to 40 inches. In places thin strata of hard sandstone are present in the bedrock. The A horizon is silty clay loam or loam. The noncalcareous parts of the A and B horizons combined are 13 to 24 inches thick. The A horizon is medium acid to neutral. The B horizon is neutral to moderately alkaline.

175—Shane silty clay loam, 2 to 10 percent slopes. This gently sloping to moderately sloping soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of Eltsac and Blythe soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-10 dryland; windbreak suitability group 2M; not assigned to a range site.

176—Shane-Nobe complex, 4 to 15 percent slopes.

This map unit consists of gently rolling and strongly sloping soils on uplands and foot slopes. It is about 55 percent Shane loam and about 25 percent Nobe clay loam. The Shane loam occupies smooth slopes and slightly convex areas. The Nobe clay loam is in numerous shallow depressions. About 20 percent of the unit is included areas of Absher, Acel, and Eltsac soils. Also included are a few small areas where the slope is less than 4 percent and a few small areas of nearly barren shale exposures on slopes of more than 15 percent.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is best suited to range. Capability unit VI-1 dryland. Shane soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Nobe soil in Saline Upland range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-5.

Shawa series

The Shawa series consists of deep, well drained soils formed in alluvium. These soils occupy fans, terraces, and foot slopes at elevations of 3,400 to 4,500 feet. Slopes are 2 to 20 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 20 inches. The mean annual air temperature is 40 to 45 degrees F. The growing season is 105 to 130 days.

Typically the surface layer is dark grayish brown loam about 12 inches thick. The surface layer is brown loam about 24 inches thick. The underlying material is pale brown gravelly loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is moderate or high. Reaction is neutral in the upper 12 inches and mildly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Shawa loam in native grass, 1,000 feet east and 420 feet south of northwest corner sec. 7, T. 17 N., R. 3 W.

A11—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine platy structure parting to moderate very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; neutral; clear wavy boundary.

A12—3 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to moderate fine

granular; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; clear wavy boundary.

A3—12 to 36 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; 10 percent gravel; mildly alkaline; diffuse boundary.

C—36 to 60 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky, nonplastic; 25 percent gravel; mildly alkaline.

The C horizon ranges from loam to gravelly or stony loam. It is calcareous in some pedons. A weak accumulation of lime is below 40 inches. The soil is 0 to 30 percent coarse fragments throughout.

177—Shawa loam, 2 to 10 percent slopes. This gently sloping and moderately sloping soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are small areas where the surface layer is gravelly or stony loam, a few small areas of Perma soils, and areas of moderately well drained soils near water channels.

Surface runoff is slow or medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IIIe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

178—Shawa loam, 10 to 20 percent slopes. This strongly sloping to moderately steep soil occupies foot slopes and fans. Included in mapping are small areas where the surface layer is stony loam and small areas of Perma soils.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1 if slope is less than 15 percent, group 4-0 if more than 15 percent.

Sheege series

The Sheege series consists of shallow, well drained soils formed in material weathered from limestone. These soils occupy uplands at elevations of 4,800 to 6,000 feet. The depth to limestone is only 10 to 20 inches. Slopes are 4 to 70 percent. The native vegeta-

tion is mainly rough fescue, bluebunch wheatgrass, Idaho fescue, and forbs and shrubs. The mean annual precipitation is 15 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the surface layer is calcareous dark gray and grayish brown stony loam about 11 inches thick. The underlying material is pale brown calcareous very stony loam about 5 inches thick. Below 16 inches is light gray limestone bedrock.

Permeability is moderate. The available water capacity is very low. Reaction is mildly alkaline in the upper 5 inches and moderately alkaline to 16 inches.

These soils are mainly used for range.

Typical profile of Sheege stony loam in native grass, 530 feet east and 1,320 feet north of southwest corner sec. 26, T. 17 N., R. 6 E.

A11—0 to 5 inches; dark gray (10YR 4/1) stony loam, black (10YR 2/1) moist; strong very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; 20 percent limestone rock fragments; slightly effervescent; mildly alkaline; clear wavy boundary.

A12—5 to 11 inches; grayish brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; few medium roots; 30 percent limestone rock fragments; strongly effervescent; moderately alkaline; clear wavy boundary.

C—11 to 16 inches; pale brown (10YR 6/3) very stony loam, brown (10YR 5/3) moist; weak very fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; few medium roots; many fine and very fine pores; 55 percent limestone fragments; violently effervescent; moderately alkaline; clear wavy boundary.

R—16 inches; light gray (2.5Y 7/2) fractured limestone bedrock.

The depth to limestone bedrock is 10 to 20 inches. Limestone fragments of stone, cobble, and gravel size range from 35 to 70 percent by volume throughout the soil. The A and C horizons are mildly alkaline or moderately alkaline.

179—Sheege stony loam, 4 to 15 percent slopes. This gently rolling and strongly sloping soil is on uplands. Included in mapping are small areas of Whitore soils on north-facing slopes, areas of Skaggs and Woosley soils, and small areas where slopes are more than 15 percent.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is used mainly for native pasture. Some areas are woodland.

Forested areas on this map unit occur mainly on the Whitore soil. The slope range is 15 to 35 percent. See map unit 216, Whitore silty clay loam, 15 to 65 percent slopes, for woodland interpretations. Capability unit VIs-1 dryland; Shallow range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-1.

180—Sheege-Rock outcrop complex, 35 to 70 percent slopes. This steep and very steep map unit is on sedimentary uplands. It is about 45 percent Sheege stony loam and 25 percent limestone rock outcrop. Sheege stony loam occupies plane slopes and convex areas. The limestone crops out on ledges, very steep slopes, and convex ridges. The Sheege soil has the profile described as typical of the series. About 25 percent of the unit is included areas of Hanson soils, and 5 percent is Whitore soils on foot slopes. Also included are small areas where slopes are less than 35 percent.

Surface runoff is rapid. The erosion hazard is slight from wind but is severe from water.

This unit is used mainly as range. Some areas are woodland.

Wooded areas occur mainly on the Whitore soil. The slope range is 15 to 35 percent. See map unit 216, Whitore silty clay loam, 15 to 65 percent slopes, for woodland interpretations. Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Sheege soil in Shallow range site, 20- to 24-inch precipitation zone.

181—Sheege-Whitore complex, 15 to 40 percent slopes. This map unit consists of moderately steep to steep soils on foot slopes and uplands. About 55 percent is Sheege stony loam and about 30 percent Whitore silty clay loam. The Sheege stony loam occupies convex slopes and ridges above limestone outcrop. The Whitore silty clay loam occupies mainly north-facing slopes. Each soil has the profile described as typical of the series. About 15 percent of the unit is included areas of Hanson and Skaggs soils. Also included are small areas of Sheege and Whitore soils where slopes are less than 15 percent and more than 40 percent.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and moderate or severe from water.

This unit is used mainly as native pasture. Some areas are woodland.

Forested areas are chiefly on Whitore soils of 15 to 40 percent slope. The following woodland interpretations are for the Whitore silty clay loams.

Douglas-fir is the most common species on this unit. There is very little lodgepole pine or ponderosa pine. At high elevations, limber pine is a minor component of the Douglas-fir stands. On these soils, Douglas-fir has a distinct competitive advantage over species normally associated with it.

Unless the stand is overstocked, Douglas-fir can be expected to reach a height of 36 to 45 feet at 50 years of age. The estimated volume per acre in a fully stocked

stand at 100 years ranges from 13,000 to 19,000 board feet per acre of from 3,900 to 5,700 cubic feet.

Selection or shelterwood harvest is well adapted if trees are healthy. Douglas-fir is recommended for planting on these soils.

The erosion hazard and equipment limitation are slight on 15 to 30 percent slopes and moderate on the 30 to 40 percent slopes. Seedling mortality and the windthrow hazard are slight. Plant competition is severe because of the competition from rhizomatous understory grasses and other understory plants and the moderate to low available water capacity.

Understory plants on Whitore soils are elk sedge, rose sedge, pinegrass, false Solomons-seal, wintergreen, meadow rue, bedstraw, twinflower, snowberry, common juniper, Oregon-grape, white spirea, mountain maple, rose, and aspen. The sedges, snowberry, and Oregon-grape have high forage value for cattle, deer, or elk. The rest have low to fair forage value. Forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants are determined not only by soil properties and climatic variations but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading by overstory trees. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, that is, the most preferred plants, are sedges, snowberry, and Oregon-grape. The rest are increasers, but they too can be expected to decrease under continued heavy grazing.

The following tabulation shows the estimated average annual air-dry yield of understory plants on Whitore soils, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total average annual yield.

10-30.....	2,000
30-50.....	1,200
50-70.....	625

It is estimated that 60 percent of the yield is potential feed for grazing animals.

Capability unit VIIe-1 dryland; windbreak suitability group 4-0; Sheege soil in Shallow range site, 20- to 24-inch precipitation zone. Whitore soil used mainly for woodland.

Sinnigam series

The Sinnigam series consists of shallow, well drained soils formed in sandstone. These soils occupy uplands at elevations of 3,500 to 4,800 feet. Sandstone bedrock is at a depth of 10 to 20 inches. Slopes are 0 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, rough fescue, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19

inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown very stony loam about 6 inches thick. The subsoil is brown very stony clay loam and extremely stony clay about 11 inches thick. Below 17 inches is hard fractured sandstone.

Permeability is moderately slow. The available water capacity is very low. Reaction is neutral.

These soils are used mainly for dryland crops and range.

Typical profile of Sinnigam very stony loam in native grass, 340 feet west and 1,920 feet north of southeast corner sec. 31, T. 18 N., R. 6 E.

A11—0 to 2 inches; dark grayish brown (10YR 4/2) very stony loam, very dark brown (10YR 2/2) moist; strong very fine granular structure; slightly hard, very friable, sticky, slightly plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; few medium pores; 30 percent sandstone fragments; neutral; clear wavy boundary.

A12—2 to 6 inches; dark grayish brown (10YR 4/2) very stony loam, very dark brown (10YR 2/2) moist; moderate fine and medium subangular blocky structure; hard, very friable, sticky, slightly plastic; many fine and very fine roots, common medium and coarse roots; many fine and very fine pores; common medium pores; 50 percent sandstone fragments; neutral; clear wavy boundary.

B21t—6 to 11 inches; brown (7.5YR 5/2) very stony flaggy clay loam, dark brown (7.5YR 3/2) moist; strong fine and very fine subangular blocky structure; hard, friable, sticky, plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; few medium pores; thin continuous coatings of unstained sand grains on ped faces; brown clay films on ped faces; 50 percent sandstone fragments; neutral; clear wavy boundary.

B22t—11 to 17 inches; brown (7.5YR 5/4) extremely stony clay, dark brown (7.5YR 4/4) moist; strong fine and very fine subangular blocky structure; very hard, friable, sticky, plastic; many fine and very fine roots; few medium roots; many fine and very fine pores; few medium pores; thin continuous clay films on ped surfaces; 70 percent sandstone fragments; neutral; abrupt wavy boundary.

R—17 inches; hard sandstone with many fractures and some weathering in upper few inches; root mat formed at contact; clay coatings on some fragments in upper 3 inches.

The depth to hard sandstone is 10 to 20 inches. The A horizon is very stony loam, loam, and channery loam. The mollic epipedon is 7 to 12 inches thick. Coarse fragments in the A horizon, mainly stones, flagstones,

and channery fragments, range from 15 to 50 percent. The A and B horizons are slightly acid to mildly alkaline.

182—Sinnigam loam, 0 to 4 percent slopes. This nearly level and undulating soil occupies sedimentary uplands. It has a profile similar to the one described as typical of the series, but the surface layer is loam. Included in mapping are a few small areas of Absarokee soils in concave positions and small areas of Castner stony loam and Sinnigam stony loam on knolls and convex slopes.

Surface runoff is medium. The erosion hazard is slight or moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is suited to range. Capability unit IVs-2 dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

Skaggs series

The Skaggs series consists of moderately deep, well drained soils formed in material weathered from limestone and shale. These soils occupy uplands at elevations of 5,000 to 6,000 feet. Limestone and shale are at depths of 20 to 40 inches. Slopes are 4 to 45 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, and forbs and shrubs. The mean annual precipitation is 18 to 24 inches. The mean annual air temperature is 38 to 42 inches. The frost-free season is 60 to 90 days.

Typically the surface layer is very dark gray loam about 10 inches thick. The underlying material is light brownish gray, calcareous very gravelly clay loam in the upper 11 inches and light gray, calcareous very stony clay loam in the lower 11 inches. Below 32 inches is light gray limestone and shale.

Permeability is moderate. The available water capacity is low or very low. Reaction is neutral or mildly alkaline in the upper 10 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Skaggs loam in an area of Raynesford-Skaggs loams, 8 to 20 percent slopes, in native grass, 900 feet east and 800 feet north of the center of sec. 11, T. 16 N., R. 7 E.

A11—0 to 4 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; strong very fine granular structure; slightly hard, very friable, slightly sticky, nonplastic; many fine and very fine roots; few limestone fragments; neutral; clear wavy boundary.

A12—4 to 10 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores;

10 percent limestone fragments; slightly effervescent; mildly alkaline; clear wavy boundary.

C1ca—10 to 21 inches; light brownish gray (10YR 6/2) very gravelly clay loam, dark grayish brown (10YR 4/2) moist; strong very fine subangular blocky structure; slightly hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; 35 percent limestone coarse fragments of gravel and cobbles; strongly effervescent; moderately alkaline; clear wavy boundary.

C2ca—21 to 32 inches; light gray (2.5Y 7/2) very stony clay loam, grayish brown (2.5Y 5/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; 45 percent limestone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cr—32 inches; light gray (2.5Y 7/2) interbedded limestone and shale, light olive brown (2.5Y 5/4) moist; strongly effervescent; moderately alkaline.

The A horizon is loam or stony loam. Depth to interbedded limestone and shale is mainly 30 to 40 inches but ranges from 20 to 40 inches. The percentage of coarse fragments ranges from 35 to 50 percent below a depth of 10 inches.

Straw series

The Straw series consists of deep, well drained soils formed in alluvium. These soils occupy flood plains, terraces, and fans at elevations of 3,300 to 3,600 feet. Slopes are 0 to 2 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 130 days.

Typically the surface layer is grayish brown, calcareous loam about 27 inches thick. The underlying material is grayish brown and light brownish gray. The upper 27 inches is calcareous loam and silt loam. The lower part is calcareous loamy sand to a depth of 66 inches or more.

Permeability is moderate. The available water capacity is high. Reaction is mildly alkaline in the upper 10 inches and mildly or moderately alkaline below.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops and woodland.

Typical profile of Straw loam in cropland, 500 feet south and 100 feet west of northeast corner SE1/4 sec. 25, T. 18 N., R. 6 E.

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

slightly sticky, slightly plastic; many fine and few medium roots; many fine and medium pores; slightly effervescent; mildly alkaline; clear wavy boundary.

A12—10 to 27 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C1—27 to 38 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; massive; hard, very friable, slightly sticky, slightly plastic; few fine and very fine roots; many fine and very fine pores; few fine masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—38 to 54 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, very friable, slightly sticky, slightly plastic; few fine and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline; clear smooth boundary.

IIC3—54 to 65 inches; light brownish gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky, nonplastic; strongly effervescent; mildly alkaline.

The A horizon is loam or silty clay loam. The C horizon is mainly loam and silt loam to a depth of 40 inches or more. In some pedons fine sandy loam to gravelly loamy sand stratifications are below about 40 inches. Coarse fragments range from a few pebbles to about 10 percent by volume in the C horizon. The Ap horizon is neutral or mildly alkaline. The C horizon is mildly alkaline or moderately alkaline.

183—Straw loam. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. The slope is 0 to 2 percent. Included in mapping are small areas cut by shallow drainageways and narrow swales, a few small areas where sand and gravel are at a depth of 24 to 40 inches, and small areas of Rivra and Glendive soils adjacent to stream channels.

Surface runoff is slow. The erosion hazard is slight from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Some areas are native pasture and woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood can be expected to reach a height of 70 to 82 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 18,000 to 27,000 board feet per acre or from 3,500 to 5,200 cubic feet.

The erosion hazard, equipment limitation, seedling mortality, and windthrow hazard are slight. Plant competition is moderate.

Clearcutting small patches in harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on this soil than associated species, such as boxelder.

This unit supports dense stands of understory vegetation. Reducing the amount of competition may be needed for good seedling survival and rapid regeneration.

Capability unit IIIc-3 dryland, IIc-1 irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

184—Straw silty clay loam. This nearly level soil occupies flood plains and swales. It has a profile similar to the one described as typical of the series, but the surface layer is silty clay loam. The slope is 0 to 2 percent. Included in mapping are small areas where the surface layer is silty clay. Also included are small areas of Glendive and Rivra soils near stream channels.

Surface runoff is slow. The erosion hazard is slight from wind and is moderate from water. This soil is subject to flooding.

This soil is used mainly for hay. It is suited to wheat, barley, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 1; not assigned to a range site.

185—Straw-Rivra complex. This map unit consists of nearly level soils on flood plains and terraces. About 55 percent is Straw loam, and about 30 percent is Rivra gravelly sandy loam. Straw loam occupies smooth slopes. Rivra gravelly sandy loam is in slightly convex positions and areas near stream channels. About 15 percent of this unit is included areas of Ryell loam, which is only 30 to 40 inches deep over sand and gravel. The Straw and Rivra soils in this unit have profiles similar to those described as typical of their respective series.

Surface runoff is slow. The erosion hazard is slight from wind and moderate from water. Flooding is a hazard. The Rivra soil has a water table within 5 feet of the surface late in spring and in summer.

This unit is used mainly for hay, pasture, and native pasture. Smaller acreages are in dryland wheat and barley. Some areas are woodland.

Forested areas are mainly plains cottonwood on the Straw soil and narrowleaf cottonwood on the Rivra soil. There are a few stands of boxelder.

Plains cottonwood on the Straw soil can be expected to reach a height of 70 to 80 feet at 30 years of age. Narrowleaf cottonwood on the Rivra soil can be expected to reach a height of 20 to 30 feet at 30 years. The estimated volume per acre at 70 years in a fully stocked stand is 18,000 to 27,000 board feet or 3,500 to 5,200

cubic feet on the Straw soil and 2,000 to 7,000 board feet or 400 to 1,300 cubic feet on the Rivra soil.

The erosion hazard is slight on the Straw soil. Equipment limitation, seedling mortality, and the windthrow hazard are slight. Plant competition is moderate.

The erosion hazard is moderate on the Rivra soil. Equipment limitation and the windthrow hazard are slight. Seedling mortality is severe. Plant competition is moderate.

The erosion hazard is moderate on the Rivra soil because of the sparse to moderately dense vegetative cover, the slow rate of vegetative recovery after disturbance, and the frequent flooding. The equipment limitation is slight on both soils, but there is some limitation of equipment usage during the periods of flooding. Seedling mortality is severe on the Rivra soil because of the very low available water capacity and the frequent flooding. Plant competition is moderate on the Straw soil because of the dense stand of understory vegetation and the inability of cottonwood seedlings to withstand competition. Plant competition is moderate on the Rivra soil because of the very low available water capacity and the sparse to moderately dense stands of understory vegetation.

Clearcutting small patches in harvesting plains cottonwood on the Straw soil favors its regeneration over boxelder. Cottonwood can tolerate very little shade competition. Harvesting the narrowleaf cottonwood on the Rivra soil can be done selectively or on a patch cut basis. Plains cottonwood grows much faster on this unit than the other trees.

Obtaining adequate regeneration on the Straw soil is generally not a problem in recently cutover areas. Regeneration is difficult in areas of the Rivra soil because of the disturbance caused during flooding and the low available water capacity.

Capability unit Ills-1 dryland. Straw soil in Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Rivra soil in Shallow to Gravel range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-1.

Tally series

The Tally series consists of deep, well drained soils formed in alluvium and eolian sands. These soils are on terraces, fans, and foot slopes at elevations of 3,300 to 4,300 feet. Slopes are 0 to 25 percent. The native vegetation is mainly prairie sandreed, bluebunch wheatgrass, Indian ricegrass, and forbs and shrubs. The mean annual precipitation is 14 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown fine sandy loam about 7 inches thick. The subsoil is brown and grayish brown fine sandy loam 15 inches thick. The

substratum to a depth of 60 inches or more is pale brown, calcareous fine sandy loam and sandy loam.

Permeability is moderately rapid. The available water capacity is low or moderate. Reaction is neutral in the upper 7 inches, mildly alkaline to 22 inches, and moderately alkaline to 60 inches.

These soils are mainly used for dryland crops and range. Some areas are used for irrigated crops.

Typical profile of Tally fine sandy loam in cropland, 1,050 feet west and 400 feet north of southeast corner NE1/4 sec. 5, T. 19 N., R. 3 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; few medium roots; neutral; clear wavy boundary.

B21—7 to 14 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate medium and coarse prismatic structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; few medium roots; many fine and very fine pores; few medium pores; mildly alkaline; clear wavy boundary.

B22—14 to 22 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; many fine and very fine pores; slightly effervescent; mildly alkaline; clear wavy boundary.

C1ca—22 to 40 inches; pale brown (10YR 6/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky, nonplastic; common fine and very fine roots; few fine sandstone pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

C2—40 to 60 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky, nonplastic; few fine and very fine roots; 10 percent lime coated sandstone fragments; strongly effervescent; moderately alkaline.

The A horizon is fine sandy loam or loam. Thickness of the noncalcareous solum ranges from 12 to 24 inches. The C horizon is sandy loam or fine sandy loam above 30 inches and sandy loam to loamy fine sand below. The volume of sandstone coarse fragments ranges from less than 10 percent in the A and B horizons to up to 15 percent below about 30 inches. Reaction is neutral to mildly alkaline in the noncalcareous part of the solum and mildly alkaline or moderately alkaline below.

186—Tally fine sandy loam, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. Some small seeped areas occupy concave positions. Included

in mapping are a few small areas of Dooley and Lihen soils.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-1 dryland, IIe-1 irrigated; windbreak suitability group 2M; not assigned to a range site.

187—Tally fine sandy loam, 2 to 8 percent slopes.

This gently sloping and moderately sloping soil occupies fans and foot slopes. It has the profile described as typical of the series. Included in mapping are a few small areas of Castner and Big Timber soils on ridges and knolls and small concave areas of Farnuf soil.

Surface runoff is slow. The erosion hazard is moderate from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-1 dryland, IIIe-3 irrigated; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

188—Tally fine sandy loam, 8 to 15 percent slopes.

This strongly sloping soil occupies fans and foot slopes. It has a profile similar to the one described as typical of the series, but scattered sandstone fragments are on the surface and throughout the surface layer and subsoil. Included in mapping are a few small areas of Castner soil on ridges and knolls.

Surface runoff is slow or medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-2 dryland; Sandy range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

189—Tally loam, 2 to 8 percent slopes. This gently sloping and moderately sloping soil occupies fans and foot slopes. It has a profile similar to the one described as typical of the Tally series, but the surface layer is loam. Also, this unit is in a slightly lower precipitation zone. Included in mapping are a few small areas where slopes are less than 2 percent or more than 8 percent. Also included are small areas where the surface layer is fine sandy loam and areas of Evanston soils.

Surface runoff is slow or medium. The erosion hazard is moderate from wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-3 dryland; windbreak suitability group 2M; not assigned to a range site.

190—Tally-Castner complex, 15 to 35 percent slopes. This map unit consists of hilly and steep soils on foot slopes and uplands. It is about 65 percent Tally loam and 25 percent Castner channery loam. Tally loam

occupies foot slopes. Castner channery loam occupies convex slopes, ridges, and knolls. Hard sandstone crops out at the edge of some benches. A few stones are on the surface. About 10 percent of this unit are included areas of Tally fine sandy loam. Also included are small areas where slopes are less than 15 percent or more than 35 percent.

The Tally soil has a profile similar to the one described as typical of the series, but the surface layer is loam. The Castner soil has a profile similar to the one described as typical of the Castner series.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to range. Capability unit VIe-1 dryland; windbreak suitability group 4-0. Tally soil in Silty range site, 15- to 19-inch precipitation zone. Castner soil in Shallow range site, 15- to 19-inch precipitation zone.

Tanna series

The Tanna series consists of moderately deep, well drained soils formed in interbedded shale and sandstone. These soils occupy uplands at elevations of 3,400 to 4,300 feet. Shale and sandstone are at depths of 20 to 40 inches. Slopes are 0 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is brown and light brownish gray clay loam 21 inches thick. The substratum is pale brown, calcareous very channery loam 4 inches thick. Below 31 inches is shale and sandstone bedrock.

Permeability is slow. The available water capacity is low. Reaction is neutral in the upper 6 inches and mildly alkaline or moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Tanna clay loam, 8 to 15 percent slopes, in cropland, 400 feet north and 150 feet east of southwest corner sec. 34, T. 22 N., R. 3 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, very friable, sticky, plastic; many fine and very fine roots; neutral; abrupt wavy boundary.

B2t—6 to 17 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine and medium blocky; very hard, friable, sticky, plastic; many fine and very fine pores; thin continuous clay films on ped surfaces; few sandstone fragments; mildly alkaline; clear wavy boundary.

B3ca—17 to 27 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse prismatic structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few lime coated sandstone fragments in the upper part and increasing to 5 percent in lower part; common fine soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIc1—27 to 31 inches; pale brown (10YR 6/3) very channery loam, brown (10YR 4/3) moist; massive; hard, very friable, slightly sticky, nonplastic; common fine and very fine roots; many fine and very fine pores; 60 percent lime coated sandstone fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIc2r—31 to 40 inches; bedrock consisting of mudstone and platy shales interbedded with 1 to 5 inch layers of hard sandstone.

The depth to bedrock ranges from 20 to 40 inches but is generally between 30 and 40 inches. The noncalcareous part of the solum ranges from 11 to 16 inches. The B2t horizon is dominantly clay loam or clay but is silty clay loam or silty clay if clay shale is the main bedrock material. The B horizon ranges from mildly to moderately alkaline.

191—Tanna clay loam, 0 to 2 percent slopes. This nearly level soil is on uplands. It has a profile similar to the one described as typical of the series but is only moderately deep over hard sandstone. Included in mapping are small areas of Dutton and Ernem soils, and areas where slopes are more than 2 percent.

Surface runoff is medium. The hazard of wind and water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIc-1 dryland; windbreak suitability group 2M; not assigned to a range site.

192—Tanna clay loam, 2 to 8 percent slopes. This undulating and gently rolling soil is on uplands. Included in mapping are a few small areas of Ethridge soil in concave slopes.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-3 dryland; windbreak suitability group 2M; not assigned to a range site.

193—Tanna clay loam, 8 to 15 percent slopes. This strongly rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small areas of Ethridge soil on concave slopes.

Also included are small areas of Yawdim and Cabbart soils on convex slopes and ridges and a few small areas where slopes are more than 15 percent.

Surface runoff is medium. The erosion hazard is moderate from water and is slight from wind.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-3 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

194—Tanna-Wabek complex, 2 to 10 percent slopes. This map unit consists of undulating and strongly sloping soils on uplands. It is about 70 percent Tanna clay loam and 20 percent Wabek gravelly loam. Tanna clay loam occupies smooth slopes and concave positions. Wabek gravelly loam occupies ridges, knolls, and some convex slopes. Included in mapping are areas of Marmarth and Castner soils.

The Tanna soil in this unit has a profile similar to the one described as typical of the Tanna series, but the soil contains a few rounded dark colored igneous pebbles. The Wabek soil has a profile similar to the one described as typical of the Wabek series.

Surface runoff is medium. The erosion hazard is moderate from wind and water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IIIe-3 dryland. Tanna soil in Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M. Wabek soil in Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-1.

Terrad series

The Terrad series consists of deep, well drained soils formed in soft shale and alluvium. These soils are on uplands and foot slopes at elevations of 3,300 to 4,800 feet. Soft shale is at a depth of 40 to 60 inches. Slopes are 2 to 15 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark reddish gray silty clay about 6 inches thick. The subsoil is weak red and reddish brown clay 20 inches thick. The substratum to a depth of 45 inches is reddish brown, calcareous silty clay. Below 45 inches is weak red shale and mudstone.

Permeability is slow. The available water capacity is moderate. Reaction is neutral in the upper 15 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Terrad silty clay in cropland, 1,040 feet west and 420 feet south of the center of sec. 13, T. 19 N., R. 6 E.

Ap—0 to 6 inches; dark reddish gray (5YR 4/2) silty clay, dark reddish brown (5YR 3/3) moist; moderate fine and very fine granular structure; hard, friable, sticky, plastic; common fine and very fine roots; neutral; abrupt wavy boundary.

B2t—6 to 15 inches; weak red (2.5YR 4/2) clay, dark reddish brown (2.5YR 3/4) moist; medium prismatic structure parting to strong fine and very fine blocky; very hard, firm, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films; neutral; clear irregular boundary.

B3ca—15 to 26 inches; reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; moderate medium prismatic structure parting to moderate fine and very fine subangular blocky; very hard, firm, sticky, plastic; few fine and very fine roots; few fine and very fine pores; common medium and coarse soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—26 to 45 inches; reddish brown (2.5YR 5/4) silty clay, reddish brown (2.5Y 4/4) moist; weak fine and very fine subangular blocky structure; extremely hard, firm, sticky, plastic; few very fine roots; common fine and very fine pores; common shale fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2r—45 to 60 inches; weak red (2.5YR 4/2) interbedded shale and mudstone; slightly effervescent; moderately alkaline.

Depth to the unweathered shale ranges mainly from 40 to 60 inches. Thickness of the noncalcareous solum ranges from 10 to 22 inches. The B horizon ranges from neutral to moderately alkaline. The C horizon is moderately or strongly alkaline.

195—Terrad silty clay, 2 to 8 percent slopes. This undulating and gently rolling soil is on uplands. It has the profile described as typical of the series. Included in mapping are a few small convex areas of Timberg soil.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IIIe-9 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

196—Terrad silty clay, 8 to 15 percent slopes. This strongly rolling soil is on uplands and foot slopes. Included in mapping are a few small areas of Darrett and Timberg soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-1 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

Thebo series

The Thebo series consists of moderately deep, well drained soils formed in soft shale and lacustrine clay. These soils are on uplands, foot slopes, and fans at elevations of 3,300 to 4,500 feet. They are only 20 to 40 inches deep over soft shale. Slopes are 0 to 10 percent. The native vegetation is mainly green needlegrass, bluebunch wheatgrass, western wheatgrass, forbs, and shrubs. The mean annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is a calcareous light brownish gray clay about 4 inches thick. The underlying material is light brownish gray calcareous clay 27 inches thick. Below 31 inches is gray calcareous platy clay shale.

Permeability is very slow. The available water capacity is low or moderate. Reaction is moderately alkaline.

These soils are mainly used for dryland crops and range.

Typical profile of Thebo clay in cropland, 2,400 feet east and 200 feet north of southwest corner sec. 20, T. 21 N., R. 1 E.

Ap—0 to 4 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate very fine granular structure; extremely hard, firm, sticky, very plastic; common fine and very fine roots; slightly effervescent; moderately alkaline; clear wavy boundary.

C1—4 to 12 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; strong fine and very fine subangular blocky structure; extremely hard, firm, sticky, very plastic; common fine and very fine roots; many fine and very fine pores; slightly effervescent; moderately alkaline; gradual irregular boundary.

C2cs—12 to 31 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; strong fine and very fine subangular blocky structure; extremely hard, firm, sticky, plastic; few fine and very fine roots; common fine and very fine pores; well expressed slickensides that intersect at angles of 20 degrees from horizontal; many fine masses and threads of gypsum; slightly effervescent; moderately alkaline; gradual smooth boundary.

C3r—31 inches; gray (5Y 6/1) and light brownish gray (2.5Y 6/2) lacustrine clay shale.

Depth to shale or lacustrine platy clay beds ranges from 20 to 40 inches.

197—Thebo clay, 0 to 4 percent slopes. This nearly level and gently sloping soil is on uplands. It has the profile described as typical of the series.

Surface runoff is medium to rapid. Erosion hazard is moderate from wind and is moderate or severe from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IVs-3 dryland; windbreak suitability group 2M; not assigned to a range site.

198—Thebo clay, 4 to 10 percent slopes. This moderately sloping and strongly sloping soil occupies fans and foot slopes. Included in mapping are a few small areas of Lisam soil on convex slopes and ridges and a few small areas of this Thebo soil where slopes are less than 4 percent or more than 10 percent.

Surface runoff is rapid. The erosion hazard is moderate from wind and is severe from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IVe-6 dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Ticell series

The Ticell series consists of shallow, well drained soils formed in alluvium of mixed mineralogy. These soils are on uplands at elevations of 3,300 to 4,400 feet. They are only 10 to 20 inches deep over hard sandstone. Slopes are 0 to 10 percent. The native vegetation is mainly bluebunch wheatgrass, rough fescue, mountain brome, and forbs and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown loam about 6 inches thick. The subsoil is light gray, calcareous silt loam about 5 inches thick. The substratum is light gray, calcareous silt loam about 4 inches thick over hard sandstone.

Permeability is moderate. The available water capacity is very low. Reaction is mildly or moderately alkaline in the upper 6 inches and moderately alkaline below.

These soils are used mainly for dryland crops and range.

Typical profile of Ticell loam in cropland, 800 feet west and 180 feet north of the center of sec. 28, T. 20 N., R. 3 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; slightly hard, very

friable, slightly sticky, slightly plastic; slightly effervescent; moderately alkaline; abrupt wavy boundary.

B2ca—6 to 11 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to weak fine and medium subangular blocky; hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; common soft masses of lime; violently effervescent; moderately alkaline; clear wavy boundary.

Cca—11 to 15 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; weak coarse prismatic structure; hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; 5 percent fine sandstone fragments; common soft masses of lime; violently effervescent; moderately alkaline; abrupt wavy boundary.

IIR—15 inches; indurated sandstone.

Depth to sandstone ranges from 10 to 20 inches. The volume of coarse fragments throughout the soil ranges from 0 to 30 percent. The Ap horizon is mildly or moderately alkaline.

199—Ticell-Castner complex, 0 to 4 percent slopes. This map unit consists of nearly level and undulating soils on uplands. It is about 45 percent Ticell loam and 30 percent Castner channery loam. The Ticell soil occupies smooth slopes and concave positions. Castner channery loam occupies convex areas. Included in mapping are areas of hard sandstone outcrop and areas of Ipano and Azaar soils.

The Ticell soil has the profile described as typical of the series. The Castner soil has a profile similar to the one described as typical.

Surface runoff is medium. The erosion hazard is moderate from wind and is slight or moderate from water.

This unit is well suited to hay, pasture, or range. It is suited to wheat and barley under dryland management. Capability unit IVs-2 dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

Tigeron series

The Tigeron series consists of deep, well drained soils formed in material weathered from fractured sandstone and alluvium. These soils are on uplands at elevations of 4,800 to 6,000 feet. Slopes are 4 to 25 percent. The native vegetation is mainly lodgepole pine, Douglas-fir, and ponderosa pine. The mean annual precipitation is 20 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically, the soil is covered with a thin layer of forest litter of undecomposed and decomposed needles, twigs, and cones. The surface layer is about 13 inches of light brownish gray and light gray flaggy sandy loam. The

subsoil to a depth of 60 inches is pale brown very flaggy sandy clay loam. The substratum is gray very flaggy loam to a depth of 66 inches or more.

Permeability is moderate. The available water capacity is low or very low. Reaction is strongly acid in the upper 60 inches and medium acid below.

These soils are mainly used for woodland and range.

Typical profile of Tigeron flaggy sandy loam in forest, 140 feet north and 250 feet west of southeast corner sec. 35, T. 17 N., R. 5 E.

O—1 inch to 0; forest litter of undecomposed and decomposed needles, twigs, and cones.

A21—0 to 3 inches; light brownish gray (10YR 6/2) flaggy sandy loam, very dark grayish brown (10YR 3/2) moist; strong thin platy structure; soft, very friable, nonsticky, nonplastic; many fine and very fine roots; continuous coatings of sand grains on surface of plates; 15 percent coarse fragments; strongly acid; clear wavy boundary.

A22—3 to 7 inches; light gray (10YR 7/2) flaggy sandy loam, dark grayish brown (10YR 4/2) moist; moderate thin platy structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots; continuous coatings of sand grains on plates; 30 percent sandstone fragments; strongly acid; clear wavy boundary.

A&B—7 to 13 inches; light gray (10YR 7/2) flaggy sandy loam, grayish brown (10YR 5/2) moist; 25 percent thin horizontal clay bands, pale brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate medium platy structure in upper 2 inches and moderate fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; few medium pores; thin clay films in root channels; thin clay bands are porous; 30 percent sandstone fragments; strongly acid; clear wavy boundary.

B&A—13 to 24 inches; pale brown (10YR 6/3) very flaggy sandy clay loam, dark brown (10YR 4/3) moist; clay bands and clay balls surrounded by A2 material of light gray (10YR 7/2) sandy loam, dark grayish brown (10YR 4/2) moist; strong fine and very fine blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few medium pores; very thick clay films on undersides of fragments and in root channels; 45 percent sandstone fragments; strongly acid; gradual wavy boundary.

B2t—24 to 60 inches; pale brown (10YR 6/3) very flaggy sandy clay loam, brown (10YR 4/3) moist; strong fine and medium blocky structure; extremely hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; few medium pores; thick continuous clay films on all ped surfaces, on all smaller fragments, and on undersides of larger fragments; clay flow in root channels; about 5 per-

cent A2 material as a very thin coating on ped surfaces and on fragments; 60 percent coarse sandstone fragments; strongly acid; gradual wavy boundary.

IIC—60 to 66 inches; gray (10YR 6/1) very flaggy loam, dark gray (10YR 4/1) moist; massive; extremely hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; few medium pores; 50 percent coarse sandstone fragments; medium acid.

The A horizon and the A&B horizon are 15 to 35 percent rock fragments. The B&A, Bt, and IIC horizons are 35 to 80 percent rock fragments. The A and B horizons are strongly to slightly acid.

200—Tigeron-Loggert complex, 4 to 25 percent slopes. This map unit consists of gently rolling to moderately steep soils on uplands and foot slopes. About 60 percent is Tigeron flaggy sandy loam, and about 25 percent is Loggert extremely stony loam. The Tigeron soil occupies smooth slopes and concave slopes. The Loggert soil is on ridges, knolls, and some convex slopes. About 15 percent of the unit is included areas of Libeg and Monad soils. Also included are small areas where the slope is more than 25 percent. The Tigeron soil has the profile described as typical of the series. The Loggert soil has a profile similar to the one described as typical of the series.

Surface runoff is slow or medium. The erosion hazard is slight from wind and moderate from water.

This unit is used as range and woodland. Forested areas are mainly on the Tigeron soils of 4 to 25 percent slopes. The following woodland interpretations are for the Tigeron and similar soils of 4 to 30 percent slopes.

Lodgepole pine and Douglas-fir are desirable wood-producing species on this unit. Lodgepole pine is the most common.

Unless the stand is overstocked, lodgepole pine can be expected to reach a height of 60 to 66 feet at 100 years of age, and Douglas-fir a height of 40 to 45 feet at 50 years. The estimated volume in a fully stocked stand of lodgepole pine at 100 years is 12,000 to 15,500 board feet, or 5,500 to 6,500 cubic feet.

The erosion hazard, equipment limitation, and windthrow hazard are slight. Seedling mortality is moderate. Plant competition is severe.

Seedling mortality is moderate because of the low available water capacity of the Tigeron soil. Plant competition is severe because of the highly competitive rhizomatous plants and the low available water capacity.

Clearcutting or the seed-tree, shelterwood, or selective systems of harvesting is adapted. Clearcutting favors the regeneration of lodgepole pine. Both lodgepole pine and Douglas-fir are suitable for planting.

Understory species on the Tigeron soil are pinegrass, elk sedge, heartleaf arnica, twinflower, grouse whortle-

berry, white spirea, thinleaf huckleberry, snowberry, princes pine, serviceberry rose, common juniper, and kinnikinnick. Elk sedge, snowberry, and serviceberry have high forage value for cattle, deer, or elk. The rest have low to fair forage value. Forage value depends on the kind of grazing animal and the season of use.

The amount of yield of understory plants is determined not only by soil properties and climatic variations but also by the kind of grazing animal, and the amount of shading by the overstory trees. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, that is, the most preferred plants, are elk sedge, huckleberry, whortleberry, and serviceberry. The rest are increasers, but they too can decrease under continued heavy grazing.

The following tabulation shows the estimated average annual yield, in pounds per acre, of understory plants on Tigeron soils, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total average annual yield.

10-30.....	2,000
30-50.....	1,200
50-70.....	625

It is estimated that 60 percent of the yield is potential feed for grazing animals.

Capability unit VIIe-1 dryland; woodland suitability group 4-1. Loggert soil in Stony range site, 20- to 24-inch precipitation zone. Tigeron soil not assigned to a range site.

Timberg series

The Timberg series consists of moderately deep, well drained soils. These soils formed in shale and siltstone. They are on uplands at elevations of 3,400 to 4,800 feet. They are only 20 to 40 inches deep over shale and siltstone. Slopes are 2 to 40 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark reddish gray silty clay loam about 7 inches thick. The subsoil is weak red, calcareous silty clay loam and silty clay 21 inches thick. The substratum is weak red, calcareous silty clay 7 inches thick. Below 35 inches is pale red, calcareous clay shale.

Permeability is moderately slow. The available water capacity is low or moderate. Reaction is mildly alkaline in the upper 7 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Timberg silty clay loam in cropland, 300 feet west and 600 feet north of southeast corner SW1/4 sec. 26, T. 18 N., R. 5 E.

Ap—0 to 7 inches; dark reddish gray (5YR 4/2) silty clay loam, dark reddish brown (5YR 3/2) moist; strong fine granular structure; hard, friable, sticky, plastic; common fine and very fine roots; mildly alkaline; abrupt wavy boundary.

B2—7 to 12 inches; weak red (2.5YR 5/2) silty clay loam, reddish brown (2.5YR 4/4) moist; strong fine subangular blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few shale fragments; strongly effervescent; moderately alkaline; clear irregular boundary.

B3ca—12 to 28 inches; weak red (10YR 5/2) silty clay, dusky red (10R 3/3) moist; moderate fine and medium blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; few shale fragments; common soft masses of segregated lime; strongly effervescent; moderately alkaline; clear wavy boundary.

C1—28 to 35 inches; weak red (10R 5/2) silty clay, weak red (10R 4/2) moist; massive; extremely hard, very firm, sticky, very plastic; few fine and very fine roots; many fine and very fine pores; few shale fragments; few soft masses of segregated lime; strongly effervescent; strongly alkaline; diffuse wavy boundary.

C2r—35 to 60 inches; pale red (10R 6/2) clay shale, few roots between plates in the upper few inches.

The A horizon is silty clay or silty clay loam. The A and B horizons combined are 18 to 30 inches thick. Depth to shale ranges from 20 to 40 inches. The A and B horizons are mildly alkaline or moderately alkaline. The C horizon is moderately alkaline or strongly alkaline.

201—Timberg silty clay loam, 8 to 15 percent slopes. This strongly rolling soil is on sedimentary uplands. It has the profile described as typical of the series. Included in mapping are a few small areas where the surface layer is gravelly clay loam, a few small areas of Big Timber or Castner soils on convex slopes and ridges, and areas of Fergus soils on concave slopes.

Surface runoff is medium. The erosion hazard is slight from wind and moderate from water.

This soil is suited to wheat, barley, and pasture under dryland management. It is also suited to range. Capability unit IVe-7 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

202—Timberg silty clay, 2 to 10 percent slopes. This undulating to strongly rolling soil is on sedimentary uplands. It has a profile similar to the one described as typical of the series, but the surface layer is mainly silty

clay. Included in mapping are small areas of Big Timber soils on convex slopes and ridges and Terrad soils on concave slopes.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is also suited to range. Capability unit IIIe-9 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

203—Timberg-Big Timber complex, 15 to 40 percent slopes. This map unit consists of hilly to steep soils on sedimentary uplands. About 60 percent is Timberg silty clay, and about 20 percent is Big Timber clay loam. Timberg silty clay is on the smooth and concave slopes. Big Timber clay loam is on the convex slopes, ridges, and knolls. About 15 percent of the unit is included areas of Castner soils, and 5 percent is nearly barren shale and sandstone outcrops along steep slopes.

The Timberg and Big Timber soils have profiles similar to those described as typical of their respective series.

Surface runoff is medium for the Timberg soil and rapid for the Big Timber soil. The erosion hazard is slight from wind and is moderate or severe from water.

This unit is used only for range. Capability unit VIe-1 dryland; windbreak suitability group 4-0. Timberg soil in Clayey range site, 15- to 19-inch precipitation zone. Big Timber soil in Shallow range site, 15- to 19-inch precipitation zone.

204—Timberg-Castner complex, 2 to 10 percent slopes. This map unit consists of undulating to strongly rolling soils on sedimentary uplands. About 60 percent is Timberg silty clay loam, and about 20 percent is Castner channery loam. Timberg silty clay loam occupies the smooth and concave slopes, and Castner channery loam the convex slopes and ridges. About 10 percent of the unit is included areas of Ticell and Bitton soils on convex slopes, and 10 percent is Darrett and Fergus soils on lower slopes and in swales.

Both soils in this unit have profiles similar to those described as typical of their respective series.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This unit is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland; not assigned to a range site. Timberg soil in windbreak suitability group 2M. Castner soil in windbreak suitability group 4-1.

Torex series

The Torex series consists of deep, well drained soils formed in alluvium and loess. These soils occupy terraces and uplands at elevations of 3,300 to 4,200 feet. Slopes are 0 to 6 percent. The native vegetation is

mainly prairie sandreed, little bluestem, Indian ricegrass, and needleandthread. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 42 to 45 degrees F. The frost-free season is 105 to 135 days.

Typically the surface layer is dark grayish brown and grayish brown loamy sand about 24 inches thick. The underlying material is light gray, calcareous very fine sandy loam to a depth of 60 inches or more.

Permeability is rapid to 24 inches and moderate below that depth. The available water capacity is moderate or high. Reaction is mildly alkaline to about 17 inches and moderately alkaline below.

These soils are used for dryland crops, pasture, and range.

Typical profile of Torex loamy sand under cultivation, 1,800 feet east and 1,200 feet south of northwest corner sec. 28, T. 19 N., R. 2 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; very weak subangular blocky structure; slightly hard, very friable, nonsticky, nonplastic; many fine and very fine roots; mildly alkaline; clear wavy boundary.

A12—8 to 17 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky, nonplastic; common fine and very fine roots; many fine and very fine pores; few pebbles; mildly alkaline; clear wavy boundary.

A13—17 to 24 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; soft, very friable, nonsticky, nonplastic; common fine and very fine roots; many fine and very fine pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

IIC—24 to 60 inches; light gray (2.5Y 7/2) very fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky, slightly plastic; few fine and very fine roots; many fine and very fine pores; many fine threads and fine masses of lime; violently effervescent; moderately alkaline.

The Ap horizon is loamy sand or loamy fine sand 6 to 8 inches thick. Depth to the very fine sandy loam or silt loam material ranges between 20 and 40 inches. The A horizon is neutral to moderately alkaline.

205—Torex loamy sand, 0 to 6 percent slopes. This nearly level to gently rolling soil occupies terraces and uplands. It has the profile described as typical of the series. Included in mapping are areas where the surface layer is loamy fine sand and small areas of Ervide and Lihen soils.

Surface runoff is slow. The erosion hazard is severe from wind but is only slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-1 dryland; Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

Turner series

The Turner series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and fans at elevations of 3,500 to 4,600 feet. They are only 24 to 40 inches deep over sand and gravel. Slopes are 0 to 4 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark gray loam about 5 inches thick. The subsoil is brown clay loam 11 inches thick. The substratum is very pale brown gravelly loam about 20 inches thick. Light brownish gray very gravelly loamy coarse sand extends to a depth of 60 inches or more. The soil is calcareous below a depth of 12 inches.

Permeability is moderate to a depth of about 36 inches and is rapid below. The available water capacity is low. Reaction is slightly acid in the upper 5 inches, neutral to 12 inches, and mildly or moderately alkaline to 60 inches.

These soils are mainly used for dryland crops.

Typical profile of Turner loam in cropland, 530 feet west and 1,060 feet north of southeast corner SW1/4 sec. 17, T. 19 N., R. 7 E.

Ap—0 to 5 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, friable, sticky, plastic; many fine and very fine roots; slightly acid; abrupt wavy boundary.

B2t—5 to 12 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong medium and fine blocky; hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; thin continuous clay films on all ped surfaces; neutral; clear wavy boundary.

B3—12 to 16 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong fine and very fine blocky; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin patchy clay films on vertical faces of peds; few pebbles; slightly effervescent; mildly alkaline; clear wavy boundary.

C1ca—16 to 36 inches; very pale brown (10YR 7/3) gravelly loam, brown (10YR 5/3) moist; strong fine and very fine subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; 25 percent

gravel size rock fragments; strongly effervescent; moderately alkaline; clear wavy boundary.

IIC2—36 to 60 inches; light brownish gray (2.5Y 6/2) very gravelly loamy coarse sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky, nonplastic; 40 percent pebbles; strongly effervescent; mildly alkaline.

Thickness of the noncalcareous A and B horizons combined is 11 to 16 inches. The B2t horizon is clay loam or sandy clay loam. Depth to the coarse textured underlying material ranges from 24 to 40 inches. The soil is 1 to 15 percent coarse fragments in the upper horizons and 40 percent or more below 24 to 40 inches. Reaction is slightly acid or neutral in the A horizon, neutral to mildly alkaline in the B2t horizon, and mildly or moderately alkaline below.

206—Turner loam, 0 to 4 percent slopes. This nearly level to gently sloping soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small areas of Fairfield and Judith soils and small convex areas of a gravelly loam.

Surface runoff is slow. The hazard of wind and water erosion is slight or moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIs-1 dryland; windbreak suitability group 3M; not assigned to a range site.

Twin Creek series

The Twin Creek series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,000 feet. Slopes are 0 to 8 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 19 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is brown loam about 7 inches thick. The subsoil is brown loam 18 inches thick. The substratum is pinkish gray loam and reddish brown clay loam to a depth of 60 inches or more. The soil is calcareous below a depth of 13 inches.

Permeability is moderate. The available water capacity is high. Reaction is neutral to a depth of 13 inches and moderately or strongly alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Twin Creek loam in cropland, 1,320 feet north and 1,000 feet east of southwest corner sec. 16, T. 18 N., R. 7 E.

- Ap—0 to 7 inches; brown (7.5YR 4/2) loam, very dark brown (7.5YR 2/2) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; neutral; abrupt wavy boundary.
- B21—7 to 13 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate medium and coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores, few medium pores; neutral; clear wavy boundary.
- B22—13 to 19 inches; brown (7.5YR 5/2) loam, brown (7.5YR 4/2) moist; moderate medium and coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores, few medium pores; slightly effervescent; moderately alkaline; clear wavy boundary.
- B23ca—19 to 25 inches; brown (7.5YR 5/2) loam, brown (7.5YR 4/2) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; few fine and very fine roots; many fine and very fine pores, few medium pores; common fine soft masses of segregated lime; strongly effervescent; moderately alkaline; clear wavy boundary.
- C1ca—25 to 45 inches; pinkish gray (7.5YR 6/2) loam, brown (7.5YR 4/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few fine and very fine roots; common fine and very fine pores; many fine soft masses and threads of segregated lime; strongly effervescent; strongly alkaline; gradual wavy boundary.
- C2—45 to 60 inches; reddish brown (5YR 5/3) clay loam, dark reddish brown (5YR 3/3) moist; massive; hard, friable, sticky, plastic; strongly effervescent; moderately alkaline.

The A horizon is loam or silty clay loam. The B and C horizons are loam or clay loam. The noncalcareous part of the soil is 10 to 20 inches thick. Rock fragments range from a few sandstone fragments to about 10 percent by volume throughout the soil.

207—Twin Creek loam, 2 to 8 percent slopes. This gently sloping to moderately sloping soil occupies terraces, fans, and foot slopes. It has the profile described as typical of the series. Included in mapping are small areas where slopes are less than 2 percent or more than 8 percent, areas where the surface layer is gravelly loam, and small areas of Fergus and Straw soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-4 dryland;

windbreak suitability group 1; not assigned to a range site.

208—Twin Creek silty clay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces. It has a profile similar to the one described as typical of the series, but the surface layer is silty clay loam. Included in mapping are a few small concave areas of silty clay and small areas of Fergus and Straw soils.

Surface runoff is slow. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. Capability unit IIIe-1 dryland; windbreak suitability group 1; not assigned to a range site.

Vanda series

The Vanda series consists of deep, well drained soils formed in alluvium. These soils occupy terraces and fans at elevations of 3,300 to 3,600 feet. Slopes are 0 to 2 percent. The native vegetation is mainly western wheatgrass, alkaligrass, Nuttall alkaligrass, saltgrass, greasewood, and forbs. The mean annual precipitation is 10 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous clay about 4 inches thick. The underlying material is light brownish gray, calcareous clay to a depth of 60 inches or more.

Permeability is very slow. The available water capacity is low or moderate. Reaction is strongly alkaline to a depth of 12 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Vanda clay in cropland, 800 feet north and 50 feet west of southeast corner sec. 8, T. 21 N., R. 2 E.

Ap—0 to 4 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; a 3-5 millimeter massive crust over weak very fine granular structure; very hard, friable, very sticky, very plastic; common very fine roots; many fine and very fine vesicular pores; slightly effervescent; strongly alkaline; abrupt wavy boundary.

C1—4 to 12 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, firm, very sticky, very plastic; common fine and very fine roots; common fine and very fine pores; slightly effervescent; strongly alkaline; clear wavy boundary.

C2—12 to 60 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, firm, very sticky, very plastic; few fine and very fine roots; common fine and very fine

pores; many fine and medium masses of gypsum; slightly effervescent; moderately alkaline.

Depth to segregated gypsum is 11 to 24 inches. Reaction is moderately alkaline or strongly alkaline.

209—Vanda clay. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Slopes are 0 to 2 percent. Included in mapping are a few small areas of Marvan and McKenzie soils.

Surface runoff is rapid. The erosion hazard is slight from wind and water.

This soil is suited to range. Capability unit VIs-1 dryland; Saline Upland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-3.

210—Vanda clay, wet. This nearly level soil occupies low terraces and bottoms adjacent to drainageways. It has a profile similar to the one described as typical of the series, but the seasonal high water is within a depth of 24 inches during the irrigation season. Slopes are 0 to 2 percent. Included in mapping are small areas of Lallie and Marvan clay, wet, soils.

Surface runoff is rapid. The erosion hazard is slight from wind and water.

This soil is suited to range. Capability unit VIIw-1 dryland; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-5.

Virgelle series

The Virgelle series consists of deep, well drained soils formed in alluvium. These soils occupy terraces at elevations of 3,300 to 3,600 feet. Slopes are 0 to 3 percent. The native vegetation is mainly prairie sandreed, needleandthread, and Indian ricegrass. The mean annual precipitation is 14 to 19 inches. The mean annual air temperature is 42 to 45 degrees F. The frost-free season is 105 to 135 days.

Typically the surface layer is gray and grayish brown loamy fine sand about 21 inches thick. The underlying material is light brownish gray, calcareous loamy fine sand in the upper 11 inches, and light gray, calcareous stratified clay loam and silty clay loam to a depth of 60 inches or more.

Permeability is rapid to about 32 inches and very slow below. The available water capacity is moderate. Reaction is neutral or mildly alkaline to a depth of 21 inches, moderately alkaline to 32 inches, and very strongly alkaline below.

These soils are used for irrigated crops, dryland crops, pasture, and range.

Typical profile of Virgelle loamy fine sand in native grass, 440 feet east and 1,420 feet south of northwest corner sec. 18, T. 19 N., R. 2 E.

A11—0 to 11 inches; gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak medium and coarse subangular blocky structure parting to single grain; soft, very friable, nonsticky, nonplastic; many fine and medium roots; neutral; gradual wavy boundary.

A12—11 to 21 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky, nonplastic; many fine and very fine roots, few medium roots; many fine and very fine pores, few medium pores; mildly alkaline; clear wavy boundary.

C1ca—21 to 32 inches; light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, nonsticky, nonplastic; few fine and very fine roots; common fine and very fine pores; strongly effervescent; moderately alkaline; clear wavy boundary.

IIC2cs—32 to 60 inches; light gray (2.5Y 7/2) stratified clay loam and silty clay loam, grayish brown (2.5Y 5/2) moist; massive; very hard, friable, sticky, plastic; few fine and very fine roots; common fine and very fine pores; common fine and medium threads and masses of lime and other salts; strongly effervescent; very strongly alkaline.

The A horizon is loamy fine sand or loamy sand. Depth to the IIC horizon ranges between 20 and 40 inches. The reaction is neutral or mildly alkaline in the A horizon, mildly or moderately alkaline in the C horizon, and strongly alkaline to very strongly alkaline in the IIC horizon.

211—Virgelle loamy fine sand, 0 to 2 percent slopes. This nearly level soil occupies terraces. It has the profile described as typical of the series. Included in mapping are areas where the surface layer is loamy sand and small areas of Tally and Yetull soils.

Surface runoff is slow. The erosion hazard is severe from wind and is slight from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IVe-1 dryland, IVe-1 irrigated; Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

212—Virgelle-Absher complex, 0 to 3 percent slopes. This map unit consists of nearly level and undulating soils on terraces and fans. It is about 55 percent Virgelle loamy fine sand and 30 percent Absher clay loam. Virgelle loamy fine sand occupies the smooth slopes and convex areas. Absher clay loam occupies shallow depressions. About 15 percent of the unit is included areas of Tally and Lennep soils and small areas where slopes are more than 3 percent.

The Virgelle soil has a profile similar to the one described as typical of the Virgelle series. The Absher soil

has a profile similar to the one described as typical of the Absher series.

Surface runoff is slow. The erosion hazard is severe from wind and is slight from water.

Soils in this unit are suited to wheat, barley, hay, and pasture under dryland management. They are also suited to range. Capability unit IVs-1 dryland. Virgelle soil in Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M. Absher soil in Dense Clay range site, 15- to 19-inch precipitation zone; windbreak suitability group 3S.

Wabek series

The Wabek series consists of deep, excessively drained soils formed in alluvium. These soils occupy terraces, fans, and uplands at elevations of 3,350 to 4,300 feet. Slopes are 2 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, prairie sandreed, green needlegrass, and forbs and shrubs. The mean annual precipitation is 12 to 16 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is dark grayish brown and grayish brown gravelly loam 10 inches thick. The underlying material is light gray extremely gravelly loamy sand and light brownish gray extremely gravelly loamy coarse sand to a depth of 60 inches or more.

Permeability is rapid. The available water capacity is very low. Reaction is mildly alkaline in the upper 10 inches and moderately alkaline below.

These soils are mainly used for range. Some areas are used for irrigated crops.

Typical profile of Wabek gravelly loam, 2 to 15 percent slopes, in native grass, 450 feet east and 4 feet south of northwest corner NE1/4 sec. 20, T. 19 N., R. 2 E.

A11—0 to 7 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; 25 percent gravel and cobbles; slightly effervescent; mildly alkaline; clear wavy boundary.

A12—7 to 10 inches; grayish brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky, nonplastic; common fine and very fine roots; 25 percent rock fragments; slightly effervescent; mildly alkaline; clear wavy boundary.

IIC1ca—10 to 25 inches; light gray (10YR 7/2) extremely gravelly loamy sand, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable, nonsticky, nonplastic; common fine and very fine roots; 70 percent rock fragments; violently effervescent; moderately alkaline; gradual wavy boundary.

IIC2—25 to 60 inches; light brownish gray (10YR 6/2) extremely gravelly loamy coarse sand, grayish brown (10YR 5/2) moist; single grain; loose, nonsticky, nonplastic; lime crusts on undersides of coarse fragments; 75 percent rock fragments; strongly effervescent; moderately alkaline.

Below a depth of 10 inches, the soil is 50 to 80 percent rock fragments of gravel and cobbles. The A horizon is neutral or mildly alkaline. The C horizon is mildly or moderately alkaline.

213—Wabek gravelly loam, 2 to 15 percent slopes.

This undulating to rolling soil occupies terraces, terrace edges, and uplands. It has the profile described as typical of the series. Included in mapping are a few areas where slopes are less than 2 percent or more than 15 percent, areas where the surface layer and underlying material are clay loam or loam, and small areas of sandy Tally and Ervide soils.

Surface runoff is slow. The erosion hazard is slight from wind and water.

This soil is best suited to range. Capability unit VIs-1 dryland; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Waybe series

The Waybe series consists of shallow, well drained soils formed in material weathered from silty shales of mixed minerals. These soils occupy uplands at elevations of 4,500 to 6,000 feet. They are only 10 to 20 inches deep over soft shale. Slopes are 20 to 65 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, Columbia needlegrass, and forbs and shrubs. The mean annual precipitation is 15 to 24 inches. The mean annual temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the surface layer is light brownish gray clay loam about 5 inches thick. The underlying material is light gray silty clay loam that is about 13 inches thick over shale.

Permeability is slow. The available water capacity is very low. Reaction is moderately alkaline.

These soils are used mainly for range.

Typical profile of Waybe clay loam in native grass, 225 feet south and 50 feet east of northwest corner NE1/4 sec. 15, T. 16 N., R. 7 E.

A1—0 to 5 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak thin platy parting to moderate fine granular structure; slightly hard, friable, sticky, plastic; many very fine roots; many very fine pores; strongly effervescent; moderately alkaline; clear wavy boundary.

C1—5 to 12 inches; light gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) moist; strong very fine blocky

structure; slightly hard, friable, sticky, plastic; common very fine roots; many very fine pores; strongly effervescent; moderately alkaline; clear wavy boundary.

C2—12 to 18 inches; light gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; weak medium to very thick platy structure; hard, friable, sticky, plastic; few very fine roots; common very fine pores; 40 percent soft shale fragments; violently effervescent; moderately alkaline; gradual smooth boundary.

C3r—18 to 60 inches; white (5Y 8/2) shale of silty clay loam texture.

Depth to shale ranges from 10 to 20 inches. The A horizon is clay loam or stony clay loam that is mildly to moderately alkaline. The C2 horizon is 30 to 70 percent by volume soft shale fragments of silty clay loam texture.

214—Waybe-Bynum clay loams, 20 to 50 percent slopes. This map unit consists of hilly to very steep soils on sedimentary uplands. About 60 percent is Waybe clay loam, and about 25 percent is Bynum clay loam. Waybe clay loam occupies the upper part of the slopes and the convex areas. Bynum clay loam occupies concave slopes. Included in mapping are about 15 percent of nearly barren limy shale and limestone outcrops. The Waybe soil has the profile described as typical of the Waybe series. The Bynum soil has the profile described as typical of the Bynum series.

Surface runoff is rapid on the Waybe soil and medium on the Bynum soil. The erosion hazard on the Waybe soil is slight from wind and severe from water. The erosion hazard on the Bynum soil is slight from wind and severe from water.

This unit is used as range. Some areas are woodland.

Forested areas are mainly on the Bynum clay loams. Small areas on north-facing slopes are stands of Douglas-fir and ponderosa pine. The following woodland interpretations are for the Bynum soils of 20 to 50 percent slopes.

Douglas-fir is the most common species on this unit. There is very little lodgepole pine or ponderosa pine. Douglas-fir has a distinct competitive advantage over the species normally associated with it.

Unless the stand is overstocked, Douglas-fir can be expected to reach a height of 30 to 35 feet at 50 years of age. The estimated volume per acre in a fully stocked stand of Douglas-fir at 100 years is 11,000 to 12,000 board feet or 3,600 to 3,900 cubic feet.

The erosion hazard and equipment limitation are moderate on the 20 to 30 percent slopes and severe on the 30 to 50 percent slopes. Seedling mortality is slight. Plant competition is severe. The windthrow hazard is moderate.

The erosion hazard is moderate to severe as a result of the 20 to 50 percent slopes and the clay loam surface texture. The equipment limitation is moderate to severe

because of the slope, the poor trafficability, and the susceptibility to soil compaction during wet periods. Slumping is also a hazard when the soils are wet. Plant competition is severe because of the competition from rhizomatous understory grasses and other plants. The windthrow hazard is moderate because of the high tree basal areas carried on these soils, the long period the soils are moist, and the somewhat restricted rooting depth.

The selective and shelterwood systems of harvest are well adapted if trees are healthy. Douglas-fir is suggested for planting.

Understory plants on the Bynum soil are elk sedge, rose sedge, pinegrass, false Solomons-seal, wintergreen, meadow rue, bedstraw, twinflower, snowberry, common juniper, Oregon-grape, white spirea, mountain maple, rose, and aspen. The sedges, snowberry, and Oregon-grape have high forage value for cattle, deer, or elk. The rest have low to fair forage value. Forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants are determined not only by soil properties and climatic variations but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading by overstory trees. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, that is, the most preferred plants, are sedges, snowberry, and Oregon-grape. The other plants are increasers, but they too can decrease under continued heavy grazing.

The following tabulation shows the estimated average annual air-dry yield, in pounds per acre, of understory plants on Bynum soils, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total average annual yield.

10-30.....	2,000
30-50.....	1,200
50-70.....	625

It is estimated that 60 percent of the yield is potential feed for grazing animals.

Capability unit VIIe-1 dryland; windbreak suitability group 4-0. Waybe soil in Shallow range site, 20- to 24-inch precipitation zone. Bynum soil in Clayey range site, 20- to 24-inch precipitation zone.

215—Waybe-Rock outcrop complex, 20 to 65 percent slopes. This moderately steep and very steep map unit is on dissected uplands. About 50 percent is Waybe stony clay loam and 20 percent outcrop of limestone and sandstone. Waybe stony clay loam occupies smooth and convex slopes. The rock crops out on the long ledges of very steep slopes, on the crests of slopes, and along deep drainageways. About 15 percent of the unit is included areas of Cheadle stony loam, and about 15 percent is Libeg and Bridger soils.

The Waybe soil has a profile similar to the one described as typical of the series.

Surface runoff is rapid. The erosion hazard is slight from wind and is severe from water.

Soils in this unit are used for range. Capability unit Vllc-1 dryland; Waybe soil in Shallow range site, 20- to 24-inch precipitation zone; windbreak suitability group 4-0.

Whitore series

The Whitore series consists of deep, well drained soils formed in alluvium derived mainly from limestone. These soils occupy uplands and foot slopes of mountains at elevations of 4,800 to 5,500 feet. Slopes are 15 to 65 percent. The native vegetation is mainly Douglas-fir, lodgepole pine, and ponderosa pine. The mean annual precipitation is 19 to 24 inches. The mean annual air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the 2-inch grayish brown silt loam surface layer is covered with a 1-inch mat of twigs, needles, and cones. The subsoil is brown silty clay loam and pale brown very channery silty clay loam about 16 inches thick. The substratum is calcareous light brownish gray and light gray very channery silty clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is low or moderate. Reaction is neutral to a depth of 9 inches and mildly alkaline or moderately alkaline below.

These soils are mainly used as woodland and range.

Typical profile of Whitore silty clay loam in forest, 1,300 feet south and 350 feet east of northwest corner sec. 16, T. 16 N., R. 6 E.

O—1 inch to 0; forest litter of undecomposed and partly decomposed needles, twigs, and cones.

A2—0 to 2 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; hard, friable, slightly sticky, plastic; many fine roots; many fine pores; 10 percent limestone fragments; neutral; abrupt smooth boundary.

B21—2 to 5 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak fine blocky structure; hard, friable, sticky, plastic; many fine roots; many fine pores; with coats of very dark grayish brown (10YR 3/2) moist; 10 percent limestone fragments; neutral; clear smooth boundary.

B22—5 to 9 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak very fine blocky structure; hard, friable, sticky, plastic; many fine roots; many fine pores; with coats of very dark grayish brown (10YR 3/2) moist; 10 percent limestone fragments; neutral; clear smooth boundary.

B3—9 to 18 inches; pale brown (10YR 6/3) very channery silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine blocky structure; hard, friable,

sticky, plastic; many fine roots; many fine pores; 35 percent limestone fragments; slightly effervescent; mildly alkaline; clear wavy boundary.

C1ca—18 to 26 inches; light brownish gray (2.5Y 6/2) very channery silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, sticky, plastic; common fine roots; common fine pores; 45 percent limestone fragments; few threads of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2ca—26 to 60 inches; light gray (2.5Y 7/2) very channery silty clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky, plastic; common roots; 50 percent limestone fragments; many fine masses of lime; strongly effervescent; moderately alkaline.

The depth to the calcic horizon ranges from 7 to 18 inches. The volume of coarse fragments ranges from 5 to 20 percent in the upper 9 inches of the soil and from 35 to 80 percent between 9 and 60 inches.

216—Whitore silty clay loam, 15 to 65 percent slopes. This moderately steep to very steep soil occupies foot slopes and uplands. It has the profile described as typical of the Whitore series. Included in mapping are small areas of limestone outcrop on ridges and convex slopes, small areas on concave slopes where this soil is only 20 to 40 inches deep over shale, areas of Sheege and Skaggs soils, and small areas of the Whitore soil where slopes are less than 15 percent.

Surface runoff is medium or rapid. The erosion hazard is slight from wind and severe from water.

This soil is used as woodland and native pasture.

Forested areas are chiefly on the Whitore silty clay loams. The following woodland interpretations are for Whitore silty clay loams of 4 to 65 percent slopes.

Douglas-fir is the most common species on this unit. There is very little lodgepole pine or ponderosa pine. At high elevations, limber pine is a minor component of the Douglas-fir stands. On these soils, Douglas-fir has a distinct competitive advantage over species normally associated with it.

Unless the stand is overstocked, Douglas-fir can be expected to reach a height of 36 to 45 feet at 50 years of age. The estimated volume per acre in a fully stocked stand of Douglas-fir at 100 years is 13,000 to 19,000 board feet or 3,900 to 5,700 cubic feet.

The erosion hazard is slight on 4 to 30 percent slopes and moderate on 30 to 60 percent slopes. The equipment limitation is slight on 4 to 30 percent slopes and moderate on 30 to 65 percent slopes. Seedling mortality is slight. Plant competition is severe. The windthrow hazard is slight.

The erosion hazard and equipment limitation are moderate because of the 30 to 60 percent slopes. Plant competition is severe because of the competition from

rhizomatous understory grasses and other understory plants and the moderate to low available water capacity.

The selective and shelterwood systems of harvest are well adapted if trees are healthy. Douglas-fir is suggested for planting.

Understory plants on Whitore soils are elk sedge, rose sedge, pinegrass, false Solomons-seal, wintergreen, meadow rue, bedstraw, twinflower, snowberry, common juniper, Oregon-grape, white spirea, mountain maple, rose, and aspen. The sedges, snowberry, and Oregon-grape have high forage value for cattle, deer, or elk. The rest have low to fair forage value. Forage value depends on the kind of grazing animal and the season of use.

The amount and kind of yield of understory plants is determined not only by soil properties and climatic variations but also by the time of grazing and its intensity, the kind of grazing animal, and the amount of shading by overstory trees. The fewer the trees, the more abundant the growth of understory plants.

Plants that decrease in abundance under close grazing, that is the most preferred plants, are sedges, snowberry, and Oregon-grape. The other plants are increasers, but they too can be expected to decrease under continued heavy grazing.

The following tabulation shows the estimated average annual air-dry yield, in pounds per acre, of understory plants on Whitore soils, under limited grazing impact or other disturbance, under specified canopy classes. The first column lists percentage of crown cover, and the second column lists total average annual yield.

10-30.....	2,000
30-50.....	1,200
50-70.....	625

It is estimated that 60 percent of the yield is potential feed for grazing animals. Capability unit VIIe-1 dryland; Silty range site, 20- to 24-inch precipitation zone; wind-break suitability group 4-0.

Winifred series

The Winifred series consists of moderately deep, well drained soils formed in material weathered from shale. These soils occupy uplands at elevations of 3,500 to 4,800 feet. Shale is at depths of 20 to 40 inches. Slopes are 2 to 35 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, forbs, and shrubs. The mean annual precipitation is 15 to 17 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 130 days.

Typically the surface layer is gray and dark gray clay loam about 7 inches thick. The subsoil is grayish brown and light olive gray, calcareous silty clay 20 inches thick. The substratum is light gray, calcareous silty clay 9 inches thick. Below 36 inches is silty clay shale.

Permeability is slow. The available water capacity is low or very low. Reaction is neutral in the upper 7 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Winifred clay loam, 8 to 15 percent slopes, in native grass, 500 feet east and 120 feet south of northwest corner sec. 16, T. 18 N., R. 2 W.

A11—0 to 3 inches; gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) moist; moderate very fine platy structure parting to moderate very fine granular; hard, friable, sticky, plastic; many fine and very fine roots, few medium roots; neutral; clear smooth boundary.

A12—3 to 7 inches; dark gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; strong very fine and fine blocky structure; very hard, friable, sticky, plastic; many fine and very fine roots, few medium roots; many fine and very fine pores, few medium pores; neutral; clear wavy boundary.

B2—7 to 16 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to strong very fine blocky; extremely hard, friable, sticky, plastic; common fine and very fine roots, few medium roots; many fine and very fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

B3ca—16 to 27 inches; light olive gray (5Y 6/2) silty clay, olive gray (5Y 5/2) moist; moderate medium prismatic structure parting to moderate medium blocky; extremely hard, firm, sticky, plastic; common fine and very fine roots; many very fine pores, common fine pores; common fine and medium soft masses of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—27 to 36 inches; light gray (5Y 7/2) silty clay, olive gray (5Y 5/2) moist; moderate medium and coarse prismatic structure parting to moderate coarse blocky; extremely hard, firm, sticky, plastic; few fine and very fine roots with more roots along prism surfaces; common fine and medium masses of segregated lime; strongly effervescent; moderately alkaline; diffuse smooth boundary.

C2r—36 to 46 inches; light gray (5Y 7/2) silty clay shale.

The depth to shale ranges from 20 to 40 inches. The thickness of the A and B horizons combined ranges from 15 to 30 inches. The A horizon is neutral or mildly alkaline. The B and C horizons are moderately or strongly alkaline.

217—Winifred clay loam, 2 to 8 percent slopes. This undulating and gently rolling soil occupies sedimentary uplands. Included in mapping are small areas of Castner and Work soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range.

Capability unit IIIe-9 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

218—Winifred clay loam, 8 to 15 percent slopes.

This strongly rolling soil occupies sedimentary uplands. It has the profile described as typical of the series. Included in mapping are small areas of Eltsac, Castner, and Work soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-7 dryland; Clayey range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

219—Winifred-Yawdim clay loams, 15 to 50 percent slopes. This map unit consists of hilly and steep soils on uplands. About 65 percent is Winifred clay loam, and about 20 percent is Yawdim clay loam. Winifred clay loam is on smooth slopes and in concave areas. Yawdim silty clay loam occupies convex slopes, ridges, and knolls. About 15 percent of this unit is included areas of Eltsac and Work soils and a few small saline areas.

The Winifred and Yawdim soils in this unit have profiles similar to those described as typical of their respective series.

Surface runoff is medium or rapid. The erosion hazard is slight from wind but is severe from water.

This unit is used mainly for range. Capability unit VIe-1 dryland; windbreak suitability group 4-0. Winifred soil in Clayey range site, 15- to 19-inch precipitation zone. Yawdim soil in Shallow range site, 15- to 19-inch precipitation zone.

Woosley series

The Woosley series consists of moderately deep, well drained soils. These soils formed in material weathered from limestone. They occupy uplands and foot slopes at elevations of 4,800 to 6,000 feet. They are only 20 to 40 inches deep over limestone. Slopes are 2 to 20 percent. The native vegetation is mainly rough fescue, Richardson needlegrass, mountain brome, forbs, and shrubs. The mean annual precipitation is 20 to 24 inches. The mean air temperature is 38 to 42 degrees F. The growing season is 60 to 90 days.

Typically the surface layer is very dark gray silt loam about 7 inches thick. The upper 14 inches of the subsoil is dark grayish brown and brown silty clay loam. The lower 13 inches is light gray, calcareous gravelly clay loam. Below 34 inches is limestone bedrock.

Permeability is moderate. The available water capacity is low or moderate. Reaction is neutral to a depth of 21 inches and moderately alkaline below.

Woosley soils are mainly used for dryland crops and range.

Typical profile of Woosley silt loam in cropland, 1,320 feet west and 300 feet south of northeast corner sec. 21, T. 16 N., R. 7 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; moderate fine subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; neutral; clear smooth boundary.

B1—7 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; few limestone fragments; neutral; clear wavy boundary.

B21t—11 to 14 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine and medium blocky; slightly hard, very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; thin continuous clay films on ped surfaces; few limestone fragments; neutral; clear wavy boundary.

B22t—14 to 21 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate fine and medium blocky; slightly hard, very friable, slightly sticky, slightly plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on ped surfaces; few limestone fragments; neutral; gradual wavy boundary.

B3ca—21 to 34 inches; light gray (2.5Y 7/2) gravelly clay loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; few fine and very fine roots; common fine and very fine pores; 15 percent coarse limestone fragments; violently effervescent; moderately alkaline; gradual wavy boundary.

R—34 inches; hard fractured limestone bedrock.

Thickness of the noncalcareous A and B horizons combined ranges from 15 to 28 inches. Depth to bedrock is 20 to 40 inches. The noncalcareous A horizon is slightly acid or neutral. The upper part of the B horizon is neutral or mildly alkaline. The lower part of the B horizon and the C horizon are mildly or moderately alkaline.

220—Woosley silt loam, 2 to 10 percent slopes.

This undulating and strongly rolling soil occupies uplands and foot slopes. It has the profile described as typical of the series. Included in mapping are a few small areas

where the surface layer is stony loam and small areas of Skaggs and Bridger soils.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVc-1 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 2M.

221—Woosley silt loam, 10 to 20 percent slopes.

This strongly rolling and moderately steep soil occupies uplands and foot slopes. Included in mapping are a few small areas where slopes are less than 10 percent, small areas where the surface layer is stony loam, and small areas of Skaggs and Sheege soils on convex slopes and ridges.

Surface runoff is medium. The erosion hazard is slight from wind and is moderate from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-5 dryland; Silty range site, 20- to 24-inch precipitation zone; windbreak suitability group 2M if slope is less than 15 percent, group 4-0 if more than 15 percent.

Work series

The Work series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,600 feet. Slopes are 0 to 35 percent. The native vegetation is mainly rough fescue, bluebunch wheatgrass, green needlegrass, and forbs and shrubs. The mean annual precipitation is 14 to 18 inches. The mean annual air temperature is 42 to 45 degrees F. The growing season is 105 to 130 days.

Typically the surface layer is dark gray clay loam about 6 inches thick. The subsoil is brown, pale brown, and very pale brown clay loam and cobbly clay loam 26 inches thick. It is calcareous in the lower part. The substratum is very pale brown, calcareous stony clay loam 15 inches thick. Below this to a depth of 67 inches or more is very pale brown, calcareous extremely stony sandy loam.

Permeability is moderately slow. The available water capacity is moderate or high. Reaction is slightly acid to a depth of 15 inches, neutral to 22 inches, moderately alkaline to 47 inches, and strongly alkaline to 67 inches.

These soils are mainly used for dryland crops and range.

Typical profile of Work loam in native grass, 4,260 feet south and 60 feet east of northwest corner NE1/4 sec. 3, T. 17 N., R. 5 E.

A1—0 to 6 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; weak fine platy structure parting to moderate fine and medium granular; hard,

very friable, slightly sticky, slightly plastic; many fine and very fine roots; many fine and very fine pores; less than 5 percent sandstone fragments; slightly acid; clear wavy boundary.

B1—6 to 10 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; strong very fine subangular blocky structure; very hard, friable, sticky, plastic; many fine and very fine roots; many fine and very fine pores; less than 5 percent sandstone fragments; slightly acid; clear wavy boundary.

B21t—10 to 15 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; strong fine and very fine blocky structure; very hard, friable, very sticky, very plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on all ped surfaces; five percent sandstone fragments; slightly acid; gradual wavy boundary.

B22t—15 to 22 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; strong fine and medium blocky structure; very hard, friable, sticky, plastic; common fine and very fine roots; many fine and very fine pores; thin continuous clay films on all ped surfaces; 10 percent sandstone fragments; neutral; abrupt wavy boundary.

B3ca—22 to 32 inches; very pale brown (10YR 7/3) cobbly clay loam, brown (10YR 5/3) moist; moderate medium and coarse blocky structure; hard, friable, sticky, plastic; few fine and very fine roots; many fine and very fine pores; 20 percent sandstone fragments with lime coatings; common fine soft masses and threads of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1ca—32 to 47 inches; very pale brown (10YR 7/3) stony clay loam, brown (10YR 5/3) moist; moderate medium platy structure; hard, friable, sticky, plastic; few fine and very fine pores; 25 percent stone size sandstone fragments; common fine soft masses and few fine threads of segregated lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2—47 to 67 inches; very pale brown (10YR 7/4) extremely stony sandy loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, slightly sticky, nonplastic; 75 percent stone-sized sandstone fragments; strongly effervescent; strongly alkaline.

The A horizon is clay loam, loam, or stony loam. Thickness of the noncalcareous A and B horizons combined ranges from 12 to 26 inches. The B2t horizon ranges from clay loam to light clay. Gravel content ranges from 0 to 15 percent in the upper 22 inches. The A horizon is slightly acid to neutral. The B horizon ranges from slightly acid to moderately alkaline.

222—Work clay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces. It has a profile similar

to the one described as typical of the series, but the underlying material between 30 and 40 inches is mainly stratified sandy loam and loam. Included in mapping are a few small areas along drainageways and terrace edges where slopes are more than 2 percent and small areas of Dooley and Harlem soils.

Surface runoff is slow. The erosion hazard is moderate from wind and slight from water.

This soil is well suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit Ille-3 dryland, IIs-3 irrigated; windbreak suitability group 1; not assigned to a range site.

223—Work clay loam, 2 to 4 percent slopes. This gently sloping soil occupies terraces, fans, and foot slopes. Included in mapping are a few small areas of Farnuf and Absarokee soils.

Surface runoff is medium. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit Ille-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

224—Work clay loam, 4 to 8 percent slopes. This moderately sloping soil occupies terraces, fans, and foot slopes. It has the profile described as typical of the series. Included in mapping are a few small areas of Absarokee and Farnuf soils.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit Ille-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

225—Work clay loam, 8 to 15 percent slopes. This strongly sloping soil occupies fans and foot slopes. Included in mapping are a few small areas of Roy and Farnuf soils.

Surface runoff is medium. The erosion hazard is moderate from wind and is moderate or severe from water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-4 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 1.

226—Work complex, 8 to 35 percent slopes. This map unit consists of strongly rolling to steep soils on foot slopes and fans. About 30 percent is Work loam, and 30 percent is Work stony loam. About 40 percent of the unit is included areas of Castner, Shawa, and Roy soils. Work loam and Work stony loam occupy smooth slopes and concave positions. Castner stony loam occupies the convex bench edges. Shawa loam and Roy stony loam occupy foot slopes and swales.

The Work soils have a profile similar to the one described as typical of the series, but the surface layer is loam or stony loam.

Surface runoff is medium. The erosion hazard is moderate from wind but is moderate or severe from water.

This unit is suited to range. Capability unit VIe-1 dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4-0.

Yamac series

The Yamac series consists of deep, well drained soils formed in alluvium. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 4,000 feet. Slopes are 0 to 15 percent. The native vegetation is mainly bluebunch wheatgrass, green needlegrass, Canby bluegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous clay loam about 8 inches thick. The subsoil is light brownish gray, calcareous clay loam and loam 20 inches thick. The substratum is light brownish gray, calcareous, stratified fine sandy loam and loam in the upper 18 inches. It is clay loam to a depth of 60 inches or more.

Permeability is moderate. The available water capacity is high. Reaction is moderately alkaline.

These soils are mainly used for dryland crops and range. Some areas are irrigated.

Typical profile of Yamac clay loam, 0 to 2 percent slopes, in cropland, 1,800 feet west and 500 feet south of northeast corner sec. 14, T. 20 N., R. 3 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate fine and very fine subangular blocky structure; very hard, friable, sticky, plastic; many fine and very fine pores; slightly effervescent; moderately alkaline; abrupt wavy boundary.

B2—8 to 17 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to weak medium and fine subangular blocky; very hard, friable, sticky, plastic; many fine and very fine pores, few medium and coarse pores; few fine masses and threads of segregated lime; strongly effervescent; moderately alkaline; clear irregular boundary.

B3ca—17 to 28 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; moderate medium and coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, sticky, plastic; many fine and very fine pores, few medium and coarse pores; common fine and medium soft masses and threads of segregated lime; strongly effervescent; moderately alkaline; abrupt wavy boundary.

IIc1—28 to 46 inches; light brownish gray (2.5Y 6/2) thinly stratified fine sandy loam and loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky, slightly plastic; common fine and very fine pores, few medium pores; few fine masses and threads of segregated lime; strongly effervescent; moderately alkaline; clear smooth boundary.

IIc2—46 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak medium and coarse subangular blocky structure; very hard, firm, sticky, plastic; common fine and very fine pores; few medium pores; few fine masses and threads of segregated lime; strongly effervescent; moderately alkaline.

The A horizon is clay loam or loam and is noncalcareous in some places. Thickness of the A and B horizons combined ranges from 15 to 30 inches.

227—Yamac loam, 4 to 8 percent slopes. This moderately sloping soil occupies fans and foot slopes. It has a profile similar to the one described as typical of the series, but the surface layer is loam. Included in mapping are a few small areas of Kobar and Binna soils.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. It is well suited to range. Capability unit IIIe-3 dryland, IIIe-1 irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

228—Yamac loam, 8 to 15 percent slopes. This strongly sloping soil occupies fans and foot slopes. It has a profile similar to the one described as typical of the series, but the surface layer is loam. Included in mapping are a few small areas of Binna and Kobar soils.

Surface runoff is medium. The erosion hazard is moderate from both wind and water.

This soil is suited to wheat, barley, hay, and pasture under dryland management. It is well suited to range. Capability unit IVe-3 dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 1.

229—Yamac clay loam, 0 to 2 percent slopes. This nearly level soil occupies terraces and fans. It has the profile described as typical of the series. Included in mapping are a few small concave areas of Harlem and Kobar soils.

Surface runoff is slow. The hazard of wind erosion is moderate and of water erosion is slight.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIc-1 dryland, IIc-1 irrigated; windbreak suitability group 1; not assigned to a range site.

230—Yamac clay loam, 2 to 4 percent slopes. This gently sloping soil occupies terraces and fans. Included in mapping are small areas of Binna and Kobar soils and a few small areas where loose sand and gravel is at depths of 24 to 40 inches.

Surface runoff is slow. The hazard of wind and water erosion is moderate.

This soil is suited to wheat, barley, hay, and pasture under dryland management and under irrigation. Capability unit IIIe-2 dryland, IIe-2 irrigated; windbreak suitability group 1; not assigned to a range site.

Yawdim series

The Yawdim series consists of shallow, well drained soils. These soils formed in material weathered from interbedded shale and siltstone. They are only 10 to 20 inches deep over the interbedded shale and siltstone. They are on uplands at elevations of 3,400 to 4,500 feet. Slopes are 4 to 70 percent. The native vegetation is mainly bluebunch wheatgrass, prairie sandreed, green needlegrass, and forbs and shrubs. The mean annual precipitation is 11 to 14 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is light brownish gray, calcareous silty clay loam about 3 inches thick. The underlying material is light yellowish brown and light brownish gray silty clay loam and silty clay 13 inches thick. Below 16 inches is platy soft shale.

Permeability is slow. The available water capacity is very low. Reaction is mildly alkaline in the upper 3 inches and moderately alkaline below.

These soils are mainly used for dryland crops and range.

Typical profile of Yawdim silty clay loam in native grass, 2,500 feet east and 1,200 feet north of southwest corner sec. 7, T. 20 N., R. 3 W.

A1—0 to 3 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine platy structure parting to weak fine granular; hard, friable, sticky, plastic; common medium and fine roots; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—3 to 10 inches; light yellowish brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; very hard, friable, sticky, plastic; common fine and very fine roots; few medium roots; many fine and very fine pores; few shale fragments; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C2—10 to 16 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky; extremely hard, friable, sticky,

plastic; common fine and very fine roots; many fine and very fine pores; few shale fragments; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C3r—16 to 60 inches; light brownish gray (2.5Y 6/2) dry and moist; platy soft shale; strongly effervescent; moderately alkaline.

The A horizon is silty clay loam, clay loam, or clay. Depth to shale ranges from 10 to 20 inches. Reaction throughout the soil is mildly alkaline or moderately alkaline.

231—Yawdim-Rentsac-Cabbart complex, 15 to 50 percent slopes. This map unit consists of hilly to very steep soils on sedimentary uplands. About 40 percent is Yawdim silty clay loam, about 20 percent is Rentsac channery loam, and about 20 percent is Cabbart loam. Yawdim silty clay loam occupies soft shale slopes and ridges. Rentsac channery loam occupies convex hard sandstone areas, and Cabbart loam occupies siltstone stratification areas. About 15 percent of the unit is included areas of Abor and Delpoint soils. Less than 5 percent is a few small areas of nearly barren shale and sandstone outcrop. Each soil in this unit has the profile described as typical of the series.

Surface runoff is rapid from Yawdim and Cabbart soils and slow or medium from Rentsac soils. The erosion hazard is slight from wind but is severe from water.

This unit is used for range. Capability unit Vlle-1 dryland; Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

232—Yawdim-Rock outcrop complex, 25 to 70 percent slopes. This map unit consists of steep to very steep soils on dissected uplands and valley walls. About 55 percent is Yawdim clay loam, and 20 percent is sandstone and shale outcrop. Yawdim clay loam occupies smooth and convex slopes. Rock outcrop occupies the crest of slopes, the sides of deep drainageways, and the ledges on very steep slopes. About 15 percent of the unit is included areas of Castner soils. About 10 percent is areas of Roy and Bitton soils on the lower slopes.

Surface runoff is rapid. The erosion hazard is slight from wind but is severe from water.

This unit is used for range. Capability unit Vlle-1 dryland. Yawdim soil in Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4-0.

Yetull series

The Yetull series consists of deep, well drained soils formed in alluvium and eolian sands. These soils occupy terraces, fans, and foot slopes at elevations of 3,300 to 3,800 feet. Slopes are 4 to 20 percent. The native vegetation is mainly prairie sandreed, Indian ricegrass, bluebunch wheatgrass, and forbs and shrubs. The mean

annual precipitation is 11 to 15 inches. The mean annual air temperature is 43 to 45 degrees F. The growing season is 105 to 135 days.

Typically the surface layer is grayish brown, calcareous loamy sand about 5 inches thick. The underlying material is grayish brown and light brownish gray, calcareous loamy coarse sand and sand to a depth of 66 inches or more.

Permeability is rapid. The available water capacity is low or very low. Reaction is mildly alkaline in the upper 5 inches and moderately alkaline below.

These soils are mainly used for range. Small areas are used for woodland.

Typical profile of Yetull loamy sand in native grass, 1,060 feet south and 530 feet east of northwest corner SW1/4 sec. 14, T. 19 N., R. 3 E.

A1—0 to 5 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; single grained; soft, loose, nonsticky, nonplastic; many fine and very fine roots; few medium roots; slightly effervescent; mildly alkaline; clear wavy boundary.

C1—5 to 15 inches; grayish brown (10YR 5/2) loamy coarse sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky, nonplastic; many fine and very fine roots; few medium roots; slightly effervescent; moderately alkaline; gradual wavy boundary.

C2—15 to 35 inches; grayish brown (10YR 5/2) sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky, nonplastic; many fine and very fine roots; strongly effervescent; moderately alkaline; gradual wavy boundary.

C3—35 to 66 inches; light brownish gray (10YR 6/2) sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky, nonplastic; common fine roots in upper part and few very fine roots below 50 inches; strongly effervescent; moderately alkaline.

The volume of coarse fragments ranges from 0 to 10 percent. Reaction is neutral or mildly alkaline in the A horizon. It is mildly or moderately alkaline in the C horizon.

233—Yetull loamy sand, 4 to 20 percent slopes. This gently rolling to hilly soil occupies terraces and foot slopes. It has the profile described as typical of the series. Included in mapping are a few small areas where slopes are less than 4 percent or more than 20 percent. Also included are small areas of Lihen and Tally soils.

Surface runoff is slow or medium. The erosion hazard is severe from wind and moderate from water.

This soil is used mainly as range. Some areas are woodland.

Forested areas are mainly plains cottonwood. There are a few stands of boxelder. Plains cottonwood on

Yetull soils can be expected to reach a height of 65 to 75 feet at 30 years of age. The expected volume at 70 years in a fully stocked stand ranges from 16,000 to 24,500 board feet per acre or from 3,100 to 4,700 cubic feet.

The erosion hazard, equipment limitation, and windthrow hazard are slight. Seedling mortality is moderate. Plant competition is moderate.

The erosion hazard is typically slight, but it can be considered moderate on the steeper grassy parts in disturbed areas. Seedling mortality is moderate because of the low available water capacity. Plant competition is moderate because of the sparse to moderately dense stands of understory vegetation, the low tolerance of cottonwood of root and shade competition, and the low available water capacity of the soils. Reducing the amount of plant competition is needed for good seedling survival and rapid stand regeneration.

Clearcutting small patches when harvesting favors the regeneration of plains cottonwood over boxelder. Cottonwood can tolerate very little competition. Plains cottonwood grows much faster on these soils than associated species, such as boxelder.

Capability unit VIe-1 dryland; Sands range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

Use and management of the soils

The soils of the Cascade County Area are used mostly for crops and range. The following pages explain how the soils can be used for these purposes and for roads, farm ponds, and other engineering structures. These pages also provide information on managing soils for urban related land use and for recreation, windbreaks, and wildlife.

Crops

About 35 percent of the Cascade County Area is used for crops and pasture. The main cultivated crops are wheat and barley. The principal forage crops are alfalfa and grass. The results of soil tests indicate the need for fertilizer.

There are four major problems in managing the soils of the area as cropland—wind erosion, water erosion and sedimentation, soil crusting, and saline seep. Each is explained briefly in the following paragraphs.

Wind erosion.—Wind erosion is a special problem early in spring when there are persistent strong winds. Unless well managed, sands and clays are readily eroded during this period. Soils having a loamy surface layer can also erode if they are cultivated in wide strips or in blocks during dry periods when the wind velocity is high.

Stripcropping and utilization of crop residue help in maintaining good soil tilth and controlling wind erosion.

Water erosion and sedimentation.—Water erosion is slight to severe in cultivated fields where the slope is more than 2 percent. It is severe along Muddy Creek, Belt Creek, and Smith River. The sediment in Muddy Creek and the lower Sun River is a major problem that requires intensive water management and a high level of cultural and vegetative practices on all land in the watershed.

Soil crusting.—Soil crusting is often a serious problem in obtaining adequate and uniform grain stands in the nearly level to slightly concave farming areas north and east of Great Falls. Reseeding or seeding to another crop is often needed. Most of the soils in these areas formed in water deposited material having a high proportion of silt and very fine sand. Generally the surface layer is more than 50 percent silt and very fine sand and has a distinct grayish or “bleached out” appearance when dry. It is underlain abruptly by a clayey subsoil that has a slow or very slow rate of water transmission.

These nearly continuous crusts and the very hard and durable clods usually form after the surface layer has been thoroughly wetted and then dried. Because the surface layer has a weak aggregate strength when wet, it tends to break down and puddle.

The major management problems on these soils are the poor seedling emergence because of the crusted surface and the difficulty of preparing a favorable seedbed because of the cloddy surface layer.

Saline seep.—Most soils in arid regions contain soluble salts. The salts released by weathering of soil material normally remain in soils of arid regions because not enough rain falls to fully wet the soil profile and leach the salts.

Saline seep results when water moves through a saline soil, commonly formed in glacial till, and collects on top of impermeable underlying shale. The problem of excess water occurs mainly in areas of crop-fallow dryland farming. During the fallow periods, more water is stored in the soil than can be used by the crop. This excess water moves downslope over the shale until it reaches the soil surface. The water then evaporates and dissolved salts are precipitated on the soil surface. The water is saline because salts have been leached from the subsoil, the glacial till parent material, and the shale. The predominant dissolved materials are sodium, magnesium, sulfate, and nitrate. The trace metallic elements, generally found in high concentrations, are aluminum, iron, manganese, strontium, lead, copper, zinc, nickel, selenium, chromium, molybdenum, and vanadium. Samples of ground water may contain up to 25,000 milligrams per liter (mg/l) of dissolved solids and may reach 41,000 mg/l, which is more saline than sea water, approximately 36,000 mg/l.

Saline seeps have increased at a rate of about 8 to 10 percent per year in parts of Cascade County as well as

throughout the northern plains region in recent years. Improved crop management is needed to prevent the loss of valuable farmland, the deterioration of shallow groundwater aquifers, the contamination of adjacent streams and reservoirs, the increased erosion along nearby coulees, and the gradual deterioration of the wildlife habitat and recreation potential of the area.

Early detection of potential saline seep areas is needed so that the problem can be corrected. New or developed wet spots, areas of late maturing crops, the germination of seed in a seep area during dry periods, the growth of foxtail barley, and the prolific growth of Belvedere summercypress late in the season indicate areas that should be examined by soil probing or by the use of electrical probe instruments to estimate the extent of seep development.

Preventing, controlling, or correcting a saline seep condition may require the coordinated efforts of several farmers. Following are examples of corrective measures:

1. Cropping more intensively, for example, including a deep-rooted grass and legume in rotation with a small grain crop. A cropping system of annual small grain can utilize the precipitation and stored moisture before it moves below the root zone in most years. In wet years, however, some water may move below the root zone.

2. Intensifying management so that the moisture supply can be used more efficiently. Such management includes applying fertilizer; decreasing the amount and kind of tillage that contributes to loss of soil moisture; and controlling weeds. Increasing the cover of residue through minimum tillage and providing for better snow distribution across the surface can decrease the loss of water through evaporation. Deep snow accumulations can be controlled by wind barriers, such as double rows of tall wheatgrass and standing stubble.

3. Planting and managing salt tolerant plants in or adjacent to the existing or potential seep discharge area. Grazing or harvest methods can eliminate heavy snow accumulations.

4. Identifying the potential saline seep and nonsaline seep areas and the areas of recharge and potential discharge.

5. Draining the potential saline seep area, either by subsurface interception of the flow or by a designed surface system that can eliminate the concentration of surface water.

Certain areas and soils are subject to saline seeps. A few strategically located observation wells can indicate possible future outbreaks. A rising water table, for example, indicates the need for a change in management. A stationary or lowering water table indicates proper management. The water table should be kept below 5 feet if at all possible.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are 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 that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main 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*, used in only some parts of the United States, 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 contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability unit is identified in the description of each map unit in the section "Soil maps for detailed planning." 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. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

The capability units in the Cascade County Area are described on the following pages, and the use and management of the soils are suggested.

Capability unit IIIe-1 dryland. This unit consists of deep, well drained soils that have a fine sandy loam surface layer and loam to very gravelly loamy sand underlying material. Slopes are 0 to 8 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is moderate. The available water capacity is moderate to low. The hazard of wind erosion is moderate. The hazard of water erosion is slight. Runoff is slow.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-2 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to silty clay loam surface layer, a loam to silty clay subsoil, and loam to silty clay loam underlying material. In places shale and sandstone are between 20 and 40 inches. Slopes are 0 to 5 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

The soils have moderate to slow permeability. The available water capacity is high to low. The hazards of wind and water erosion are slight to moderate. Runoff is medium or slow.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help control erosion. The use of crop residue helps maintain good soil tilth and also helps to control erosion.

Capability unit IIIe-3 dryland. This unit consists of deep and moderately deep, well drained soils that have

a loam, clay loam, cobbly clay loam, or silty clay loam surface layer. The subsoil and underlying material are loam to silty clay loam. Some soils have shale and sandstone between 20 and 40 inches. Slopes are 2 to 10 percent. Precipitation is 11 to 18 inches. The growing season is 105 to 135 days.

Permeability is moderate to slow. The available water capacity is high to low. The hazard of wind erosion is slight to moderate. The hazard of water erosion is moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-4 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to silty clay loam surface layer and subsoil. The underlying material is very gravelly sandy loam to clay. Shale and sandstone may occur between 20 and 40 inches in some soils of this unit. Slopes are 0 to 10 percent. Precipitation is 14 to 20 inches. The growing season is 105 to 135 days.

Permeability is moderate to very slow. The available water capacity is high to low. The hazards of wind and water erosion are slight or moderate. Runoff is medium or slow.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, grassed waterways, contour cultivation, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-5 dryland. This unit consists of deep, well drained soils that have a silty clay surface layer and underlying material. Slopes are 0 to 4 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

The soils are slowly permeable, and the available water capacity is high. The hazard of wind erosion is moderate. The hazard of water erosion is slight or moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, stripcropping, contour cultivation, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-6 dryland. This unit consists of deep and moderately deep, well drained and moderately well drained soils that have a silty clay or clay surface layer and underlying material. Shale and sandstone may occur between 20 and 40 inches in some soils in this

unit. Slopes are 0 to 4 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is very slow to slow. The available water capacity is high to low. The hazard of wind erosion is moderate to slight. The hazard of water erosion is slight. Runoff is slow to medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-7 dryland. This unit consists of deep and moderately deep, well drained soils that have a silty clay loam surface layer, a silty clay subsoil, and silty clay loam and clay loam underlying material. Shale and sandstone are between 20 and 40 inches in some soils in this unit. Slopes are 2 to 8 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is high to low. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-8 dryland. This unit consists of deep, well drained soils that have a calcareous silty clay loam to clay surface layer, subsoil, and underlying material. Slopes are 2 to 8 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is very slow to moderately slow. The available water capacity is high. The hazards of wind and water erosion are moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-9 dryland. This unit consists of deep and moderately deep, well drained soils that have a clay loam to clay surface layer and a silty clay to clay subsoil and underlying material. Shale and sandstone are between 20 and 40 inches in some soils in this unit. Slopes are 2 to 10 percent. Precipitation is 13 to 19 inches. The growing season is 105 to 135 days.

Permeability is very slow to moderately slow. The available water capacity is high to low. The hazard of wind erosion is slight or moderate. The hazard of water erosion is moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-10 dryland. This unit consists of deep and moderately deep, well drained soils that have a silty clay loam surface layer, a silty clay or clay subsoil, and silty clay loam to clay underlying material. In places shale is between 20 and 40 inches. Slopes are 2 to 10 percent. Precipitation is 12 to 19 inches. The growing season is 105 to 135 days.

Permeability is very slow and slow. The available water capacity is high to low. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIw-1 dryland. This unit consists of deep, moderately well drained to poorly drained soils. These soils have a silty clay loam to clay surface layer, subsoil, and underlying material. Some soils are affected by flooding, and others are subject to ponding. Slopes are 0 to 2 percent. Precipitation is 12 to 18 inches. The growing season is 105 to 135 days.

Permeability is very slow to slow. The available water capacity is high. The hazard of wind erosion is slight. The hazard of water erosion is slight or moderate. Runoff is ponded or slow.

The soils are suited to wheat, barley, hay, and pasture. Flooding or ponding may damage crops.

Minimum tillage and utilization of crop residue help in maintaining soil tilth.

Capability unit IIIs-1 dryland. This unit consists of deep, well drained soils that have a loam surface layer and underlying material. Very gravelly loamy sand is between 28 and 40 inches. Some soils in this unit are cobbly loams. Slopes are 0 to 5 percent. Precipitation is 11 to 19 inches. The growing season is 105 to 135 days.

Permeability is moderate or moderately rapid in the upper part of the soil and moderately rapid or rapid in the lower part. The available water capacity is low or moderate. The hazards of wind and water erosion are slight or moderate. Runoff is slow or medium.

The soils are suited to wheat, barley, hay, and pasture.

Minimum tillage, stripcropping, and grassed waterways help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIs-2 dryland. This unit consists of deep and moderately deep, well drained soils. These soils have a silty clay loam surface layer that crusts when dry. The subsoil and underlying material are silty clay. Shale and siltstone are between 20 and 40 inches in some soils in this unit. Slopes are 0 to 4 percent. Precipitation is 11 to 17 inches. The growing season is 105 to 135 days.

Permeability is slow or very slow. The available water capacity is low to high. The hazards of wind and water erosion are slight. Runoff is medium to ponded.

The soils are suited to wheat, barley, hay, and pasture. The crusty surface layer reduces seedling emergence.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIC-1 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to silty clay loam surface layer, a loam to silty clay subsoil, and fine sandy loam to silty clay underlying material. Shale and sandstone are between 20 and 40 inches in some soils. Slopes are 0 to 2 percent. Precipitation is 11 to 16 inches. The growing season is 105 to 135 days.

Permeability is slow to moderate. The available water capacity is low to high. The hazards of wind and water erosion are slight. Runoff is slow or medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIC-2 dryland. This unit consists of deep, well drained soils that have a clay loam and silty clay loam surface layer, a clay loam to clay subsoil, and loam to silty clay loam underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow and moderately slow. The available water capacity is high. The hazards of wind and water erosion are slight. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIC-3 dryland. This unit consists of deep, well drained soils that have a loam to silty clay loam surface layer. The subsoil is loam to light silty clay that is underlain by stratified loamy sand to silty clay loam. Slopes are 0 to 2 percent. Precipitation is 14 to 19 inches. The growing season is 105 to 135 days.

These soils are moderately permeable, and the available water capacity is moderate to high. The hazards of

wind and water erosion are slight. Runoff is medium to slow.

The soils are well suited to wheat, barley, hay, and pasture. They are also well suited as range.

Minimum tillage, contour cultivation, grassed waterways, and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVE-1 dryland. This unit consists of deep and moderately deep, well drained soils. These soils have a loamy sand and loamy fine sand surface layer and underlying material. Some soils have clay loam to very fine sandy loam underlying material between 20 and 40 inches. Slopes are 0 to 8 percent. Precipitation is 14 to 18 inches. The growing season is 105 to 135 days.

Permeability is rapid. The available water capacity is low. The hazard of wind erosion is severe. The hazard of water erosion is slight. Runoff is slow.

The soils are suited to wheat, barley, hay, and pasture, but seedling establishment is difficult because of wind erosion.

Minimum tillage, strip cropping, and continuous cropping help control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVE-2 dryland. This unit consists of deep and moderately deep, well drained soils that have a fine sandy loam or sandy loam surface layer and subsoil. Some soils have clay loam or clay underlying material between 20 and 40 inches. Others have sandstone and shale between 20 and 40 inches. Slopes are 0 to 15 percent. Precipitation is 11 to 18 inches. The growing season is 105 to 135 days.

In most areas permeability is moderate to moderately rapid and the available water capacity is low to moderate. In some areas permeability is slow below 20 inches. The hazard of wind erosion is moderate or severe. The hazard of water erosion is slight to moderate. Runoff is slow.

The soils are suited to wheat, barley, hay, and pasture.

Minimum tillage, strip cropping, and continuous cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVE-3 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to silty clay loam surface layer, subsoil, and underlying material. Some soils have shale and sandstone between 20 and 40 inches. Slopes are 2 to 15 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

In most areas permeability is slow to moderate and the available water capacity is low to high. The hazard of

wind erosion is slight or moderate. The hazard of water erosion is moderate or severe. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-4 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to silty clay loam surface layer and a loam to clay subsoil and underlying material. Most soils have shale and sandstone between 20 and 40 inches. Slopes are 8 to 20 percent. Precipitation is 13 to 20 inches. The growing season is 105 to 135 days.

Permeability is very slow to moderate. The available water capacity is low to high. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is medium.

The soils are well suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-5 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam or silt loam surface layer. The subsoil and underlying material are loam to silty clay loam. In some places limestone bedrock is between 20 and 40 inches. Slopes are 4 to 20 percent. Precipitation is 16 to 24 inches. The growing season is 60 to 100 days.

Permeability is moderate to moderately slow. The available water capacity is low to high. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is slow or medium.

These soils are well suited to wheat, barley, hay, and pasture. A short growing season may reduce crop yields.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-6 dryland. This unit consists of deep and moderately deep, well drained soils that have a clay loam to clay surface layer. The subsoil and underlying material are silty clay or clay. Shale bedrock is between 20 and 40 inches in some soils in this unit. Slopes are 2 to 15 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is very slow. The available water capacity is low to high. The hazard of wind erosion is moderate. The hazard of water erosion is moderate to severe. Runoff is medium to rapid.

The soils are suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-7 dryland. This unit consists of deep and moderately deep, well drained soils that have a silty clay loam or silty clay surface layer, subsoil, and underlying material. Some soils have shale bedrock between 20 and 40 inches. Slopes are 8 to 15 percent. Precipitation is 14 to 19 inches. The growing season is 105 to 135 days.

Permeability is moderately slow and slow. The available water capacity is low to high. The hazard of wind erosion is slight to moderate. The hazard of water erosion is moderate. Runoff is medium.

The soils are suited to wheat, barley, hay, and pasture.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-8 dryland. This unit consists of deep, well drained soils that have a clay loam surface layer and loam and clay loam underlying material. Slopes are 2 to 10 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is moderate. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is rapid.

The soils are suited to wheat, barley, hay, and pasture. The strongly alkaline underlying material reduces crop yields.

Minimum tillage, contour cultivation, grassed waterways, and stripcropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVw-1 dryland. This unit consists of deep, somewhat poorly drained soils that have a loam or clay loam surface layer, subsoil, and underlying material. Depth to the water table ranges from 1 to 3 feet during the irrigation season. Slopes are 0 to 8 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is high. The hazard of wind erosion is slight. The hazard of water erosion is slight or moderate. Runoff is medium.

The soils are well suited to hay and pasture. Some areas are suited to most crops commonly grown in the area.

Minimum tillage, continuous cropping, and drainage improve production and help to control erosion. Utilization of crop residue helps in maintaining good soil tilth.

Capability unit IVs-1 dryland. This unit consists of deep, well drained soils that have a clay loam surface

layer, a silty clay subsoil, and mainly silty clay or clay underlying material. These soils are affected by salts. Slopes are 0 to 3 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is very slow. The available water capacity is moderate. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight. Runoff is slow.

The soils are suited to wheat, barley, hay, and pasture. The strongly alkaline lower subsoil and underlying material reduce crop yields.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining soil tilth and also helps in controlling erosion.

Capability unit IVs-2 dryland. This unit consists of shallow to deep, well drained soils that have a loam and channery, cobbly, or stony loam surface layer. The subsoil and underlying material are very gravelly sand to very stony clay loam. Slopes are 0 to 4 percent. Precipitation is 11 to 19 inches. The growing season is 105 to 135 days.

Permeability is moderately slow to very rapid. The available water capacity is low or very low. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight to severe. Runoff is medium or slow.

The soils are suited to wheat, barley, hay, and pasture.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVs-3 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam to clay surface layer and underlying material. These soils are mainly strongly alkaline. Slopes are 0 to 10 percent. Precipitation is 11 to 16 inches. The growing season is 105 to 135 days.

Permeability is very slow to slow. The available water capacity is moderate to low. The hazards of wind and water erosion are slight or moderate. Runoff is slow to medium.

The soils are suited to wheat, barley, hay, and pasture. The strongly alkaline underlying material reduces crop yields.

Minimum tillage and strip cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVc-1 dryland. This unit consists of deep and moderately deep, well drained soils that have a loam and silt loam surface layer and a clay loam to stony clay loam subsoil. The underlying material is mainly gravelly clay loam to silty clay loam. Limestone bedrock is between 20 and 40 inches in some soils. Slopes are 2 to 10 percent. Precipitation is 18 to 24 inches. The growing season is 60 to 100 days.

Permeability is moderate to moderately slow. The available water capacity is low to high. The hazards of wind and water erosion are slight. Runoff is slow or medium.

The soils are suited to wheat, barley, hay, and pasture. Frost may reduce crop yields.

Minimum tillage and continuous cropping help to control erosion. Utilization of crop residue helps in maintaining good soil tilth.

Capability unit VIe-1 dryland. This unit consists of shallow to deep, moderately well drained to somewhat excessively drained soils. These soils have a loamy sand to clay surface layer, subsoil, and underlying material. Some are gravelly to stony. Slopes are 0 to 50 percent. Precipitation is 11 to 20 inches. The growing season is 60 to 135 days.

The soils are very slowly to very rapidly permeable. Available water capacity is very low to high. The hazard of wind erosion is slight to severe. The hazard of water erosion is slight or moderate. The soils that have a clay surface layer are sticky and plastic when wet and very hard when dry.

Management of the soils in this unit is suggested under "Range" in the appropriate range site.

Capability unit VIw-1 dryland. This unit consists of deep, poorly drained soils that have a loam to clay surface layer and underlying material. Some soils are affected by salts. Slopes are 0 to 4 percent. Precipitation is 11 to 20 inches. The growing season is 105 to 135 days.

The soils are very slowly to moderately permeable. The available water capacity is moderate to high. The hazards of wind and water erosion are slight. Surface crusting of the soils affected by salts severely hinders seedling emergence.

Management of the soils in this unit is suggested under "Range" in the appropriate range site.

Capability unit VI s-1 dryland. This unit consists of shallow to deep, well drained soils that have a loam to clay surface layer and underlying material. Some soils are gravelly, cobbly, channery, or stony. In some places the soils are affected by salts. Slopes are 0 to 15 percent. Precipitation is 10 to 24 inches. The growing season is 60 to 135 days.

The soils are very slowly to rapidly permeable. The available water capacity is very low to moderate. The hazard of wind erosion is slight to severe. The hazard of water erosion is slight. The soils that have a clay surface layer are sticky and plastic when wet. Surface crusting of the soils affected by salts severely hinders seedling emergence.

Management of the soils in this unit is suggested under "Range" in the appropriate range site.

Capability unit VIIe-1 dryland. This unit consists of shallow to deep, well drained soils that have a loam to clay surface layer and underlying material. Some soils are gravelly, cobbly, channery, or stony. Slopes are 4 to 70 percent. Precipitation is 11 to 24 inches. The growing season is 60 to 135 days.

Permeability is very slow to moderate. The available water capacity is very low to high. The hazard of wind erosion is slight. The hazard of water erosion is slight to severe.

Management of the soils in this unit is suggested under "Range" in the appropriate range site.

Capability unit IIe-1 irrigated. This unit consists of deep, well drained soils that have a loam or clay loam surface layer, subsoil, and underlying material. Some soils are cobbly. Slopes are 0 to 5 percent. Precipitation is 11 to 18 inches, and the growing season is 105 to 135 days.

The soils have moderate to moderately slow permeability. The available water capacity is low to high. The hazard of wind erosion is slight. Water erosion is slight to moderate. Runoff is medium.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. The use of crop residue helps to maintain good soil tilth and also helps to control erosion.

Capability unit IIe-2 irrigated. This unit consists of deep, well drained soils that have a clay loam or silty clay loam surface layer. The subsoil and underlying material are silty clay loam or silty clay. Slopes are 2 to 4 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is moderate to moderately slow. The available water capacity is high. The hazards of wind and water erosion are slight or moderate. Runoff is slow or medium.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIs-1 irrigated. This unit consists of deep, well drained soils that have a fine sandy loam surface layer. The subsoil is fine sandy loam to sandy clay loam. The underlying material is fine sandy loam to loamy fine sand. Slopes are 0 to 8 percent. Precipitation is 11 to 17 inches. The growing season is 105 to 135 days.

Permeability is moderate to moderately rapid. The available water capacity is moderate. The hazard of wind

erosion is moderate. The hazard of water erosion is slight. Runoff is slow.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIs-2 irrigated. This unit consists of deep, well drained soils that have a loam or cobbly loam surface layer and subsoil. The underlying material is very gravelly loamy sand to light clay loam. Slopes are 0 to 2 percent. Precipitation is 11 to 17 inches. The growing season is 105 to 135 days.

Permeability is slow to moderately rapid. The available water capacity is low to high. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight. Runoff is slow or medium.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIs-3 irrigated. This unit consists of deep, well drained soils that have a clay loam or silty clay loam surface layer, a clay loam to silty clay subsoil, and sandy loam to silty clay loam underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 19 inches. The growing season is 105 to 135 days.

Permeability is moderately slow to moderate. The available water capacity is high. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight. Runoff is medium or slow.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIc-1 irrigated. This unit consists of deep, well drained or moderately well drained soils that have a loam to silty clay loam surface layer and subsoil and loamy sand to silty clay loam underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 19 inches. The growing season is 105 to 135 days.

Permeability is moderately slow to moderately rapid. The available water capacity is moderate to high. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight. Runoff is medium or slow.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-1 irrigated. This unit consists of deep, well drained soils that have a loam to silty clay loam surface layer, a clay loam or silty clay loam subsoil, and loam to silty clay underlying material. Slopes are 2 to 8 percent. Precipitation is 11 to 18 inches. The growing season is 105 to 135 days.

Permeability is moderate to moderately slow. The available water capacity is high. The hazards of wind and water erosion are slight or moderate. Runoff is medium.

The soils are suited to most crops commonly grown in the area. The main crops are hay, pasture, wheat, and barley.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-2 irrigated. This unit consists of deep, well drained soils that have a fine sandy loam surface layer and subsoil and sandy loam to fine sandy loam underlying material. Slopes are 2 to 8 percent. Precipitation is 14 to 17 inches. The growing season is 105 to 135 days.

Permeability is moderately rapid. The available water capacity is moderate. The hazard of wind erosion is moderate. The hazard of water erosion is slight. Runoff is slow.

The soils are well suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIe-3 irrigated. This unit consists of deep, well drained soils that have a silty clay surface layer and underlying material. Slopes are 2 to 4 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is high. The hazards of wind and water erosion are moderate. Runoff is medium.

The soils are suited to most crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in main-

taining good soil tilth and also helps in controlling erosion.

Capability unit IIIw-1 irrigated. This unit consists of deep, moderately well drained soils that have a loam surface layer and underlying material. A seasonal high water table is between 4 and 5 feet. Some accumulations of soluble salts are in the profile. Slopes are 0 to 2 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is moderate. The available water capacity is high. The hazards of wind and water erosion are slight. Runoff is slow.

The soils are suited mainly to hay and pasture. They are also used for wheat and barley.

Minimum tillage and good water management help to lower the water table and control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IIIs-1 irrigated. This unit consists of deep, well drained or moderately well drained soils. These soils have a silty clay surface layer and loam to silty clay underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is high. The hazard of wind erosion is slight to moderate. The hazard of water erosion is slight. Runoff is slow to medium.

The soils are suited to most crops commonly grown in the area except potatoes. The main crops are hay, pasture, wheat, and barley.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-1 irrigated. This unit consists of deep, well drained soils that have a loamy sand or loamy fine sand surface layer and underlying material. Some soils have strongly alkaline clayey material between 40 and 60 inches. Slopes are 0 to 8 percent. Precipitation is 14 to 16 inches. The growing season is 105 to 135 days.

Permeability is rapid. The available water capacity is low. The hazard of wind erosion is severe. The hazard of water erosion is slight. Runoff is slow.

The soils are suited to most crops commonly grown in the area. The main crops are hay, pasture, wheat, and barley.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-2 irrigated. This unit consists of deep, well drained soils that have a loam to cobbly clay

loam surface layer. The underlying material is clay loam to very gravelly loamy sand. Slopes are 4 to 10 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow to moderate. The available water capacity is moderate to low. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is medium.

The soils are suited to most crops commonly grown in the area. The main crops are hay, pasture, wheat, and barley.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-3 irrigated. This unit consists of deep, well drained soils that have a clay or silty clay surface layer and underlying material. Slopes are 2 to 8 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow to very slow. The available water capacity is high. The hazards of wind and water erosion are moderate. Runoff is medium.

The soils are suited to selected crops commonly grown in the area. The main crops are hay and pasture.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVe-4 irrigated. This unit consists of deep, well drained, strongly alkaline soils. These soils have a clay loam surface layer and stratified loam to clay loam underlying material. Slopes are 2 to 10 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is moderate. The hazard of wind erosion is slight. The hazard of water erosion is moderate. Runoff is rapid.

The soils are suited to selected crops commonly grown in the area. The main crops are hay and pasture. A small acreage is in wheat and barley. The strongly alkaline underlying material reduces the yields of many crops.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth and also helps in controlling erosion.

Capability unit IVw-1 irrigated. This unit consists of deep, poorly drained to moderately well drained soils. These soils have a loam to clay surface layer and underlying material. Slopes are 0 to 8 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is slow to very slow. The available water capacity is moderate. The hazards of wind and water

erosion are slight to moderate. Runoff is very slow to medium.

The soils are suited to selected crops commonly grown in the area. The main crops are hay and pasture. The wet and salty soils reduce yields of many crops.

Minimum tillage and good water management help to reduce wetness. Utilization of crop residue helps in maintaining good soil tilth.

Capability unit IVs-1 irrigated. This unit consists of deep, well drained soils that have a clay loam surface layer. The subsoil and underlying material are silty clay. These soils are moderately alkaline to strongly alkaline. Slopes are 0 to 2 percent. Precipitation is 11 to 15 inches. The growing season is 105 to 135 days.

Permeability is very slow. The available water capacity is moderate. The hazard of wind erosion is slight or moderate. The hazard of water erosion is slight. Runoff is medium.

The soils are suited to selected crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture.

Minimum tillage and good water management help in maintaining soil tilth and productivity.

Capability unit IVs-2 irrigated. This unit consists of deep, well drained soils that have a gravelly sandy loam to loam surface layer. The underlying material is very gravelly sandy loam to very gravelly sand. Slopes are 0 to 2 percent. Precipitation is 11 to 16 inches. The growing season is 105 to 135 days.

Permeability is moderately slow to very rapid. The available water capacity is low to very low. The hazard of wind erosion is slight to moderate. The hazard of water erosion is slight to severe. Runoff is slow to medium.

The soils are suited to selected crops commonly grown in the area. The main crops are hay and pasture.

Minimum tillage, utilization of crop residue, and good water management help in maintaining good soil tilth.

Capability unit IVs-3 irrigated. This unit consists of deep, well drained soils that have a clay surface layer and underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is very slow. The available water capacity is high. The hazard of wind erosion is moderate. The hazard of water erosion is slight. Runoff is slow.

The soils are suited to selected crops commonly grown in the area. The main crops are hay and pasture. A small acreage is in wheat and barley.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good tilth and also helps in controlling erosion.

Capability unit IVs-4 irrigated. This unit consists of deep, well drained, strongly alkaline soils. These soils

have a clay loam surface layer and stratified loam to clay loam underlying material. Slopes are 0 to 2 percent. Precipitation is 11 to 14 inches. The growing season is 105 to 135 days.

Permeability is slow. The available water capacity is moderate. The hazards of wind and water erosion are slight. Runoff is slow.

The soils are suited to selected crops commonly grown in the area. The main crops are wheat, barley, hay, and pasture. The strongly alkaline underlying material reduces yields of many crops.

Minimum tillage and good water management help to control erosion. Utilization of crop residue helps in maintaining good soil tilth.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely

to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Woodland

Harold E. Hunter, woodland conservationist, Soil Conservation Service, helped prepare this section.

About 92,000 acres of the survey area is forested. More than three-fourths of this acreage is privately owned. The rest is under management of the state, county, or federal government. Two-thirds of the 92,000 acres of forest land is classified as commercial forest. Essentially, all the forest land is grazed.

In some parts of the county the forest and grassland are intermingled. Here, the forested areas generally occur on north- and east-facing slopes and in landscape positions that receive additional moisture. In these areas of intermingled grassland and forest, a soil can support both grass and trees. Interpretations of the soil for use as either range or woodland are provided in this survey. On mountain slopes at the higher elevations, the forest becomes continuous, occupying all aspects and landscape positions.

Forest types covering the largest acreages within the survey area are ponderosa pine and Douglas-fir. Lodgepole pine covers a moderate acreage at the higher elevations. Lodgepole pine is the most extensive forest type in Cascade County, but it occurs chiefly on National Forest Land outside the survey area. The major stands of ponderosa pine and Douglas-fir occur on private lands. Other species within the survey area are subalpine fir, Engelmann spruce, limber pine, plains cottonwood, boxelder, and narrowleaf cottonwood. Plains cottonwood is the most productive stand. About 10,000 acres of cottonwood, chiefly plains cottonwood, occur on stream flood plains within the survey area. In a few areas, beneath the crown canopy of the cottonwoods, the more tolerant boxelder is reproducing and forming a secondary stand.

Many of the softwood stands are 80 to 90 years old and nearing maturity. Cottonwood stands are generally 40 to 70 years old and mature. Conditions can be improved and productivity increased on about 60,000 acres by thinning the stands and harvesting mature and diseased trees. Planting is needed on about 4,500 acres. Forage yield of the forest understory plants can be increased on about half the total forest area that is grazed by wildlife and livestock.

Protection from fire on private, state, and county lands is provided directly by the Division of Forestry, Department of Natural Resources and Conservation. Insect and disease control on private lands is essentially the responsibility of the private landowners. Technical assistance to the private landowner concerned with insect and disease control is available from the Division of Forestry.

There are no known insect or disease epidemics in the area. Endemic populations of insects and disease, however, are affecting the growth, quality, and condition of stands in the area. Dwarf mistletoe is prevalent throughout stands of lodgepole pine and Douglas-fir. Spruce budworm is affecting the growth and quality of Douglas-fir. Pine bark beetles attack stands of ponderosa pine, particularly where slash has been allowed to accumulate. In some areas, porcupines are seriously affecting the quality and growth of timber stands, generally ponderosa pine. The soils of the survey area do not appear to have a marked effect on the incidence of disease or insect infestation.

One portable sawmill is operating within the area and processing mostly cottonwood. Softwood timber is generally processed by sawmills outside the area. From 1951 to 1964, pulpwood from nearby National Forest Land was harvested and shipped to pulp mills in the Lake States.

Intensive forest management is becoming a reality in the survey area as a result of conservation programs, an expanding market, and educational work by public and private foresters.

To aid those who manage forest land in Cascade County, soil interpretations relating to woodland use and management have been developed. Considered in these interpretations are timber productivity, erosion hazard, equipment limitations, plant competition, seedling mortality, windthrow hazard, applicable silvicultural systems, species suitability, and yields, and the kinds of understory plants.

The woodland management needed on each forested soil is suggested under "Soil maps for detailed planning."

Management and productivity

In the paragraphs that follow are definitions and explanations of terms used in the map unit descriptions of soils that support a forest resource.

Potential soil productivity is the estimated yield of each forest species that a given soil can produce under a given level of management. Site index is a common index of potential soil productivity. Site index is the average height attained by the dominant or codominant trees at 30 (cottonwood), 50 (Douglas-fir) or 100 (lodgepole pine, ponderosa pine) years of age. Site index values can be related to yield tables to determine potential board foot or cubic foot volumes (yield) of wood crops per acre. The species for which yield and site index

calculations were made in each map unit is generally for the most common species on the unit and the most desirable to be managed for timber production.

The yield estimates and site index ratings for the various species were determined from the following sources of information:

Site index values for narrowleaf and plains cottonwood were determined by adjusting site index curves for eastern cottonwood. The site index curves for eastern cottonwood were developed from information in reference 5. Gross board foot volumes per acre were determined by the ground measurements taken during the soil survey. Eight foot logs down to an 8-inch top diameter were measured in determining board foot volumes. Cubic volume per acre was determined by applying a conversion factor of 5.2 board feet per cubic foot. Cubic volume includes the entire tree exclusive of bark and twigs.

Site index values and wood volumes per acre for ponderosa pine were calculated from data in reference 7. The board foot volumes per acre determined from this publication are based upon the Scribner log rule. All trees larger than 6.6 inches in diameter at breast height (4.5 feet) to a 6-inch diameter (inside bark) top were included in the calculations. Cubic foot volumes are calculated for all trees 0.6 inch and more in diameter including stump and tip but not bark.

Site index values for inland Douglas-fir were determined from reference 4. Board foot and cubic foot volumes per acre were calculated from information contained in tables in reference 9. The board foot volumes per acre determined from this publication are based upon the Scribner log rule for all trees larger than 5.0 inches in diameter at breast height (4.5 feet). Cubic volumes are for trees 0.6 inch and more in diameter at breast height and include the stump and tip but not the bark.

Site index values for lodgepole pine were determined from reference 1. Board foot and cubic foot volumes were calculated from information contained in reference 6. The board foot volumes per acre determined from this publication are based upon the Scribner log rule. All trees larger than 10 inches in diameter at breast height to an 8-inch top diameter (inside bark) were included in the calculations. Cubic foot volumes are based upon measurements of all trees taller than 4.5 feet from ground line to tip, exclusive of bark.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

In this survey area evaluations were based on clearcut areas where slash had been burned and reasonable care used in logging to avoid the funneling of skid trails and the resulting concentration of water.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Silvicultural system refers to methods of harvest that provide for the regeneration of desirable tree species, develop a desirable stand structure, and aid in insect and disease control. The application of a silvicultural system is determined by the kinds of trees a given soil supports, the management objective, and the condition of the stands. The silvicultural systems suggested in the following paragraphs apply mainly to regenerating stands of desirable timber producing species where disease or insect infestation is not a limitation in the choice of a system.

The selection system is the periodic removal of one or more mature and immature trees. Regeneration is established almost continuously, and an uneven aged stand is maintained. This system favors the regeneration of the trees that can tolerate competition.

The shelterwood system is the removal of the stand in a series of cuts. Regeneration occurs under a partial forest canopy. After regeneration is established a final harvest cut removes the shelterwood and permits the stand to develop in the open as an even-aged stand. This system is well adapted to sites where shelter is needed for new reproduction. It favors regeneration of the species that are less able to survive competition.

In the seed-tree system, nearly all the timber in a selected area is harvested in one cut. A few of the better trees are left throughout the area to provide seed. Sometimes they are harvested after regeneration is established.

In the clearcut system, all the trees in an area are harvested in one cut. Natural regeneration depends on the seed left from the crowns of harvest trees, the seedlings already established, or the windblown seed from the surrounding forest. This system is often used in an attempt to establish young healthy stands in areas of diseased, overmature and dying, or insect killed trees.

Yield of understory plants is determined by measuring the air-dry weight of the annual growth of understory plants up to the height grazing animals can reach. Yield is determined not only by the kind of soil and the climatic variation within the area in which the soil occurs, but also by the canopy density. Yield values are given for three different levels of tree canopy density. An assessment is made of the amount of yield that is potential feed for grazing animals, and the more desirable forage plants identified.

Windbreaks

Windbreaks are belts of trees and shrubs planted to alter the environment for beneficial purposes. Windbreaks shelter farmsteads and feedlots from the wind, control drifting snow, and reduce fuel and building maintenance costs, stock mortality, and feed requirements.

Field windbreaks, or shelterbelts, generally single row plantings, protect fallow fields from wind erosion. By reducing windspeed, they protect new seedlings and crops and help create a beneficial microclimate for plant growth. By holding winter snows on the field, they improve soil moisture.

In addition to controlling the wind and snow around farmsteads, feedlots, and fields, a good windbreak makes an area more attractive and furnishes food and cover for birds and other wildlife. It can serve as a snow fence along roads and highways as well as farms and fields. It can also screen unsightly areas and deaden sounds from highway traffic, industry, or railroads.

Planning the windbreak is essential. The location, selection, and arrangement of species within the windbreak and provisions for weed control are highly important. The kind of soil should be considered. Not all species grow on all soils. No cottonwood or willow, for example, grows on a droughty, sandy, very gravelly, or shallow soil. Cara-

gana will not survive on a soil that is saturated for more than 2 weeks.

Soils that have about the same degree of soil-related hazards and limitations and are thus suited to about the same kinds of trees and shrubs are grouped accordingly. The four groupings in the Cascade County Area are part of a statewide system.

Each group is identified by a two-part symbol. In the first three groups, the numerals 1 through 3 indicate progressively more severe limitations. The letters M, S, and W, the second part of the symbol, indicate the kind of soil-related hazard and limitation. *M* refers to available water capacity, *S* to salinity and alkalinity, and *W* to the permanent water table.

All soils in windbreak suitability group 4 have very severe limitations. The second part of the symbol in this group, also a numeral, indicates a specific hazard or limitation. The numeral *0* indicates slope of more than 15 percent, *1* very low water holding capacity, *2* very poor drainage and a high water table, and *5* strong salinity and alkalinity.

Information on designing and establishing windbreaks is available in local offices of the Soil Conservation Service, the Soil Conservation District, and Extension Service.

Each windbreak suitability group recognized in the Cascade County Area is described on the pages that follow.

Windbreak suitability group 1

This group consists of deep, well drained and moderately well drained soils. The available water capacity ranges from 6 to more than 9 inches. Zones of concentrated lime, if they occur, are below 24 inches. The amount of potentially detrimental salts is low. Slopes range from 0 to 15 percent. The average annual precipitation is 11 to 24 inches. The average growing season is 60 to 135 days.

The texture of the surface layer and subsoil ranges from loam to silty clay. The percentage of coarse fragments, gravel and cobbles, ranges from 0 to about 30 percent. The underlying material is mainly loam to silty clay that is less than 30 percent coarse fragments. Depth to bedrock ranges from 40 to more than 60 inches. Depth to sandy gravel ranges from 40 to 60 inches on a few soils. Permeability is moderate to slow.

These soils occur at elevations of 3,300 to 6,000 feet on terraces, fans, foot slopes, and uplands. There are few limitations to the establishment of windbreaks and shelterbelts. In dryland areas, particularly grassy areas, summer fallow is needed before planting. Continual cultivation of the windbreak or shelterbelt to conserve moisture is suggested to insure maximum development. Irrigation increases growth of all trees and shrubs. On the steeper slopes, control of runoff from rainfall and snowmelt may be needed to prevent excessive erosion.

The trees and shrubs suitable as dryland and irrigated plantings and the expected height of the species at 20 years, according to available data, are shown in the following tabulations:

	<i>Feet</i>
<i>Trees</i>	
American elm.....	20
Blue spruce.....	14
Green ash.....	18
Golden willow.....	--
Ponderosa pine.....	17
Robusta cottonwood.....	--
Russian-olive.....	17
Siberian crabapple.....	--
Siberian elm.....	22
Scotch pine.....	--
White poplar.....	--
White willow.....	--
	<i>Feet</i>
<i>Shrubs</i>	
American plum.....	--
Common chokecherry.....	--
Lilac.....	9
Rocky Mountain juniper.....	11
Silver buffaloberry.....	--
Siberian peashrub.....	12
Skunkbush sumac.....	--
Tatarian honeysuckle.....	--
Western sandcherry.....	--

Windbreak suitability group 2M

This group consists of moderately deep and deep, well drained soils. The available water capacity ranges from 5 to 9 inches. Zones of concentrated lime, if they occur, are below 24 inches. The amount of potentially detrimental salts is moderate to low. Slopes range from 0 to 15 percent. The average annual precipitation is 11 to 22 inches. The average growing season is 60 to 135 days.

The texture of the surface layer is loamy fine sand to clay. The percentage of coarse fragments, gravel to stone sized, ranges from 0 to more than 50 percent. The subsoil and underlying material range from loamy fine sand to clay that is 0 to more than 50 percent coarse fragments. Depth to limestone, sandstone, or shale ranges from 20 to more than 60 inches. Depth to sandy gravel ranges from 40 to 66 inches on a few soils. Permeability is rapid to very slow.

These soils occur at elevations of 3,300 to 6,000 feet on terraces, fans, foot slopes, and uplands. In dryland areas, the moderate available water capacity is the chief limitation to planting. It can be overcome by cultivation for the elimination of water consumption by grasses or weeds and by proper selection, arrangement, and spacing of species. Because of the moderate available water capacity, seedling mortality can be expected to be moderate to low and replanting is sometimes needed. Growth rates are average in well cultivated areas. Limitations are moderate to the establishment and development of windbreaks.

For plantings in sodded areas, two seasons of summer fallow are suggested. Fallow provides moisture for good establishment and initial growth. Before planting on soils that have a sandy loam or coarser textured surface layer, erosion control may be needed during the fallow period.

If pre-emergence herbicides are used for weed control, rates should be reduced if the soils have a sandy loam or loamy sand surface layer and coarse fragments of more than 50 percent.

On the steeper slopes, plans should be made to control erosion from runoff.

The trees and shrubs suitable as dryland and irrigated plantings and the expected height of the species at 20 years, according to available data, are shown in the following tabulations:

	<i>Feet</i>
<i>Trees</i>	
Blue spruce.....	--
Green ash.....	17
Ponderosa pine.....	16
Russian-olive.....	16
Siberian crabapple.....	--
Siberian elm.....	20
Scotch pine.....	--
<i>Feet</i>	
<i>Shrubs</i>	
American plum.....	--
Common chokecherry.....	--
Lilac.....	--
Nanking cherry.....	--
Rocky Mountain juniper.....	10
Silver buffaloberry.....	--
Siberian peashrub.....	9
Western sandcherry.....	--

Windbreak suitability group 3M

This group consists of shallow and moderately deep, well drained soils. The available water capacity ranges from 2 to 5 inches. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is low. Slopes range from 0 to 15 percent. The average annual precipitation is 11 to 24 inches. The average growing season is 60 to 135 days.

The texture of the surface layer is dominantly loamy sand to clay, but in places it is gravelly, cobbly, or stony. The underlying material is bedrock or sandy gravel. Depth to bedrock ranges from 6 to more than 60 inches. Depth to sandy gravel ranges from 8 to 36 inches on a few soils. Permeability is slow to very rapid.

These soils occur at elevations of 3,300 to 6,000 feet on terraces, fans, foot slopes, and uplands. In dryland areas, the chief limitation to the establishment of trees and shrubs is the low available water capacity. This limitation can be overcome in irrigated areas, but irrigations should be frequent. Because of the low available water capacity, choice of species is limited; seedling mortality is moderate to high; replanting may be needed to establish a full stand; and growth rates are reduced.

On the steeper areas, plans should be made to control erosion from runoff. In order to provide adequate moisture for dryland plantings in sodded areas, two seasons of summer fallow are suggested. Before planting on soils that have a sandy loam or coarser textured surface layer, wind erosion control may be needed in the fallow period.

The trees and shrubs suitable as dryland and irrigated plantings are shown in the following columns:

- Trees*
- Ponderosa pine
- Russian-olive
- Siberian crabapple
- Siberian elm
- Shrubs*
- Lilac
- Siberian peashrub
- Skunkbush sumac

Windbreak suitability group 3S

This group consists of deep, well drained and moderately well drained soils. The available water capacity ranges from 6 to 9 inches. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is high. Slopes range from 0 to 10 percent. The average annual precipitation is 11 to 16 inches. The average growing season is 105 to 135 days.

The texture of the surface layer is loam, clay loam, or clay. The subsoil is silty clay or clay. The underlying material is sandy clay loam, loam, clay loam, or silty clay. Depth to bedrock is more than 60 inches. Permeability is slow or very slow.

These soils occur at elevations of 3,200 to 4,000 feet on terraces, fans, and foot slopes. The severe concentration of salts is the chief limitation to planting. Because salts are detrimental to plant growth, the choice of species is limited. Establishment may be difficult. Growth is below average.

The trees and shrubs suitable as dryland and irrigated plantings are shown in the following columns:

- Trees*
- Russian-olive
- Siberian elm
- Shrubs*
- Silver buffaloberry
- Siberian peashrub
- Skunkbush sumac

Windbreak suitability group 3W

This group consists of deep, moderately well drained, somewhat poorly drained, or poorly drained soils. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is moderate. Slopes range from 0 to 8 percent. The average annual precipitation is 11 to 15 inches. The average growing season is 105 to 135 days.

The texture of the surface layer is loam, clay loam, or silty clay. The underlying material is loam, clay loam, or silty clay. Depth to bedrock is more than 60 inches. Depth to sandy gravel in most areas is more than 50 inches. Permeability is moderate or slow.

These soils occur at elevations of 3,300 to 4,100 feet on terraces and fans. The soil wetness caused by poor drainage and the moderate levels of salts are the chief limitations to planting. These limitations severely restrict the choice of species and make the establishment and care of trees and shrubs difficult in dryland areas.

The trees and shrubs suitable as dryland and irrigated plantings are shown in the following columns:

Trees

Golden willow
Green ash
Plains cottonwood
Ponderosa pine
Robusta cottonwood
Siberian elm
White willow

Shrubs

Rocky Mountain juniper
Siberian peashrub
Silver buffaloberry
Tatarian honeysuckle
Western sandcherry

Windbreak suitability group 4-0

This group consists of shallow to deep, well drained soils. The available water capacity ranges from 3 to more than 9 inches. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is low to moderate. Slopes range from 15 to 70 percent. The average annual precipitation is 11 to 24 inches. The average growing season is 60 to 135 days.

The texture of the surface layer ranges from loam or silt loam to clay. The percentage of gravel, channers, cobbles, and stones ranges from 0 to 50 percent. The subsoil and underlying material range from fine sandy loam to clay. The percentage of coarse fragments ranges from 0 to more than 70 percent. Depth to limestone, sandstone, or shale ranges from 6 to more than 60 inches. Permeability is moderately rapid to very slow.

These soils occur at elevations of 3,300 to 6,000 feet on uplands and foot slopes. Slope is the chief limitation. Planting, cultivating, irrigating, and controlling runoff to minimize erosion are very difficult. Some soils are further limited by the low moisture holding capacity and the moderate level of detrimental salts. Generally, these soils are not suitable for windbreaks.

If the soil surface is more than 50 percent coarse fragments by volume, the application rates of pre-emergence herbicides should be reduced. Depth of herbicide movement increases if there is a large volume of coarse fragments.

The trees and shrubs suitable as dryland and irrigated plantings are shown in the following columns:

Trees

Ponderosa pine
Russian-olive
Siberian crabapple
Siberian elm

Shrubs

Rocky Mountain juniper
Siberian peashrub
Skunkbush sumac
Tatarian honeysuckle

On soils that have a more favorable moisture holding capacity, such species as blue spruce, Scotch pine, green ash, common chokecherry, and lilac can be considered.

Windbreak suitability group 4-1

This group consists of shallow and deep, well drained soils. The available water capacity ranges from 1 to 3 inches. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is low. Slopes range from 0 to 35 percent. The average annual precipitation is 11 to 24 inches. The average growing season is 60 to 135 days.

The texture of the surface layer is loam, gravelly loam, stony to extremely stony loam, channery loam, and very flaggy loam. The subsoil is very flaggy loam, stony clay loam, or extremely stony sandy clay loam. The underlying material is very gravelly loamy sand, very channery loam, or stony loam and clay loam. Depth to bedrock ranges from 6 to more than 60 inches. Depth to sandy gravel ranges from 8 to 10 inches in some soils. Permeability is moderately slow to very rapid.

These soils occur at elevations of 3,200 to 6,000 feet on uplands, terraces, fans, and flood plains. In dryland areas, the chief limitation to the establishment of trees and shrubs is the low available water capacity. This limitation can be overcome in irrigated areas, but frequent applications of water are needed. Because of the low available water capacity, the choice of species is limited; seedling mortality is moderate to high; replanting may be needed to establish a full stand; and growth rates are reduced.

In sodded dryland areas, two seasons of summer fallow are needed to provide adequate moisture at planting time.

If slopes are more than 15 percent, planting, cultivating, irrigation, and providing for the control of runoff are very difficult. On all gently sloping to steep slopes, adequate control of irrigation water is needed. Generally, these soils are not suitable for the establishment of windbreaks.

The trees and shrubs suitable as dryland plantings are shown in the following columns:

Trees

Ponderosa pine
Russian-olive

Shrubs

Lilac
Rocky Mountain juniper
Siberian peashrub
Skunkbush sumac

The trees and shrubs suitable as irrigated plantings are shown in the following columns:

Trees

Amur maple
Blue spruce
Golden willow
Green ash
Midwest Manchurian crabapple
Plains cottonwood
Ponderosa pine
Robusta cottonwood
Russian-olive
Siberian crabapple
Siberian elm
White poplar
White willow

Shrubs

American plum
Silver buffaloberry
Common chokecherry
Lilac
Purpleosier willow
Western sandcherry
Siberian peashrub
Tatarian honeysuckle

Windbreak suitability group 4-2

This group consists of deep, moderately well drained or poorly drained and very poorly drained soils subject to ponding. The available water capacity is more than 9 inches. The amount of potentially detrimental salts is moderate. Slopes range from 0 to 2 percent. The average annual precipitation is 12 to 17 inches. The average growing season is 105 to 135 days.

The texture of the surface layer is clay or silty clay loam. The underlying material is clay. Depth to bedrock is more than 60 inches. Permeability is slow or very slow.

These soils occur at elevations of 3,300 to 4,000 feet on terraces and in basins. The potential for ponding makes selection of suitable species and their establishment most difficult. If the soil is ponded for longer than a month, establishment of woody species may be impossible. Generally, these soils are not suitable for the establishment of windbreaks.

The trees and shrubs suitable as dryland plantings are shown in the following columns:

Trees

Golden willow
Plains cottonwood
Robusta cottonwood
Siberian elm
White poplar
White willow

Shrubs

Lilac
Purpleosier willow
Redosier dogwood
Silver buffaloberry

Windbreak suitability group 4-5

This group consists of deep, strongly alkaline, moderately well drained and well drained soils. The available water capacity ranges from 6 to 9 inches. Zones of concentrated lime, if they occur, are below 15 inches. The amount of potentially detrimental salts is high. Slopes range from 0 to 8 percent. The average annual precipitation is 10 to 15 inches. The average growing season is 105 to 135 days.

The texture of the surface layer is clay loam, silty clay, or clay. The underlying material is silty clay loam, silty clay, or clay. Depth to bedrock is more than 60 inches. Permeability is very slow.

These soils occur at elevations of 3,300 to 4,300 feet on terraces, fans, and foot slopes. The chief limitation to the planting of trees and shrubs is the very severe concentration of salts. Because salts are detrimental to plant growth, the choice of species is very limited and establishment very difficult. On these soils the growth rate, survival, and condition of plants are very poor. Opportunity for alleviating the salty condition is very limited. Generally these soils are not suitable for the growth of trees and shrubs.

The trees and shrubs marginally suitable as dryland plantings are shown in the following columns:

Trees

Russian-olive

Shrubs

Silver buffaloberry
Siberian peashrub
Skunkbush sumac

Rangeland

Joseph A. Wirak, range conservationist, Soil Conservation Service, helped prepare this section.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

The descriptions of the range sites on the pages that follow state the total annual production of vegetation in favorable and less favorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year, growing conditions are well below average, generally because of low available soil moisture.

Characteristic species of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each site are listed by common name. Under *Percent composition by weight*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

About 55 percent of the Cascade County Area is rangeland. The chief vegetation is mid and tall grasses, forbs, and shrubs.

On the following pages the range sites of the survey area are described, the climax plants and principal invaders on the site are listed, and the potential annual yield of air-dry herbage is estimated for each site in excellent condition.

Subirrigated range site 15-inch to 19-inch precipitation zone

This range site of deep loams and clay loams is mainly along stream channels and valley bottoms. The water table is rarely above the surface, but an effective ground water table occurs throughout the growing season. Slopes range from 0 to 8 percent. Permeability is moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Tufted hairgrass.....	30
Tall reedgrass.....	30
Sedges.....	25
Mat muhly.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 5,000 pounds of air-dry herbage per acre in favorable years, and in less favorable years, only 3,500 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, tufted hairgrass, tall reedgrass, and sedges decrease. Some of the principal increasers are mat muhly, sedges, and woody species. If overgrazing continues, Baltic rush and wild iris invade the site.

Overflow range site 10-inch to 14-inch precipitation zone

This range site consists of deep, well drained to poorly drained soils on terraces, basins, and long narrow valley bottoms. Slopes range from 0 to 4 percent. The soils have a loam to clay surface layer. The underlying material is sandy loam to clay. Permeability is moderate to very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Basin wildrye.....	30
Green needlegrass.....	20
Canby bluegrass.....	20
Slender wheatgrass.....	10
Western wheatgrass.....	5
Needleandthread.....	5
Shrubs.....	5
Forbs.....	5

This range site in excellent condition produces approximately 2,000 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,200 pounds per acre. Approximately 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, basin wildrye, green needlegrass, and Canby bluegrass decrease and are replaced by western wheatgrass, needleandthread, perennial forbs, and woody species. If overgrazing continues, Kentucky bluegrass, annual bromes, annual forbs, and noxious weeds invade the site.

Overflow range site 15-inch to 19-inch precipitation zone

This range site consists of deep, well drained to very poorly drained soils on bottom lands in narrow valleys. Slopes range from 0 to 4 percent. The soils have a loam or clay loam surface layer. The underlying material is sandy loam to clay. Permeability is moderate to slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Basin wildrye.....	35
Rough fescue.....	30
Canby bluegrass.....	10
Slender wheatgrass.....	5
Western wheatgrass.....	5
Sedges.....	5
Shrubs.....	5
Forbs.....	5

This range site in excellent condition produces approximately 3,000 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 2,000 pounds. Approximately 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, basin wildrye, rough fescue, Canby bluegrass, and slender wheatgrass decrease and are replaced by western wheatgrass, sedges, perennials, and woody species. If overgrazing continues, Kentucky bluegrass, annual bromes, annual forbs, and noxious weeds invade the site.

Saline Lowland range site 10-inch to 14-inch precipitation zone

This range site consists of deep, somewhat poorly drained to very poorly drained soils that are on foot slopes, in hillside seeps, and in drainageways. Slopes range from 0 to 8 percent. The soils have a loam to clay surface layer. The underlying material is sandy loam to clay. Permeability is moderate to very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Alkali cordgrass.....	30
Alkali sacaton.....	20
Alkaligrass.....	20
Basin wildrye.....	10
Saltgrass.....	5
Mat muhly.....	5
Sedges.....	5
Other shrubs.....	5

This range site in excellent condition produces about 3,000 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,500 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, basin wildrye, alkali sacaton, and alkaligrass decrease. Saltgrass, mat muhly, sedges, and woody species increase. If overgrazing continues, foxtail barley, Baltic rush, and annual weeds invade the site.

Sands range site 15-inch to 19-inch precipitation zone

This range site consists of deep, well drained soils along old stream channels, terraces, and uplands. Slopes range from 0 to 20 percent. The soils have a loamy sand or loamy fine sand surface layer. The underlying material is loamy fine sand to sand. Permeability is rapid to moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Prairie sandreed.....	30
Indian ricegrass.....	30
Bluebunch wheatgrass.....	10
Needleandthread.....	10
Sand dropseed.....	5
Sedges.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,600 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 2,200 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, prairie sandreed, Indian ricegrass, and bluebunch wheatgrass decrease and are replaced by needleandthread, sand dropseed, sedges, perennial forbs, and woody species. If overgrazing continues, annual bromes and noxious weeds invade the site.

Sandy range site 10-inch to 14-inch precipitation zone

This range site consists of deep and moderately deep, well drained soils on terraces and uplands. Slopes range from 0 to 20 percent. The soils have a sandy loam or fine sandy loam surface layer. The underlying material is dominantly sandy loam. Permeability is moderately rapid to moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

	<i>Percent</i>
<i>Plants</i>	
Prairie sandreed.....	30
Bluebunch wheatgrass.....	20
Indian ricegrass.....	10
Needleandthread.....	5
Sedges.....	5
Western wheatgrass.....	5
Blue grama.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 1,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 900 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, prairie sandreed, bluebunch wheatgrass, and Indian ricegrass decrease and are replaced by needleandthread, sedges, western wheatgrass, blue grama, perennial forbs, and woody species. If overgrazing continues, annual bromes and noxious weeds invade the site.

Sandy range site 15-inch to 19-inch precipitation zone

This range site consists of deep and moderately deep, well drained soils on terraces and uplands. Slopes range from 0 to 15 percent. The soils have a sandy loam or fine sandy loam surface layer. The underlying material is sandy loam to silty clay loam. Permeability is moderately rapid to moderately slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

	<i>Percent</i>
<i>Plants</i>	
Prairie sandreed.....	35
Indian ricegrass.....	20
Bluebunch wheatgrass.....	15
Needleandthread.....	5
Sedges.....	5
Western wheatgrass.....	5
Blue grama.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,500 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, prairie sandreed, bluebunch wheatgrass, and Indian ricegrass decrease and are replaced by needleandthread, sedges, western wheatgrass, blue grama, perennial forbs, and woody species. If overgrazing continues, annual bromes and noxious weeds invade the site.

Silty range site 10-inch to 14-inch precipitation zone

This range site consists of deep to moderately deep, well drained soils on terraces, foot slopes, and uplands. Slopes range from 0 to 20 percent. The soils have a loam, cobbly loam, clay loam, or cobbly clay loam surface layer. The underlying material is sandy loam to clay. Permeability is moderate to slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

	<i>Percent</i>
<i>Plants</i>	
Bluebunch wheatgrass.....	45
Green needlegrass.....	10
Canby bluegrass.....	10
Western wheatgrass.....	10
Needleandthread.....	10
Blue grama.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 1,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 900 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, green needlegrass, and Canby bluegrass decrease and are replaced by western wheatgrass, needleandthread, blue grama, perennial forbs, and woody species. If overgrazing continues, annual bromes, club moss, and noxious weeds invade the site.

Silty range site 15-inch to 19-inch precipitation zone

This range site consists of moderately deep to deep, well drained soils on terraces, foot slopes, and uplands. Slopes range from 0 to 65 percent. The soils have a loam to very stony loam and silt loam to silty clay loam surface layer. The underlying material is gravelly loam to clay loam. Permeability is moderate to moderately slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	35
Bluebunch wheatgrass.....	30
Green needlegrass.....	10
Idaho fescue.....	5
Western wheatgrass.....	5
Needleandthread.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,900 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, bluebunch wheatgrass, and green needlegrass decrease and are replaced by Idaho fescue, western wheatgrass, needleandthread, perennial forbs, and woody species. If overgrazing continues, timothy, annual bromes, club moss, and noxious weeds invade the site.

Silty range site 20-inch to 24-inch precipitation zone

This range site consists of deep to moderately deep, well drained soils on terraces, foot slopes, and uplands. Slopes range from 2 to 45 percent. The soils have a loam, stony loam, or silt loam surface layer and a very channery sandy clay loam to silty clay loam subsoil. Some soils contain from 15 to 60 percent coarse fragments. The underlying material is loam or gravelly loam to clay loam. Permeability is moderate to moderately slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	60
Forbs.....	15
Richardson needlegrass.....	5
Mountain brome.....	5
Idaho fescue.....	5
Sedges.....	5
Other shrubs.....	5

This range site in excellent condition produces about 3,800 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low

as 2,400 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, Richardson needlegrass, mountain brome, and forbs decrease and are replaced by Idaho fescue, perennial forbs, sedges, and woody species. If overgrazing continues, Kentucky bluegrass, timothy, needleleaf sedge, annual bromes, and club moss invade the site.

Clayey range site 10-inch to 14-inch precipitation zone

This range site consists of deep and moderately deep, well drained soils on terraces, foot slopes, fans, and shale uplands. Slopes range from 0 to 25 percent. The soils have a clay loam to clay surface layer. The underlying material is loam to clay. Permeability is moderate to very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Green needlegrass.....	40
Bluebunch wheatgrass.....	25
Western wheatgrass.....	15
Blue grama.....	5
Sandberg bluegrass.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 1,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 800 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, green needlegrass and bluebunch wheatgrass decrease and are replaced by western wheatgrass, blue grama, Sandberg bluegrass, forbs, and woody species. If overgrazing continues, annual bromes, broom snakeweed, and curlycup gumweed invade the site.

Clayey range site 15-inch to 19-inch precipitation zone

This range site consists of deep to moderately deep, well drained to moderately well drained soils on terraces, foot slopes, fans, and uplands. Slopes range from 0 to 70 percent. The soils have a clay loam to clay surface layer and underlying material. Some areas are underlain by shale or sandstone. Permeability is moderate to very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	30
Bluebunch wheatgrass.....	20
Green needlegrass.....	15
Forbs.....	15
Western wheatgrass.....	10
Idaho fescue.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,300 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,800 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, bluebunch wheatgrass, green needlegrass, and forbs decrease and are replaced by western wheatgrass, Idaho fescue, forbs, and woody species. If overgrazing continues, annual bromes and noxious weeds invade the site.

Clayey range site 20-inch to 24-inch precipitation zone

This range site consists of deep, well drained soils on the foot slopes and uplands. Slopes range from 20 to 50 percent. The soils have a clay loam surface layer. The underlying material is silty clay loam and clay loam. Permeability is moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	30
Columbia needlegrass.....	15
Forbs.....	15
Basin wildrye.....	10
Bluebunch wheatgrass.....	10
Idaho fescue.....	10
Timber danthonia.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,800 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 2,400 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, Columbia needlegrass, basin wildrye, and bluebunch wheatgrass decrease and are replaced by Idaho fescue, timber danthonia, forbs, and woody increasers. If overgrazing continues, Kentucky bluegrass, dandelions, and noxious weeds invade the site.

Thin Hilly range site 10-inch to 14-inch precipitation zone

This range site consists of deep, well drained soils on terrace edges and dissected slopes. Slopes range from 8 to 60 percent. The soils have a clay loam to silty clay

loam surface layer. The underlying material is silt loam to silty clay. Permeability is moderately slow and slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	30
Green needlegrass.....	30
Western wheatgrass.....	15
Needleandthread.....	10
Forbs.....	5
Sedges.....	5
Other shrubs.....	5

This range site in excellent condition produces about 1,200 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 500 pounds per acre. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass and green needlegrass decrease. Some of the principal increasers are western wheatgrass, needleandthread, sedges, and woody species. If overgrazing continues, annual bromes, needleleaf sedge, annual forbs, and broom snakeweed invade the site.

Stony range site 15-inch to 19-inch precipitation zone

This range site consists of deep, well drained soils on uplands. Slopes range from 2 to 50 percent. The soil has an extremely stony loam surface layer and an extremely stony sandy clay loam subsoil and underlying material. Permeability is moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	45
Bluebunch wheatgrass.....	25
Forbs.....	15
Idaho fescue.....	5
Timber danthonia.....	5
Other shrubs.....	5

This range site in excellent condition produces about 1,900 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,000 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, bluebunch wheatgrass, and forbs decrease. Some of the principal increasers are Idaho fescue, timber danthonia, forbs, and woody species. If overgrazing continues, woody species, Kentucky bluegrass, and annuals invade the site.

Stony range site 20-inch to 24-inch precipitation zone

This range site consists of deep and moderately deep, well drained soils on bedrock benches and bench edges.

Slopes range from 4 to 70 percent. The soils have a stony loam, flaggy sandy loam, and extremely stony loam surface layer. The underlying material is extremely stony sandy clay loam or loam. Permeability is moderate.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	60
Bluebunch wheatgrass.....	15
Forbs.....	15
Idaho fescue.....	5
Other shrubs.....	5

This range site in excellent condition produces about 2,400 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,200 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, bluebunch wheatgrass, and forbs decrease. Some of the principal increasers are Idaho fescue, forbs, and woody species. If overgrazing continues, woody species, Kentucky bluegrass, and club moss invade the site.

Shallow Clay range site 10-inch to 14-inch precipitation zone

This range site consists of shallow, well drained soils on shale uplands. Slopes range from 4 to 50 percent. The soils have a clay surface layer. The underlying material is clay over shale. Permeability is very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	40
Green needlegrass.....	30
Western wheatgrass.....	15
Forbs.....	10
Nuttall saltbush.....	5

If this range site is in excellent condition, it produces about 700 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 350 pounds per acre. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, green needlegrass, and western wheatgrass decrease. Some of the principal increasers are Sandberg bluegrass, prairie junegrass, blue grama, and forbs. If overgrazing continues, broom snakeweed, rubber rabbitbrush, and noxious weeds invade the site.

Shallow Clay range site 15-inch to 19-inch precipitation zone

This range site consists of moderately deep, well drained soils on shale uplands. Slopes range from 10 to

20 percent. The soils have a clay surface layer. The underlying material is clay over shale. Permeability is very low.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	40
Green needlegrass.....	30
Western wheatgrass.....	15
Prairie sandreed.....	5
Nuttall saltbush.....	5
Forbs.....	5

If this range site is in excellent condition, it produces about 1,100 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 650 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, green needlegrass, and western wheatgrass decrease. Some of the principal increasers are Sandberg bluegrass, prairie junegrass, and forbs. If overgrazing continues, broom snakeweed, rubber rabbitbrush, and noxious weeds invade the site.

Shallow to Gravel range site 10-inch to 14-inch precipitation zone

This range site consists of deep, well drained soils on stream terraces, high benches, and bench edges. Slopes range from 0 to 45 percent. The soils have a loam to very gravelly loam or cobbly loam surface layer. The underlying material is extremely gravelly and cobbly loamy sand or sandy loam. Permeability is very rapid to moderately slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	35
Western wheatgrass.....	25
Needleandthread.....	20
Blue grama.....	5
Forbs.....	5
Sedges.....	5
Other shrubs.....	5

If this range site is in excellent condition, it produces about 900 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 500 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, western wheatgrass, and needleandthread decrease. Some of the principal increasers are blue grama, forbs, sedges, and woody species. If overgrazing continues, annual bromes, needleleaf sedge, and cactus invade the site.

Shallow range site 10-inch to 14-inch precipitation zone

This range site consists of shallow, well drained soils on bedrock and shale uplands. Slopes range from 0 to 70 percent. The surface layer is very channery sandy loam to very stony loam, clay loam, or silty clay loam. The underlying material is channery loam to clay over bedrock or shale. Permeability is moderately rapid to slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	40
Prairie sandreed.....	20
Green needlegrass.....	10
Needleandthread.....	5
Western wheatgrass.....	5
Blue grama.....	5
Sedges.....	5
Forbs.....	5
Other shrubs.....	5

If this range site is in excellent condition, it produces about 800 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 400 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, prairie sandreed, and green needlegrass decrease. Some of the principal increasers are needleandthread, western wheatgrass, blue grama, sedges, forbs, and woody species. If overgrazing continues, annual bromes and noxious weeds invade the site.

Shallow range site 15-inch to 19-inch precipitation zone

This range site consists of shallow, well drained soils on bedrock and shale uplands. Slopes range from 0 to 70 percent. The soils have loamy fine sand to clay loam and gravelly to very stony loam surface layers, subsoils, and underlying material. The underlying material is over shale and hard sandstone bedrock. Permeability is moderate to moderately slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Bluebunch wheatgrass.....	40
Rough fescue.....	25
Green needlegrass.....	5
Prairie sandreed.....	5
Needleandthread.....	5
Western wheatgrass.....	5
Idaho fescue.....	5
Forbs.....	5
Other shrubs.....	5

If this range site is in excellent condition, it produces about 1,200 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to

as low as 800 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, bluebunch wheatgrass, rough fescue, green needlegrass, and prairie sandreed decrease. Some of the principal increasers are Idaho fescue, western wheatgrass, needleandthread, forbs, and woody species. If overgrazing continues, annual bromes, needleleaf sedge, annual forbs, and club moss invade the site.

Shallow range site 20-inch to 24-inch precipitation zone

This range site consists of shallow, well drained soils on hard sandstone, limestone, and shale uplands. Slopes range from 2 to 70 percent. The surface layer and underlying material are flaggy stony and gravelly loam or clay loam. The underlying material is over hard limestone, sandstone, and shale. Permeability is moderate to slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Rough fescue.....	50
Bluebunch wheatgrass.....	20
Richardson needlegrass.....	15
Forbs.....	5
Idaho fescue.....	5
Other shrubs.....	5

If this range site is in excellent condition, it produces about 2,000 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 1,200 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, rough fescue, bluebunch wheatgrass, Richardson needlegrass, and forbs decrease. Some of the principal increasers are Idaho fescue, forbs, and woody species. If overgrazing continues, Kentucky bluegrass, annual bromes, and annual forbs invade the site.

Dense Clay range site 10-inch to 14-inch precipitation zone

This range site consists of moderately deep to deep, well drained soils on terraces. Slopes range from 0 to 5 percent. The soils have a loam to clay loam surface layer. The underlying material is clay or silty clay. Permeability is very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Green needlegrass.....	40
Western wheatgrass.....	40
Plains reedgrass.....	5
Sandberg bluegrass.....	5
Forbs.....	5
Other shrubs.....	5

This range site in excellent condition produces about 700 pounds of air-dry herbage per acre in favorable years, and in less favorable years, production drops to as low as 250 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, green needlegrass and western wheatgrass decrease. Some of the principal increasers are blue grama, Sandberg bluegrass, forbs, and woody species. If overgrazing continues, curlycup gumweed, annual forbs, bromes, and cactus invade the site.

Dense Clay range site 15-inch to 19-inch precipitation zone

This range site consists of deep, well drained soils on terraces and fans. Slopes range from 0 to 8 percent. The soils have a silty clay loam to clay loam surface layer. The underlying material is silty clay loam to clay. Permeability is slow to very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Green needlegrass.....	40
Western wheatgrass.....	35
Needleandthread.....	10
Nuttall saltbush.....	5
Sandberg bluegrass.....	5
Forbs.....	5

If this range site is in excellent condition, it produces about 800 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 400 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, green needlegrass decreases. Some of the principal increasers are western wheatgrass, Sandberg bluegrass, and forbs. If overgrazing continues, annual bromes, cactus, broom snakeweed, and curlycup gumweed invade the site.

Saline Upland range site 10-inch to 14-inch precipitation zone

This range site consists of deep, well drained soils on terraces and fans. Slopes range from 0 to 15 percent. The soils have a clay loam to clay surface layer. The

underlying material is silty clay loam to clay. Permeability is very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Western wheatgrass.....	45
Alkaligrass.....	25
Nuttall saltbush.....	15
Greasewood.....	10
Forbs.....	5

This range site in excellent condition produces about 600 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 200 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, western wheatgrass, alkaligrass, and Nuttall saltbush decrease. Some of the principal increasers are greasewood and forbs. If overgrazing continues, areas become nearly barren and only Nuttall saltbush and greasewood remain.

Saline Upland range site 15-inch to 19-inch precipitation zone

This range site consists of deep, well drained soils on fans, foot slopes, and uplands. Slopes range from 4 to 15 percent. The soils have a clay loam to clay surface layer. The underlying material is silty clay loam to clay. Permeability is very slow.

The following tabulation lists the approximate species composition, by weight, of the climax, or potential, plant community:

<i>Plants</i>	<i>Percent</i>
Western wheatgrass.....	50
Alkaligrass.....	20
Nuttall saltbush.....	15
Greasewood.....	10
Forbs.....	5

If this range site is in excellent condition, it produces about 700 pounds of air-dry herbage per acre in favorable years. In less favorable years, production drops to as low as 300 pounds. About 90 percent is from plants that furnish forage for livestock and wildlife.

Under continuous heavy grazing, western wheatgrass, alkaligrass, and Nuttall saltbush decrease. Some of the principal increasers are inland saltgrass, greasewood, and forbs. If overgrazing continues, areas become nearly barren and only Nuttall saltbush and greasewood remain.

Wildlife

Ronald F. Batchelor, biologist, Soil Conservation Service, helped prepare this section.

The soils, topography, climate, and a wide variety of native and other suitable kinds of vegetation favor wild-

life habitat development in the Cascade County Area and provide a high potential for managing the land to increase and maintain various kinds of wildlife. The principal kinds of native game are white-tailed deer, mule deer, elk, antelope, ring-necked pheasant, Hungarian partridge, sharptail grouse, ruffed grouse, blue grouse, and furbearers, such as raccoons, foxes, skunks, and mink. Predators are coyotes and bobcats. Also in the survey area are numerous species of nongame birds.

Most ponds and lakes are stocked with trout. The Missouri, Smith, and Sun Rivers afford good to excellent fishing. Ducks and geese use the lakes and streams during migration and for nesting.

Successful management of wildlife on any tract of land depends on a suitable and available supply of food, cover, and water. The lack, the unfavorable balance, or the poor distribution of any one of these necessities may severely limit or account for the absence of desired wildlife species. Soil information provides a valuable tool in creating, improving, or maintaining suitable food, cover, and water for wildlife.

Most wildlife habitat is managed by planting suitable vegetation, or by manipulating existing vegetation in order to bring about natural establishment and to increase or improve desired plants. Water areas can be created or natural ones improved as wildlife habitat.

Soil interpretations for wildlife habitat serve a variety of purposes. They help in broad-scale planning of wildlife management areas, parks, nature areas or in acquiring wildlife land. They aid in selecting the more suitable sites for various kinds of management. They indicate the intensity of management needed to achieve satisfactory results. They can also indicate why managing a particular area for a given kind of wildlife may not generally be feasible.

The soil areas shown on the soil survey maps are rated only according to the type of soil. How they may be influenced by adjoining areas is not considered in the rating. Some influences on habitat, such as elevation and aspect, must be appraised onsite.

Soil directly influences the kind and amount of vegetation and the amount of water available. In this way, soil indirectly influences the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are (1) thickness of the soil, (2) texture of the surface layer, (3) available water capacity, (4) wetness, (5) surface stoniness or rockiness, (6) flood hazard, (7) slope, (8) permeability of the soil to air and water, and (9) salinity or alkalinity within a depth of 20 inches.

In table 3, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements

of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are crested wheatgrass, intermediate wheatgrass, sweetclover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are little bluestem, bluebunch wheatgrass, forbs, and legumes.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants

are honeysuckle, cottonwood, dogwood, maple, and silverberry.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and ornamental trees and shrubs.

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

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, excluding submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, spikerush and other rushes, sedges, and burreed.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are waterfowl feeding areas, wildlife ponds, and beaver ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include Hungarian partridge, ring-necked pheasant, killdeer, rabbit, red fox, skunk, snakes, songbirds, and woodchuck.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include black bear, blue and ruffed grouse, elk, red fox, mule deer, white-tailed deer, raccoon, squirrel, thrushes, vireos, wild turkeys, and woodpeckers.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks,

geese, herons, shore birds, muskrat, mink, beaver, and snakes.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include badger, curlew, coyote, Hungarian partridge, sharptailed grouse, antelope, white-tailed deer, mule deer, meadowlark, skunk, weasel, and prairie dog.

Engineering

Wayne Otto, engineer, Soil Conservation Service, helped prepare this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Engineering properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste dis-

posal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 10 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 8, for water management. Table 7 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Engineering properties

Table 4 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 4 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil maps for detailed planning."

Texture is described in table 4 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than

52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (3) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (2).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 4. Also in table 4 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index is estimated on the basis

of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 5 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 5. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 6 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell poten-

tial, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 6 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of

excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Engineering interpretations

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information is not site specific and does not eliminate the need for onsite investigation.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 7 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 4 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 4.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches

thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a

system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 8 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 10. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 10 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for

these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 10 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Recreation

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 10.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads

and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Formation and classification of the soils

This part of the survey explains the factors of soil formation and relates them to the formation of soils in the survey area. It also defines the current system of classifying soils and classifies the soils of the area according to that system.

Factors of soil formation

Soil consists of mineral matter mixed with varying amounts of organic matter derived mostly from vegetation. The mineral matter is derived from parent material that has been weathered and broken down through the combined effects of climate, living organisms, and topography over long periods of time. Within short distances, the combination of these factors varies. Consequently, the soils that form differ in fertility, productivity, and physical and chemical characteristics.

Parent material

The soils in the Cascade County Area formed dominantly in glacial sediments on stream terraces, benches, and fans. In places they formed over sandstone, limestone, shale, and igneous rock.

The Keewatin ice sheet covered the northeastern part of the survey area during late Wisconsin Glaciation. The soils that formed in glacial till or glaciolacustrine material, such as Gerber soils, are generally silty clay loams or silty clays. The soils that formed in weathered shale, for example, Abor soils, are clayey. Clay is the basic constituent of shale. The soils that formed in mixed alluvium derived from sandstone and shale, such as Korent soils, are loamy.

Many soils in the survey area acquired salts and sodium from the parent material. The soils between Ulm and Cascade are good examples of those formed in salt- and sodium-affected parent material. The salts and sodium make these soils saline or alkali and limit the kind and amount of plant cover.

Climate

Climate, mainly temperature and precipitation, is an active force in the formation of soils. Erosion and alternate freezing and heating break down rocks into material in which soils form. The weathered material is further broken down by such chemical reactions as solution and hydration.

In this survey area precipitation ranges from about 11 to 24 inches. In the driest and warmest parts are soils of the Aridisol order, such as Cargill soils. In cooler, wetter parts are soils of the Mollisol order, for example, Absarokee soils.

Living organisms

Living organisms are active in the formation of soils. Fungi and algae contribute to the decomposition of rocks. As the rocks decompose, the grasses, shrubs, and trees grow and support animal life.

The kinds of plants and animals largely determine the kinds and amount of organic matter that is added to the soil. They also determine how this matter is incorporated with the mineral part of the soil. Roots, rodents, and insects penetrate the soil and influence its structure. Common rodents are gophers, prairie dogs, badgers, rabbits, and marmots. Pebbles and stones on the surface of terraces and in many other areas have been dug up by burrowing rodents. Leaves, roots, and whole plants remain on the surface layer where they are changed to humus by micro-organisms, chemicals in the soil, and insects. Organic matter is the main source of the dark color in the surface layer.

The vegetation in Cascade County Area ranges from short and mid grasses and shrubs on the plains to tall grasses, ponderosa pine, and Douglas-fir stands in the mountainous areas.

Topography

Topography, or relief, is determined by the resistance of bedrock or soil material to erosion by water and wind. In the eroded uplands of the survey area, runoff has carved deep valleys with many branches into the original bedrock. The rugged relief contrasts sharply with the smooth low relief of the terraces and flood plains of the river valleys.

In the uplands the number and the distinctness of soil horizons decrease as slope increases. Steep soils with rapid runoff have many characteristics similar to those of soils formed in arid climates. Level soils that receive runoff from higher-lying areas have many of the characteristics of soils that formed in humid climates. An example of this pattern is the shallow, steep Yawdim soil and the deep Work soil in swales and terraces. The Yawdim soil has no B horizon, but the Work soil has a B horizon 10 to 15 inches thick.

Time

The change that takes place in a soil over a long period of time is called soil genesis. This change gives the soil distinct horizons, or layers, by which it can be recognized. The kinds and arrangements of these horizons are called soil morphology. Horizons are described in terms of color, texture, structure, consistence, thickness, permeability, and chemistry.

Soils are classified as young to mature. The age of a soil is determined from the thickness of the A horizon, the content of organic matter and of clay, the depth to which soluble material is leached, and the form and distribution of calcium carbonate and gypsum in the soil.

Have loam, a soil of the Entisol order, is an example of a young soil. It is on a flood plain adjacent to a flowing stream. It contains little organic matter with which to form an A horizon, it has no clay accumulation, and little translocation of carbonates has occurred to form B2 and Cca horizons.

The Farnuf soils formed in parent material that is similar to, but much older than, the parent material of Have loam. Farnuf soils formed in alluvium on terraces and upland slopes. They are mature soils of the Mollisol order.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (10).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are

observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 12, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquents (*Hapl*, meaning simple horizons, plus *aquent*, the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistency, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, nonacid, mesic, Typic Haplaquents.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and

in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistency, and mineral and chemical composition.

General nature of the area

This part of the survey describes the physiography and drainage of the Cascade County Area, the climate, the sources of ground water, the natural resources, the settlement, farming, and industry, and the markets and transportation.

Physiography and drainage

The Cascade County Area lies in both glaciated and unglaciated parts of the Missouri Plateau, which is in the northern part of the Great Plains Province. The parent materials in this area are the materials weathering from sedimentary and igneous rocks; the loamy and clayey deposits laid down as glacial till and glaciolacustrine material, and the alluvium on broad high benches, foot slopes, and fans and in small closed basins and valleys. The landscape is dominantly one of nearly level to rolling plains and benches. The eastern, southern, and southwestern parts, however, are mountainous with deep canyons. The elevation ranges from about 2,730 feet above sea level where the Missouri River flows into Chouteau County to about 8,000 feet on some of the higher mountain peaks.

The Missouri River, the largest river in the area, flows generally north to northeast. Three major tributaries flow into the Missouri; two flow northward, and one eastward. The Smith River flows into the Missouri near Ulm, Montana, and Belt Creek, about 15 miles northeast of Great Falls. The Sun River, the largest tributary in the survey area, flows in an eastward direction to confluence with the Missouri at the southwest edge of Great Falls.

Climate

By Clair O. Clark, soil scientist, Soil Conservation Service, and the National Weather Service, U.S. Department of Agriculture, Great Falls, Montana.

Cascade County is well east of the ridge line of the Continental Divide. The climate has many continental characteristics. One important exception, however, is the "Chinook" winds, which are common during the colder months of the year. The winds are most common along the Missouri River from above Cascade to the Chouteau County line but occur nearly as often along the Sun River from the Lewis and Clark County line eastward and over the central and northeast quarter of the county. As a result of these winds, valley locations are generally warm for Montana. Some of the sheltered or higher valley areas are considerably cooler. The average annual temperature at both Cascade and Great Falls is above

45 degrees F. At Adel, about 22 miles south of Cascade, elevation 5,200 feet, it is 41.4 degrees. Summers are pleasantly warm. High temperatures are recorded on only a very few days in any year. At Great Falls, for example, only 15 days a year, on the average, have maximums of 90 degrees or higher.

Table 13 gives data on temperature and precipitation for the survey area, as recorded at Great Falls for the period 1941 to 1970. Table 14 shows probable dates of the first freeze in fall and the last freeze in spring.

As is usual in areas having large variations in elevation and more or less irregular topographic features, differences in the amount of precipitation are considerable. In general, the driest area is the northwest corner of the county where precipitation averages as little as 11 or 12 inches a year. In the principal grain-growing areas along the Sun and Missouri Rivers, it averages between 12 and 16 inches a year. The wettest areas are along the mountains of the southeast corner. Snowfall is not particularly heavy. In most of the valleys it averages 50 to 60 inches a year.

Precipitation is heaviest in late spring through early summer in the populated areas but is fairly steady all year along the southern mountains. In the valley from two-thirds to three-fourths of the annual precipitation falls usually during the April-September growing season. Rainfall in May and June is frequent and sometimes heavy; in June it averages 4 inches or more in some of the wetter areas. Late summer and fall weather is mostly sunny and pleasantly warm, but afternoon showers or thunderstorms occur during July and August on an average of 1 day in 4. Thunderstorms throughout the county occur on about 50 days a year, about 90 percent during the May-August period. These storms sometimes are accompanied by hail, but the hailstorms occur mostly in the northern half of the county and are severe enough to cause damage only in limited areas.

At Great Falls the sun shines 64 percent of the possible time throughout the year—46 percent in November to 80 percent in July. The average relative humidity at 5:00 a.m. ranges from 63 percent in July and August to 74 percent in June. The relative humidity at 5:00 p.m. ranges from 62 percent in January to 29 percent in August. The average freeze-free periods for the county vary considerably, ranging from 135 days at Great Falls to 55 days at Adel.

Severe flooding occurs along the Lower Sun River, Belt Creek, Sand Coulee Creek, and the Missouri River in some years of above normal precipitation. Tornadoes are rare. A funnel cloud can be observed somewhere in the county about 1 year in 7 but only rarely results in slight damage.

The Chinook winds are persistent and strong. At Great Falls the average windspeed for the year is 14.2 miles per hour; 82 miles per hour was recorded in December, 1956. Cold waves are no longer as dangerous as they were 30 or 50 years ago, partly because of better warn-

ing facilities. They can still present serious problems, however, for the unwary or unprepared.

Ground water sources

The water-bearing rocks of the Great Falls region are confined mainly to the basal Colorado and the Kootenai Formations. A number of sandstone beds, which are porous and transmit water freely, occur in these formations. Other formations that contain an adequate supply of good quality water are the Eagle and Claggett Sandstones of the Montana Formation and the coarse-grained conglomeratic sandstone of the Ellis Formation. Around the sides of Square and Fort Shaw Buttes a number of small springs issue from the base of the Eagle Sandstone.

In the Kootenai Formation are several water-bearing horizons. A massive gray sandstone, 25 to 80 feet thick over coal, is the source of a number of wells and springs along Otter Creek. This large volume of water above the coal seam makes mining difficult. Above the gray sandstone are a number of massive sandstones, interbedded with red shale, that have numerous small springs issuing from their base. Where exposed, from the eastern margin of the fields to the Smith River, these sandstone beds are the sources of numerous small springs. West of Stockett, however, they are overlain by basal sandstones of the Colorado Formation, which cap the plateau summits west and south of Sand Coulee and extend to beyond the Missouri River, including the benchland north of Ulm. Throughout this area, springs occur frequently at the base of the Colorado Sandstone. Well borings in this sandstone generally provide a good supply of water.

In addition to the good source of domestic water supply from springs in the Great Falls region, there are a number of localities in the larger valleys where most of the water is from shallow wells. On the summits of some of the plateaus bordering the Little Belt Mountains, wells are 100 to 300 feet deep. To the west and north of Great Falls, throughout the highland districts, wells are commonly shallow. They are rarely drilled below the base of the terrace gravel, which is only 25 to 40 feet thick. In the larger valleys that cross the western part of the district, wells are shallower than those on the benchland and water is more abundant. Wells in this area are only 15 to 75 feet deep. A few deep wells have been drilled in the tableland east of Great Falls, near the south end of the Sun River bridge. Others are farther up the Missouri River and at Ulm. The deepest boring in this part of Montana extends to depths of 2,000 and 2,500 feet.

Natural resources

Cascade County has paralleled the course of most mining counties in the state during the last three decades. As metal mining declined, nonmetal production

increased. This increase is related to the accelerated activity in defense installation, public works, housing, highways, and private businesses that require tremendous quantities of sand, gravel, and stone. During 1957 and 1958, Cascade County ranked first in nonmetal production in the state. Nonmetallic minerals other than sand, gravel, and stone, however, have not been extensively produced in Cascade County. Limestone, expandable shale, fine clay, gypsum, bentonite, and building stone have been produced in small quantities.

The earliest recorded coal mining in Cascade County was done in 1876 near Belt. From that time until the completion of natural gas lines from the Cut Bank Field in Glacier County, Montana, coal mining was the most profitable and extensive mining industry in the county. It is estimated that the total output of bituminous coal was about 36 million tons. The largest coal mining operations were at Belt, Stockett, and Sand Coulee and on Hound Creek near the Smith River. In addition, there were a number of small scale and intermittent producers in the area.

Railroads within the state consumed most of the coal. Local smelters, other industries, and homes consumed the rest.

The most productive and largest of the several fields in the county is the Great Falls Field. It occupies an extensive area southwest, south, and southeast of Great Falls. The coal occurs in the Belt Creek bed, which was formerly assigned to the Kootenai Formation but which is now considered to be part of the Morrison Formation. The Valier Field in the northwest corner of the county contains two coal beds of minable thickness. Because the coal in this bed is low-ranking bituminous coal, little has been mined.

Settlement, farming, and industry

The Blackfeet Indians were in possession of the area of Cascade County when the Lewis and Clark Expedition passed through in 1804 and 1805. Trapping and trading with the Indians followed the expedition.

Cascade County was organized on September 18, 1887, from parts of Chouteau, Lewis and Clark, and Meagher Counties. Parts of Meagher County were annexed between 1890 and 1900, parts of Cascade County were ceded to Judith Basin County in 1920 and 1941, and there was an exchange of areas with Lewis and Clark County in 1941.

Cascade County has exhibited a strong and continuous growth rate since its organization in 1887. The 1968 estimated population of 83,166 reflects an increase of 98 percent since 1940 and an increase of 13.3 percent from 1960 to 1968.

The expansion of Great Falls and housing projects throughout the survey area on desirable farmland and ranchland is reducing the farmland acreage.

The Cascade County survey area lies between a rich mining and stock raising district and the great agricultural plains of north-central Montana. It has a variety and abundance of resources, such as water, timber, coal, rangeland, and cropland.

Raising beef cattle is the major livestock industry. Sheep, swine, dairy, horses, and poultry are also raised.

Crops grown in Cascade County area are those varieties of small grain and forage crops that mature in 90 to 135 days. Based on the 1967 Conservation Needs Inventory for Cascade County, 37,345 acres is irrigated.

Stock raising, the first industry established, was followed by dryland farming, mining, and irrigation and more recently by industrial development.

The development of hydro-electrical power from the falls was no doubt the most important factor in the rapid growth of Great Falls. Five dams were constructed utilizing the 480-foot fall in the 16-mile reach of the river, with water passing through the Black Eagle Plant, which has 18,000 kW of capability; Rainbow, with 35,000 kW; Cochrane, with 60,000 kW; Ryan, with 60,000 kW; and Morony, with 47,000 kW. The Black Eagle Plant, built in 1890, was Montana's first hydro-electric power development. It was rebuilt in 1927. Rainbow went into operation in 1910, and Ryan was completed in 1915. Both were developed to serve the nonferrous metal mining and smelting industry. Morony was completed in 1931, and Cochrane, the newest plant on the Montana power system, was placed in operation in 1958.

Flour milling in Great Falls began in 1885, when the first mill in this area was built. Another large plant was built in 1892.

Some of the other major industries and businesses located in the Cascade County area are smelting, oil refineries, timber harvesting, meat processing, machinery distributors, and district headquarters for many insurance companies, wholesale firms, and government agencies.

Markets and transportation

Metropolitan Great Falls is the market center for a county of more than 80,000. Because of its size and the variety of service, it draws the major portion of hard goods purchases from more than one-third of the state of Montana.

Wheat and other grains are marketed at elevators in Armington, Belt, Cascade, Fife, Fort Shaw, Great Falls, Portage, Salem, Sand Coulee, Simms, Sun River, Tracy, Ulm, and Vaughn. The stockyards and transportation to Great Falls provide ranches with good livestock marketing facilities. Great Falls is also a distribution point for wholesale firms that deal in farm machinery, groceries, construction equipment, and the service industries connected with them.

Great Falls was an early center of air flight activities. In 1942, Gore Field was selected by the U.S. Air Force

as a training center. In the same year a large airfield, then known as East Base, was built. In 1954, this field was made a Strategic Air Command and Air Defense Command Center.

Great Falls and the Cascade County Area are served by the International Airport and by five airlines that provide overnight air freight to most points west of the Mississippi River and to a large part of Western Canada.

Full rail service is available from the Burlington Northern and Milwaukee lines. Branch lines extend in every direction into the agricultural and mining areas. High volume, low cost transportation can be provided throughout the United States and also to Canadian markets.

Interstate Highway 15 and U.S. Highways 87 and 89 intersect at Great Falls. Connections to U.S. Highways 2, 10, and 12 and Interstate 90 place Great Falls as a hub for motor transport to the entire Northwest.

Approximately 30 interstate truck carriers are represented in Great Falls. Reciprocal agreements with other carriers provide trucking service anywhere in the nation.

Regional parcel and passenger bus service is provided by four local and regional carriers. National service is also provided.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	<i>Inches</i>
Very low.....	0 to 3
Low.....	3 to 6
Moderate.....	6 to 9
High.....	More than 9

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Channery soil. A soil, that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

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

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave. Unstable walls of cuts made by earth-moving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth, soil. The depth in inches from the surface to a root-restricting layer in the soil. Following are the depth classes used in this survey:

	<i>Inches</i>
Deep.....	more than 40
Moderately deep.....	20 to 40
Shallow.....	10 to 20
Very shallow.....	less than 10

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing

season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess alkali. Excess exchangeable sodium. The resulting poor physical properties restrict the growth of plants.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime. Excess carbonates. Excessive carbonates, or lime, restrict the growth of some plants.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A₂ horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties

typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Increasesers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasesers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor

aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water of subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	<i>pH</i>
Extremely acid.....	Below 4.5
Very strongly acid.....	4.5 to 5.0
Strongly acid.....	5.1 to 5.5
Medium acid.....	5.6 to 6.0
Slightly acid.....	6.1 to 6.5
Neutral.....	6.6 to 7.3
Mildly alkaline.....	7.4 to 7.8
Moderately alkaline.....	7.9 to 8.4
Strongly alkaline.....	8.5 to 9.0
Very strongly alkaline.....	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Depth, soil.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

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 can soak into the soil or flow slowly to a

prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordi-

narily rich in organic matter, used to topdress road-banks, lawns, and gardens.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within 1 year; specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water. *Water table, apparent.* A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.