

This is a scanned version of the text of the original Soil Survey report of Adams County, Washington issued September 1967. Original tables and maps were deleted. There may be references in the text that refer to a table that is not in this document.

Updated tables were generated from the NRCS National Soil Information System (NASIS). The soil map data has been digitized and may include some updated information. These are available from <http://soildatamart.nrcs.usda.gov>.

Please contact the State Soil Scientist, Natural Resources Conservation Service (formerly Soil Conservation Service) for additional information.

SOIL SURVEY OF ADAMS COUNTY, WASHINGTON

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

ADAMS COUNTY is in the southeastern part of Washington (fig. 1). It has a total area of 1,212,800 acres. Ritzville, the principal city and county seat, is 60 miles southwest of Spokane and 210 miles east of Olympia, the State capital.

The Dryland Experiment Station of Washington State University is in Adams County. It consists of 320 acres, of which about 260 acres is used for crop-production experiments.

How Soils Are Mapped and Classified

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

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

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

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

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

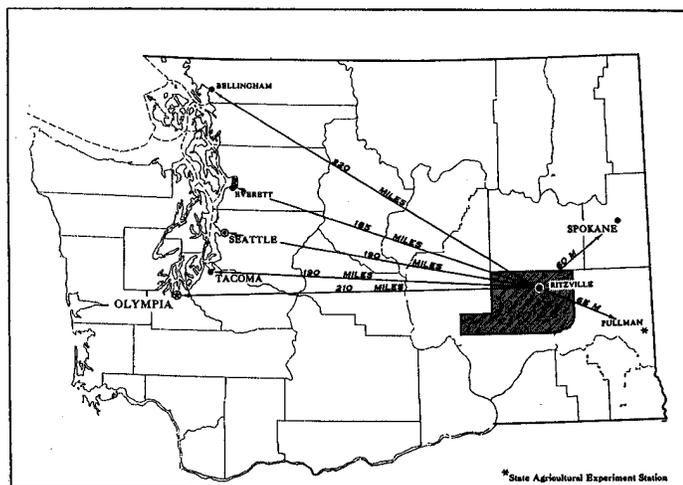


Figure 1.-Location of Adams County in Washington.

The annual precipitation ranges from 7 to 10 inches along the western edge of the county, and gradually increases to 12 to 14 inches at the higher elevations in the eastern part. Precipitation is very light in summer. It gradually increases in fall, reaches a peak of 1 inch to 1 1/2 inches each month in winter, and then decreases early in spring. It increases in May and June and drops sharply in July.

The county was once entirely grassland. Early settlements were along the streams and creeks, and the first settlers raised livestock. Cultivated crops have been grown since 1880. Currently, 778,525 acres are under cultivation. Wheat is the principal nonirrigated crop.

In 1959, about 48,280 acres was under irrigation. The southwestern part of the county lies within the Columbia Basin Irrigation Project and is irrigated with water from the East Low Canal. Sugar beets, beans, corn, potatoes, and alfalfa are the major irrigated crops.

a series, all the soils having a surface layer of the same texture belong to one soil type. Shano silt loam and Shano very fine sandy loam are two soil types in the Shano series. The difference in texture of their surface layer is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Shano silt loam, 0 to 2 percent slopes, is one of several phases of Shano silt loam, a soil type that ranges from nearly level to steep.

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

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed or occur in such small individual tracts that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it; for example, Anders-Kuhl very rocky silt loams, 0 to 15 percent slopes. In most areas surveyed there are tracts that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These tracts are shown on the map like other mapping units, but they are given descriptive names, such as Rock outcrop, and are called land types rather than soils.

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

But only part of a soil survey is done when the soils have been named and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the

method of organization commonly used in soil survey reports. The soil scientists set up trial groups based on the yield and practice tables and other data. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

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

There are six soil associations in Adams County. Two are in the part of the county where precipitation is moderate; two are in the part where precipitation is moderately low; and the other two are in the part where precipitation is low.

Silt loam soils in areas of moderate precipitation (10 to 14 inches).-These soils are in the eastern part of the county and make up the Walla Walla-Endicott and Benge-Anders-Kuhl associations. They formed in silty materials, under bunchgrass. They have a dark-colored surface layer. Except for small basins in the channeled scablands, they are well drained. The depth to lime is about 4 feet, except where bedrock or a hardpan is near the surface. Most of these areas are used for range.

Silt loam soils in areas of moderately low precipitation (9 to 12 inches).-These soils are in the central part of the county and make up the Ritzville-Willis and Stratford-Roloff-Starbuck associations. They formed in silty materials, under bunchgrass. Their surface layer is slightly dark colored. Except for small basins in the channeled scablands, these soils are well drained. The depth to lime is about 3 feet, except where bedrock or a hardpan is near the surface. For the most part, these areas are cultivated and in dryland grain.

Loamy soils in areas of low precipitation (7 to 9 inches).-These soils are in the western part of the county and make up the Shano-Burke and Ephrata-Neppel-Royal associations. They formed under somewhat sparse, natural bunchgrass vegetation. They have a light-colored surface layer, are well drained, and have moderate or moderately rapid permeability. The depth to lime commonly is about 2 feet. Most of the acreage is

cultivated either to dryland grain or to a variety of irrigated crops.

1. Walla Walla-Endicott association

Nearly level to steep soils that are moderately shallow to very deep over a lime-silica hardpan

This association is on the uplands in the eastern part of Adams County. It consists of moderately permeable soils that formed, under bunchgrass, from wind-deposited material. It has a branchlike drainage pattern. The annual precipitation is 12 to 14 inches. This association makes up about 5 percent of the county.

Walla Walla soils are moderately deep to very deep and nearly level to steep. Endicott soils occur on nearly level ridgetops and gentle slopes and are 20 to 40 inches deep over a lime-silica cemented hardpan. Also in this association are Onyx and Hermiston soils, which occupy drainageways and are occasionally flooded. Onyx soils are noncalcareous. Hermiston soils are calcareous at a depth of about 20 inches.

The farms in this association are 600 to 900 acres in size. More than 95 percent of the acreage is cultivated. Wheat and barley are grown in a summer-fallow system. Wind erosion is a hazard, but water erosion is a more serious problem.

Upland game birds, chiefly pheasants, are plentiful. Canadian geese and mallard ducks feed in the wheatfields in fall and early in winter.

2. Benge-Anders-Kuhl association

Nearly level to strongly sloping soils of the channeled scablands; shallow to moderately deep over basalt and gravel

This association is in the eastern part of the county. It consists of soils that formed, under bunchgrass, from alluvium and wind-deposited materials. The landscape is one of basalt outcrops, undrained basins, islands of loess, and glacial outwash. The annual precipitation is 12 to 14 inches. This association makes up about 24 percent of the county.

Benge soils are underlain by gravel, and Anders soils are underlain by basalt. Kuhl soils are shallow over basalt. These soils are stony in many places, and rock outcrops are common. Chard and Beckley soils, which are also in this association, are on terraces. Chard soils are moderately coarse textured and very deep. Beckley soils are moderately coarse textured and are 20 to 40 inches deep over coarse sand.

The dominant soils of this association are used mainly for range. The ranches are large, or 1,000 to more than 50,000 acres in size. Cattle ranching is the leading livestock operation. Stock is carried on the ranches throughout the year. About 75 percent of the deeper soils, mainly Chard and Beckley soils, is cultivated, and wheat and barley are grown under a summer-fallow system. Both wind and water erosion are hazards on the cultivated soils.

This association is in the fall flightpath of Canadian geese and mallard ducks. It contains numerous potholes and lakes. The birds rest on these and feed in the wheatfields of the adjoining Walla Walla-Endicott association. A few whitetail deer roam the association, and there are a few raccoon. The coyote is a common predator.

3. Ritzville-Willis association

Nearly level to steep soils that are shallow to very deep over a lime-silica hardpan

This association is on the rolling uplands in the central part of the county. It consists of soils that formed, under bunchgrass, from wind-deposited material. It has a branchlike drainage pattern. The annual precipitation is 9 to 12 inches. This association makes up about 24 percent of the county.

Ritzville soils are moderately shallow to very deep and nearly level to very steep. Willis soils occur on the more nearly level ridgetops, are gently sloping, and are shallow and moderately deep over a lime-silica cemented hardpan. Esquatzel soils occupy the drainageways and are subject to occasional flooding. All of these soils are silty, well drained, and moderately permeable.

The farms in this association are about 700 to 1,200 acres in size. More than 95 percent of the acreage is cultivated. Wheat and barley are grown in a summer-fallow system. The hazard of wind and water erosion is slight to severe. Moisture conservation is a problem.

Upland game birds, chiefly pheasants, are important wildlife species in this association. The coyote is a common predator. The number of ground squirrels and jackrabbits varies, and in some years these animals cause considerable damage to crops.

4. Stratford-Roloff-Starbuck association

Nearly level to strongly sloping soils of the channeled scablands; shallow to moderately deep over basalt and gravel

This association is in the central part of the county. It consists of soils that formed, under bunchgrass, from alluvium and wind-deposited materials. The landscape is one of basalt outcrops, undrained basins, and glacial outwash. The annual precipitation is 9 to 12 inches. This association makes up about 10 percent of the county.

Stratford soils are silty and are moderately deep over gravel. Roloff soils are silty and are moderately deep over basalt. Starbuck soils are shallow over basalt. Roloff soils occur mainly in association with Starbuck soils and Rock outcrop. Also in this association are Emdent, Farrell, Magallon, and Esquatzel soils. Emdent soils are saline, are very deep and moderately shallow, and contain large quantities of volcanic ash. They occupy undrained basins and are underlain by basalt. Farrell and Magallon soils occupy terraces. Farrell soils are very deep and moderately coarse textured. Magallon soils are moderately coarse textured and moderately deep over coarse sand. The silty Esquatzel soils occupy drainageways and are flooded occasionally.

This association is used mainly for range. The ranches are 1,000 to 2,000 acres in size. The areas in range are grazed by cattle. The deeper soils are cultivated; about 85 percent of the acreage of Farrell and Magallon soils is cultivated. Wheat and barley are grown under a summer-fallow system. Wind and water erosion are hazards on the cultivated soils.

Several townsites, including Ritzville and Lind, are located on Esquatzel soils along drainageways. Minor flooding has been a problem.

Upland game birds, chiefly pheasants, California quail, and chukars, are important wildlife species in this associ-

ation. In fall and early in winter, geese feed in the wheatfields. East of Rattlesnake Flats, there are a few pronghorn antelope left from a small herd planted by the Washington State Department of Game. The coyote is a common predator.

5. Shano-Burke association

Gently sloping to steep silt loams that are moderately deep to very deep over a lime-silica hardpan

This association is on the uplands in the western part of the county. It consists of soils that formed, under bunchgrass, from wind-deposited materials. It has a branchlike drainage pattern. The annual precipitation is 7 to 9 inches. This association makes up about 27 percent of the county.

Shano soils are moderately shallow to very deep and rolling or steep. Burke soils are on the more nearly level ridgetops and on gentle slopes. They are shallow or moderately deep over a lime-silica cemented hardpan. Both are well drained and moderately permeable. Also in this association are Sagemoor and Esquatzel soils. Sagemoor soils are underlain by slowly permeable silts (Touchet beds). Esquatzel soils occupy drainageways and are subject to occasional flooding.

The farms are large, 2,000 to 5,000 acres or more in size, in most of the association. More than 95 percent of the acreage is cultivated. Wheat and rye are grown under a summer-fallow system. The hazard of wind and water erosion is slight to severe. Moisture conservation is a problem. A few deep wells have been drilled, and in spring supplemental water is applied to the wheat crop in some places by means of sprinkler systems. Parts of this association are within the boundaries of the Columbia Basin Irrigation Project. The farms in these parts are 60 to 120 acres in size. Sugar beets, corn, beans, potatoes, and hay are the main crops.

Upland game birds, chiefly ringnecked pheasants, Hungarian partridges, and California quail, are important wildlife species in this association. They are more numerous in the irrigated part than elsewhere. The area is also heavily populated with ducks in the fall. The coyote is a common predator in the nonirrigated part. The jackrabbit population varies; in some years rabbits cause considerable damage to crops.

6. Ephrata-Neppel-Royal association

Nearly level to steep sandy loams, fine sandy loams, and very fine sandy loams that are moderately deep to deep over a lime-silica hardpan, Ringold beds, or gravel

This association is in the western part of the county. It consists of soils that formed, under bunchgrass, from alluvium and wind-modified materials derived from loess and glacial outwash. The annual precipitation is 7 to 9 inches. This association makes up about 10 percent of the county.

Ephrata soils are moderately coarse textured and moderately deep over gravel. Neppel soils are loamy and are moderately deep over waterworn fragments of a lime-silica cemented hardpan and lesser amounts of basaltic sands and gravel. Royal soils are very lee and are medium textured or moderately coarse texture. Also in this association are Scootene, Warden, and Prosser soils. Scootene soils developed from loamy alluvium and have

gravel throughout the profile. Warden soils developed from loamy windblown materials over reworked silty lacustrine material. Prosser soils are loamy and are moderately deep over basalt.

More than 97 percent of this association is under development for irrigation by the Columbia Basin Irrigation Project. Farms are in units of 80 to 160 acres of irrigable land. Sugar beets, beans, potatoes, field corn, and hay are the main crops. In general, the soils are fertile.

Othello, the fastest growing town in the county, is located in this association.

Ducks and upland game birds are important wildlife species along irrigation right-of-ways and bodies of water. The potholes and lakes of the Prosser-Starbuck rocky complexes have been stocked with perch, trout, crappie, sunfish, and bass by the Washington State Department of Game.

Descriptions of the Soils

This section describes the soil series and mapping units of Adams County. A general description of each series is followed by brief descriptions of the mapping units in that series. For full information about any one mapping unit, it is necessary to read the description of the soil series as well as the description of the mapping unit.

Two kinds of mapping units are described. A high-intensity survey was made of the soils within the boundaries of the Columbia Basin Irrigation Project, and a medium-intensity survey was made of the soils of the rest of the county. The composition of the medium-intensity mapping units is more variable than that of the high-intensity units but has been controlled well enough to allow interpretations for the expected uses of the soils.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the soil map and indicates whether it is a high-intensity or a medium-intensity unit. For a soil within the high-intensity survey, the symbol consists of a combination of capital and lower-case letters (BwB). It includes a number if the soil is eroded. For a soil within the medium-intensity survey, the symbol consists of capital letters (BEB). This symbol also includes a number if the soil is eroded. Two symbols in parentheses following the name of the mapping unit indicate that the soil occurred within both the high-intensity and medium-intensity surveys.

Listed at the end of the description of each mapping unit are the capability unit and the range site in which the soil has been placed. The page on which each capability unit and each range site is described can be found readily by referring to the "Guide to Mapping Units" at the back of the report. The approximate acreage and proportionate extent of each mapping unit are given in tables 1 and 2.

Soil scientists, engineers, students, and others who want detailed descriptions of soil series should turn to the section "Formation and Classification of the Soils." Many terms used in the soil descriptions and other sections of the report are defined in the Glossary.

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

Anders Series

The Anders series consists of well-drained, medium-textured soils underlain by basalt bedrock at a depth of 20 to 40 inches. These soils formed under bunchgrass, in silty glacial outwash that was derived from basalt rock and loess and was mixed with some volcanic ash. They occupy nearly level to strongly sloping outwash plains and terraces in the eastern part of the county. The elevation ranges from 1,500 to 1,800 feet. The annual precipitation is 12 to 14 inches.

The surface layer is silt loam about 12 inches thick. It is very dark brown in the upper part and very dark grayish brown below. The subsoil is dark-brown silt loam and is 10 to 40 percent gravel-sized basalt fragments. These fragments increase in number with depth. The subsoil is underlain by basalt at a depth of 20 to 40 inches.

Anders soils are used principally for range. Some areas are used for dryland grain or irrigated hay and pasture.

Anders silt loam, 0 to 5 percent slopes (ABB).-This is a silty soil on outwash plains and terraces. Most slopes are about 2 percent. Small areas of rock outcrop, soils less than 20 inches deep or more than 40 inches deep, and tracts of Bengé silt loam were included in mapping.

Representative profile:

Surface soil-

0 to 12 inches, silt loam; very dark brown in upper part, very dark grayish brown in lower part; granular structure; very friable or friable; neutral; abundant roots; small amount of gravel.

Subsoil-

12 to 27 inches, dark-brown silt loam; subangular blocky structure; friable; mildly alkaline; plentiful roots; 10 to 40 percent gravel-sized basalt fragments below a depth of 19 inches; fragments increase in number with depth.

Bedrock-

27 inches +, basalt.

This soil is well drained and moderately permeable. It holds about 4 to 7 inches of water that plants can use. It has good tilth and is easily worked. In places it is wet in spring, arid this delays tillage. A few stones are present, so care is needed in using certain types of equipment for deep tillage. Runoff is slow, and the erosion hazard is slight.

This soil is used mainly for range. Areas that have deteriorated can be summer fallowed and seeded to adapted grass. Where wells are available, irrigation is feasible. Some of the large areas of this soil are cultivated. Wheat and barley are grown on these in a crop-fallow system. Nonlegumes respond to nitrogen fertilizer. (Capability unit IIIs-1, nonirrigated; range site 5)

Anders silt loam, 5 to 20 percent slopes (ABC).-This soil has no wet spots that delay tillage early in spring. Runoff is medium, and the erosion hazard is moderate. (Capability unit IIIe-2, nonirrigated; range site 5)

Anders cobbly silt loam, 0 to 15 percent slopes (ACC).-The surface layer of this soil is 2 to 3 inches thinner than that of Anders silt loam, 0 to 5 percent slopes. Small noncobbly areas were included in mapping.

This soil holds 3 to 6 inches of water that is available to plants. It is used mainly for range but partly for

cultivated crops. Small grain is grown in a crop-fallow system. Grain crops respond to nitrogen. Cobblestones interfere with tillage, and some need to be removed. Small areas are irrigated for pasture and hay. (Capability unit IVe-8, nonirrigated; range site 10)

Anders-Kuhl very stony silt loams, 0 to 15 percent slopes (AKC).-This complex consists of about equal amounts of Anders stony silt loam and Kuhl very stony silt loam. Also included are small areas of Anders soils that are free of stones. The topography is hummocky. The hummocks are 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are generally 1 to 2 feet higher than the areas in between. The Anders soil occupies the hummocks, and the Kuhl soil the areas between the hummocks.

The Anders soil in this complex is similar to Anders silt loam, 0 to 5 percent slopes, except that it is stony, its surface layer is 3 to 5 inches thinner, and the slope is as much as 15 percent.

The Kuhl soil in this complex is a very stony soil on undulating basalt plateaus. Most slopes are about 10 percent.

Representative profile:

Surface layer-

0 to 6 inches, very dark grayish-brown very stony silt loam; platy structure; very friable; neutral; abundant roots.

6 to 11 inches, dark-brown stony silt loam; platy structure; very friable; neutral; plentiful roots.

Subsoil-

11 to 15 inches, dark yellowish-brown stony silt loam; prismatic structure; very friable; mildly alkaline, plentiful roots.

Bedrock-

15 inches +, basalt.

The surface layer and subsoil are either very stony loam or very stony silt loam and are 5 to 50 percent gravel, cobblestones, and stones. The surface layer is 7 to 12 inches thick. The color ranges from dark yellowish brown to brown. In places there is some lime accumulation on the basalt bedrock. The depth to bedrock ranges from 12 to 20 inches.

These soils are well drained and moderately permeable. They hold from 1 to 3 inches of water that plants can use. Runoff is slow to medium. The hazard of erosion is slight to moderate.

This complex is used for range. A few small areas of nonstony soils or of soils from which the stones have been cleared are irrigated and cultivated or planted to pasture. In most areas of this complex the soils are so intermingled that separate management of the components is not practical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Anders stony silt loam-capability unit VIe-1 (nonirrigated), range site 10; Kuhl very stony silt loam-capability unit VIIs-1 (nonirrigated), range site 10.

Anders-Kuhl very rocky silt loams, 0 to 15 percent slopes (ALC).-This complex is 30 to 50 percent Anders stony silt loam, 25 to 30 percent Kuhl very stony silt loam, and 20 to 45 percent rock outcrops. Also included are some areas of Anders soils that are free of stones. Between the rock outcrops, the topography is hummocky. The hummocks are 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are generally 1 to 2 feet higher than the areas in between. The Anders soil

occupies the hummocks, and the Kuhl soil the areas between the hummocks.

This complex is used for grazing. It is valuable for range because springs are plentiful and free water is near the surface. Most of it is unsuitable for cultivated crops because of stones and rock outcrops. In a few places the Anders soil can be seeded; however removal of stones may be needed. In many parts of this complex, however, the soils are so intermingled that separate management of the components is not practical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Anders stony silt loam-capability unit VIe-1 (nonirrigated), range site 10; Kuhl very stony silt loam-capability unit VIIs-1, range site 10; rock outcrops-capability unit VIIIs-1, no range site classification.

Anders-Kuhl extremely rocky silt loams, 0 to 15 percent slopes (AMC).-This complex is 40 to 60 percent rock outcrops. The rest consists of about equal amounts of Anders stony silt loam and Kuhl very stony silt loam. These soils occur as long, narrow depressions between the rock outcrops. The topography is hummocky. The hummocks are generally 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are 1 to 2 feet higher than the areas in between. The Anders soil occupies the hummocks, and the Kuhl soil the areas in between.

This complex is used for grazing. Cultivation is not practical. In places the Anders soil can be reseeded. In most areas of the complex, the soils are so intermingled that separate management of the components is not practical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Anders stony silt loam-capability unit VIe-1 (nonirrigated), range site 10; Kuhl very stony silt loam-capability unit VIIs-1 (nonirrigated), range site 10; rock outcrops-capability unit VIIIs-1, no range site classification.

Beckley Series

The Beckley series consists of somewhat excessively drained, moderately coarse textured soils underlain by coarse basalt sand at a depth of 20 to 40 inches. These soils developed under bunchgrass, from glaciofluvial material derived from basalt rocks and loess. They occupy gently sloping to strongly sloping terraces that border glacial outwash plains and major drains in the eastern part of the county. The elevation ranges from 1,500 to 1,800 feet. The annual precipitation is 12 to 14 inches

The surface layer is very dark brown coarse sandy loam about 11 inches thick. The subsoil is dark-brown coarse sandy loam. The substratum is basalt sand. Small basalt fragments are common throughout the soil.

Beckley soils are noncalcareous. They are used for small grain and range.

Beckley coarse sandy loam, 5 to 30 percent slopes (BCD).-This soil occupies terraces that adjoin outwash plains. Most slopes are about 8 percent. Most of the steeper slopes are short. A few areas that are less than 21 inches deep over coarse sand and some that have a layer of loamy sand above the coarse sand were included in mapping.

Representative profile:

Surface layer-

0 to 11 inches, very dark brown coarse sandy loam; granular structure; very friable or friable; mildly alkaline; abundant roots.

Subsoil-

11 to 23 inches, dark-brown coarse sandy loam; weak, subangular blocky structure; very friable; mildly alkaline; plentiful roots.

Substratum-

23 to 60 inches +, loose, coarse basalt sand.

The surface layer ranges from 10 to 13 inches in thickness. In places on short terrace breaks, it is fine sandy loam. In spots, some gravel or cobblestones occur in the profile. The depth to coarse sand ranges from 20 to 40 inches.

This soil is somewhat excessively drained and has moderately rapid permeability. It has good tilth and is easily worked. It holds 5 to 7 inches of water that plants can use. Runoff is slow. There is a slight hazard of water erosion and a moderate hazard of wind erosion.

This soil is fertile except that it is deficient in nitrogen. Most of the acreage is cultivated. The part that is more susceptible to wind erosion is used for range or is in perennial grass. Small grain is grown in a crop-fallow system. Grain crops respond to nitrogen. (Capability unit IIIe-2, nonirrigated; range site 8)

Benge Series

The Benge series consists of well-drained, medium-textured soils underlain by gravel at a depth of 20 to 40 inches. These soils formed under bunchgrass, from gravelly alluvium derived from loess and basalt rock. They occupy nearly level to strongly sloping outwash plains and terraces in the eastern part of the county. The elevation ranges from 1,500 to 2,500 feet. The annual precipitation is 12 to 14 inches.

The surface layer is very dark brown silt loam about 10 inches thick. In many places it is gravelly or stony. The subsoil is dark-brown gravelly silt loam that is 25 to 50 percent gravel. The substratum is basalt gravel and sand.

Benge soils are used principally for range. Some areas are used for dryland grain or for irrigated hay and pasture.

Benge silt loam, 0 to 5 percent slopes (BEB).- This is a silty soil on outwash plains and terraces. Most slopes are about 2 percent. Small areas of rock outcrop and of soils less than 20 inches deep or more than 40 inches deep were included in mapping. A profile of this soil is shown in figure 2.

Representative profile:

Surface layer-

0 to 10 inches, very dark brown silt loam; granular structure; friable; neutral; abundant roots; small amount of gravel.

Subsoil-

10 to 26 inches, dark-brown gravelly silt loam; weak, medium, prismatic structure in upper part, massive in lower part; very friable; mildly alkaline; many roots; 25 to 50 percent gravel; amount of gravel increases with depth.

Substratum-

26 inches +, basalt gravel and sand; some lime coatings on underside of gravel; mildly alkaline.

The thickness of the surface layer ranges from 10 to 13 inches. The depth to gravel is 20 to 40 inches.

This soil is well drained and moderately permeable. It has good tilth and is easily worked. It holds 5 to 7 inches of water that plants can use. Wet spots in depressions may make it necessary to delay tillage in spring. Surface runoff is slow, and the erosion hazard is slight.

About 50 percent of the acreage is cultivated. Areas that have deteriorated can be summer fallowed and seeded to adapted grass. Where wells are available, seeding of irrigated pastures and alfalfa hay is possible. Dryland areas are used for small grain. Crops respond to nitrogen. (Capability unit IIIs-1, nonirrigated; range site 5)



Figure 2.-Profile of Benge silt loam, 0 to 5 percent slopes, showing large quantity of gravel in subsoil. Distance from surface to bottom of hole is about 3 feet.

Benge silt loam, 5 to 30 percent slopes (BED).-The surface layer of this soil is 2 to 3 inches thinner than that of Benge silt loam, 0 to 5 percent slopes. Runoff is medium and the erosion hazard is moderate. (Capability unit IIIe-2, nonirrigated; range site 5)

Benge gravelly silt loam, 0 to 15 percent slopes (BGC).-The surface layer of this soil is 2 to 3 inches thinner than that of Benge silt loam, 0 to 5 percent slopes, and the amount of water held and available to plants is less than 5 inches. Hummocks make up 15 percent of the acreage. Most of the hummocks are between 10 and 30 feet in diameter and are a foot or two high. The soil is deeper in the hummocks than between them. Small nongravelly areas were included in mapping.

This soil is used mainly for range, but a small part of it is used for small grain, which is grown in a crop-fallow system. Grain crops respond to nitrogen. Cobblestones make tillage difficult, and some of them need to be removed. Small areas have been irrigated for pasture and hay. (Capability unit IVe-8, nonirrigated; range site 5)

Benge gravelly silt loam, 15 to 30 percent slopes (BGD).-This soil is used only for range. Runoff is medium, and the erosion hazard is moderate. Steep, short terrace breaks were included in mapping. (Capability unit VIe-1, nonirrigated; range site 5)

Benge very stony silt loam, 0 to 30 percent slopes (BND).-This soil is hummocky and is deeper in the hummocks than between them. It holds less than 5 inches of water that plants can use. Some areas in which the soil is nonstony and less than 20 inches deep were included in mapping.

Most of this soil is used for range. Cultivation is impractical. Small areas have been cleared of stones and are irrigated for pasture and hay. (Capability unit VIIs-1, nonirrigated; range site 10).

Benge very rocky silt loam, 0 to 30 percent slopes (BRD).-This mapping unit is a complex that is 15 to 20 percent rock outcrops; 10 to 30 percent Benge very stony silt loam; 5 to 10 percent Benge silt loam that has a slope range of 5 to 30 percent; and 40 to 60 percent Benge silt loam that has a slope range of 0 to 5 percent. Also included are small areas of Anders and Emdent soils.

This complex is used for range. Most of it is not suitable for the common cultivated crops because of the stones and rock outcrops. It is valuable for range because free water is near the surface and seeps from the steeper slopes. Springs are numerous in the lower areas, mainly in the Evident soils.

Most nonstony and nonrocky areas of this complex are less than one-half acre in size. Some long narrow strips are as much as 5 acres in extent and could be cultivated if accessible. In most areas of this complex, however, the component soils are so intermingled that they cannot, practically, be managed separately.

As a complex: capability unit VIe-1 (nonirrigated), range site 5. By components: Benge silt loam in 0 to 5 percent slope range-capability unit IIIs-1 (nonirrigated), range site 5; Benge silt loam in 5 to 30 percent slope range-capability unit IIIe-2 (nonirrigated), range site 5; Benge very stony silt loam-capability unit VIIs-1 (nonirrigated), range site 10; rock outcrops-capability unit VIIIs-1, no range site classification.

Benge extremely rocky silt loam, 0 to 30 percent slopes (BTD).-This mapping unit is a complex that is 40 to 60 percent rock outcrops; 20 to 30 percent Benge very stony silt loam; 10 to 15 percent Benge silt loam in the 5 to 30 percent slope range; and 20 to 30 percent Benge silt loam in the 0 to 5 percent range slope. Also included are small areas of Anders and Emdent soils.

This complex is used for range. Most of it is not suitable for the common cultivated crops because of the stones and rock outcrops. It is valuable for range, because free water is near the surface and seeps from the steeper slopes. Springs are numerous in this complex, mainly in the Emdent soils.

Most nonstony and nonrocky areas of this complex are less than one-half acre in size. Some long narrow strips are as much as 4 acres in extent and could be cultivated if accessible. In places the nonstony and nonrocky areas are large enough to be reseeded to perennial grasses. In most areas of this complex, however, the soils are so intermingled that separate management of the components is not practical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Benge silt loam-capability unit VIe-1, range site 5; Benge very stony silt loam-capability unit VIIs-1 (nonirrigated), range site 10; rock outcrops-capability unit VIIIs-1, no range classification.

Burke Series

The Burke series consists of well-drained, medium-textured soils underlain by a lime-silica cemented hardpan at a depth of 15 to 40 inches. These soils formed under bunchgrass and sagebrush, in loess of mixed origin. They occupy gently sloping to steep uplands in the western part of the county. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown silt loam about 4 inches thick. The subsoil is dark-brown, calcareous very fine sandy loam or silt loam. The hardpan overlies softly consolidated flood-plain or lake sediments, gravelly alluvial deposits, or basalt bedrock.

Most of the acreage is cultivated. Large areas are irrigated under the Columbia Basin Irrigation Project.

Burke silt loam, 0 to 2 percent slopes (BuA).--This is a silty soil on uplands in the western part of the county.

Representative profile:

Surface layer-

0 to 4 inches, dark grayish-brown silt loam; granular structure; very friable; mildly alkaline; abundant roots; few white hardpan fragments.

Subsoil-

4 to 22 inches, dark-brown silt loam; massive; very friable; moderately alkaline; calcareous; abundant roots; few white hardpan fragments.

Substratum-

22 inches +, indurated, lime-silica cemented hardpan.

The surface layer is 3 to 6 inches thick. The subsoil ranges from very fine sandy loam to silt loam. Lime-silica cemented fragments are common on the surface and throughout the profile. The depth to free lime is 4 to 10 inches. The depth to the hardpan is 20 to 40 inches.

This soil is well drained and moderately permeable. It has good tilth and is easily worked. It holds 5 to 7 inches of water that plants can use. Roots penetrate as far down

as the hardpan. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight to moderate.

This soil is suited to both surface and sprinkler irrigation, and more than 90 percent of it is irrigated. Drainage is a problem in places if excess water is applied or if water seeps from higher lying soils. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. (Capability unit IIs-2, irrigated; range site 4)

Burke silt loam, 2 to 5 percent slopes (BuB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. Furrows and corrugations should be held to a 2 percent gradient, or the length of run should be reduced. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. (Capability unit IIE-3, irrigated; range site 4)

Burke silt loam, 5 to 10 percent slopes (BuC).-In irrigated areas of this soil, runoff is rapid and the hazard of water erosion is severe. Sprinkler irrigation is the most suitable. There is no hazard of seepage from higher lying soils. Row crops are not generally grown. (Capability unit IIIe-3, irrigated; range site 4)

Burke silt loam, 10 to 15 percent slopes (BuD).-In irrigated areas of this soil, runoff is very rapid and the hazard of water erosion is very severe. Only sprinkler irrigation is suitable. (Capability unit IVs-1, irrigated; range site 4)

Burke silt loam, 15 to 30 percent slopes (BuE).-This soil can be irrigated by sprinkler systems and used for grass and alfalfa or for orchards and vineyards that are protected with a permanent cover crop. In irrigated areas, runoff is very rapid and the hazard of water erosion is very severe. (Capability unit VIe-1, irrigated; range site 4)

Burke silt loam, shallow, 0 to 5 percent slopes (BvB).-This soil holds 3 to 4 inches of water that plants can use. In irrigated areas, runoff is slow to medium and the hazard of water erosion is slight to moderate. Either sprinkler or surface irrigation is suitable. Excess irrigation or seepage from higher lying soils causes drainage problems in places. The depth to the lime-silica hardpan is 15 to 20 inches. Beans, alfalfa, grass, corn, potatoes, grain, and mint are the major crops. (Capability unit IVs-1, irrigated; range site 9)

Burke silt loam, shallow, 5 to 10 percent slopes (BvC).-In irrigated areas of this soil, runoff is rapid and the hazard of water erosion is severe. Surface irrigation is not suitable. This soil is used mainly for hay and pasture crops. Row crops are not generally grown. (Capability unit IVs-4, irrigated; range site 9)

Burke silt loam, shallow, 15 to 30 percent slopes (BvE).-In irrigated areas of this soil, runoff is very rapid and the erosion hazard is very severe. Sprinklers can be used, and hay and pasture crops can be grown. Row crops are not suitable. (Capability unit VIe-1, irrigated; range site 9)

Burke gravelly silt loam, 0 to 5 percent slopes (BwB).-This soil is 20 to 40 percent gravel-sized fragments from the lime-silica hardpan. The depth to the hardpan is 15 to 20 inches. The available water capacity is 2 to 4 inches. In irrigated areas, runoff is medium and the hazard of water erosion is moderate. Either sprinkler or surface irrigation is suitable. Excess irrigation

or seepage from higher lying soils causes drainage problems in places. Alfalfa, grass, corn, grain, and mint are the major crops. (Capability unit IVs-1, irrigated; range site 9)

Burke silt loam, 0 to 5 percent slopes (BUB).-This soil is outside the boundaries of the Columbia Basin Irrigation Project and is used only for grazing and dryland grain. Rye or wheat is grown in a crop-fallow system. Low rainfall, drying winds, and the limited moisture-holding capacity make this soil marginal for dryland cultivation. (Capability unit IVE-7, nonirrigated; range site 4)

Burke silt loam, 5 to 30 percent slopes (BUD).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. It is used for grazing and for dryland grain. Rye or wheat is grown in a crop-fallow system. Low rainfall, drying winds, and limited moisture-holding capacity make this soil marginal for dryland cultivation. (Capability unit IVE-7, nonirrigated; range site 4)

Burke silt loam, 0 to 30 percent slopes, eroded (BUD2).-Much of the original surface layer of this soil has been removed by wind erosion. In many places the soil is calcareous throughout. Areas of soil less than 20 inches deep and small areas where the slope is more than 30 percent were included in mapping. This soil is unsuited to cultivation but is suited to grazing. (Capability unit VIe-2, nonirrigated; range site 9)

Burke silt loam, 30 to 40 percent slopes, eroded (BUE2).-This soil is suited to grazing. The erosion hazard is severe. (Capability unit VIe-2, nonirrigated; range site 9)

Chamber Series, Calcareous Variant

This variant of the Chamber series is a poorly drained soil that formed under sedges, rushes, and grasses, from alluvium of mixed origin. It is in depressions and basins in the eastern part of the county. The annual precipitation is 12 to 14 inches.

The surface layer is silt loam about 9 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The subsoil is dark-gray silty clay that is strongly calcareous in the lower part. Basalt bedrock is at a depth of 30 to 50 inches.

This soil is used mainly for grazing and as a wildlife habitat.

Chamber silt loam, calcareous variant, 0 to 2 percent slopes (CCA).-This soil is in depressions and basins. Small stony patches, rock outcrops, and areas that are underlain by gravel below a depth of 30 inches were included in mapping.

Representative profile:

Surface layer-

0 to 5 inches, very dark gray silt loam; weak, fine, granular structure; very friable; neutral; abundant roots.

5 to 9 inches, dark-gray silt loam; massive; friable; neutral; abundant roots.

Subsoil-

9 to 40 inches, dark-gray silty clay; moderate, medium, prismatic structure breaking to subangular blocky; firm; strongly alkaline and noncalcareous at a depth of 9 to 32 inches, moderately alkaline and strongly calcareous below a depth of 32 inches; segregated lime below a depth of 32 inches; abundant roots.

Substratum-

40 inches +, basalt bedrock.

The depth to bedrock ranges from 30 to 50 inches.

This soil is poorly drained and slowly permeable. It holds about 5 to 7 inches of water that plants can use. Workability is poor. Runoff is very slow, and water often ponds in winter and spring. The erosion hazard is none to slight.

This soil is used mainly for limited grazing and as a wildlife habitat. A few drained areas have been cropped. Drainage outlets are difficult to find. (Capability unit VIw-1, nonirrigated; range site 1)

Chard Series

The Chard series consists of well-drained, medium-textured soils that formed under bunchgrass, in glaciofluvial material derived from loess and basalt. These soils occupy nearly level to strongly sloping dissected terraces in the eastern part of the county. The elevation ranges from 1,200 to 1,600 feet. The annual precipitation is 12 to 14 inches.

The surface layer consists of silt loam and is about 12 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is dark-brown loam, very fine sandy loam, or silt loam, and grades to sandy loam in the lower part. It is calcareous at a depth of 24 to 45 inches. The substratum is coarse basalt sand. Coarse sand and small fragments of basalt are common throughout the profile.

Most of the acreage is cultivated.

Chard silt loam, 0 to 5 percent slopes (CHB).-This is a silty soil on terraces that border outwash plains. Most slopes are about 4 percent.

Representative profile:

Surface layer-

0 to 12 inches, silt loam, very dark brown in upper part, very dark grayish brown in lower part; granular structure; very friable; plentiful roots; mildly alkaline.

Subsoil-

12 to 44 inches, stratified layers of dark-brown very fine sandy loam and sandy loam; weak, prismatic structure in upper part massive in lower part; very friable; plentiful roots to a depth of 27 inches, few below this depth; moderately alkaline; calcareous and strongly alkaline below a depth of 37 inches.

Substratum-

44 to 60 inches +, coarse basalt sand; single grain; loose; strongly alkaline; calcareous.

The surface layer ranges from 10 to 14 inches in thickness and is 5 to 15 percent coarse basalt sand. Lenses and strata of fine gravel are common in the lower part of the profile. The depth to calcareous material is 24 to 45 inches.

This soil is well drained and moderately permeable. It has good tilth and is easily worked. It holds 7 to 9 inches of water that plants can use. It is high in fertility except that it is deficient in nitrogen. Runoff is slow. The hazard of wind and water erosion is slight.

This soil is used principally for small grain. Crops respond to nitrogen. (Capability unit IIc-1, nonirrigated; range site 5)

Chard silt loam, 5 to 30 percent slopes (CHD).-The surface layer of this soil is 2 to 4 inches thinner than that of Chard silt loam, 0 to 5 percent slopes. In places on the steeper slopes, 25 to 50 percent of the original surface layer has been lost through erosion. Runoff is medium, and the hazard of water erosion is mod-

erate. There are some limitations on the use of machinery on the steeper slopes. (Capability unit IIIe-1, nonirrigated; range site 5)

Emdent Series

The Emdent series consists of moderately well drained and somewhat poorly drained, medium-textured, saline-alkali soils that formed from volcanic ash and alluvium derived from loess and basalt. These soils occupy nearly level depressions, basins, or potholes in the eastern part of the county. The elevation ranges from 1,500 to 1,800 feet. The annual precipitation is 10 to 14 inches.

The surface layer is very dark gray, black, or brown, very strongly alkaline silt loam. The subsoil is dark-colored, stratified, calcareous silt loam that is mostly volcanic ash and diatomite. The substratum is fine sandy loam. In places it is underlain by basalt at a depth of more than 24 inches.

These soils are used mainly for range. Many drained areas are irrigated. Alfalfa and grass are the principal crops grown under irrigation.

Emdent silt loam, 0 to 5 percent slopes (ECB).-This is a silty soil in depressions and basins. Most slopes are about 2 percent. Highly organic black soils (peat and muck) were including mapping.

Representative profile:

Surface layer-

0 to 16 inches, very dark gray silt loam; moderate, fine, platy and weak, medium, subangular blocky structure; friable; very strongly alkaline, strongly calcareous; plentiful roots.

Subsoil-

16 to 26 inches, dark-gray and dark grayish-brown silt loam; massive; friable; few roots; moderately alkaline; calcareous.

Substratum-

26 to 60 inches +, light brownish-gray and light-gray very fine sandy loam; massive; very friable; very few roots; moderately alkaline; calcareous to a depth of 52 inches, noncalcareous below this depth.

The surface layer ranges from 10 to 20 inches in thickness and from very dark gray to black in color. In places the subsoil contains a weak, discontinuous hardpan. The depth to basalt is 36 to more than 60 inches. The depth to the water table varies between 2 and 8 feet during the year.

This soil is somewhat poorly drained and moderately permeable. It holds about 7 to 11 inches of water that salt-tolerant plants can use. Runoff is very slow, and there is little or no hazard of water erosion. Drainage is hard to establish because outlets usually require blasting. The hazard of wind erosion is slight to moderate if this soil is cultivated.

This soil is used for grazing and is especially good for summer grazing. It can be planted to alkali-tolerant grass. It provides excellent sites for waterholes for livestock. (Capability unit VIw-1, nonirrigated; range site 1)

Emdent silt loam, drained, 0 to 5 percent slopes (EDB).-This soil is mainly along Cow Creek and in depressions in the channeled scablands east of Cow Creek. Its somewhat poor natural drainage has been improved by stream cutting or by artificial means, and it is now moderately well drained.

This soil is suited to range and to alfalfa and grass. If cultivated, it tends to become powdery and susceptible

to severe wind erosion. Part of the acreage is irrigated, and some areas along Caw Creek are subirrigated. Part of the acreage is subject to flooding. This part is not suited to dryland crops but can be used for small grain if irrigated and protected against flooding. (Capability unit VIs-2, nonirrigated; range site 1)

Emdent silt loam, moderately shallow, 0 to 8 percent slopes (EFB).-The depth to basalt bedrock in this soil is 24 to 36 inches, and the available water capacity for salt-tolerant plants is about 4 to 6 inches. This soil is used for grazing. (Capability unit VIw-1, nonirrigated; range site 1)

Emdent very rocky silt loam, 0 to 15 percent slopes (EGC).-This mapping unit is a complex that is 15 to 20 percent rock outcrops; 10 to 30 percent moderately shallow Emdent silt loam in the 0 to 8 percent slope range; and 50 to 70 percent Emdent silt loam in the 0 to 5 percent slope range. Also included are small areas of Anders soils. The deep Emdent soil occupies small basins and consequently has poor surface drainage. Most areas are 1/2 to 1 acre in size, but some are as large as 5 acres. Rock outcrops surround the basins. The moderately shallow Emdent soil generally occurs in channels and passageways that connect the deeper basins.

This complex is used for grazing. It has free water near the surface. The larger basins can be seeded to salt-tolerant grasses. In many parts of the complex, however, the soils are so intermingled that separate management of the components is impractical.

As a complex: capability unit VIs-1 (nonirrigated), range site 1. By components: Emdent silt loam-capability unit VIw-1 (nonirrigated), range site 1; Emdent silt loam, moderately shallow-capability unit VIw-1 (nonirrigated), range site 1; rock outcrops-capability unit VIIs-1, no range classification.

Emdent extremely rocky silt loam, 0 to 15 percent slopes (EMC).-This mapping unit is a complex that is 40 to 60 percent rock outcrops; 20 to 30 percent moderately shallow Emdent silt loam in the 0 to 8 percent slope range; and 30 to 50 percent Emdent silt loam in the 0 to 5 percent slope range. Also included are small areas of Anders soils. The deeper Emdent soil occurs in small basins and consequently has poor surface drainage. Most areas are 1/2 to 1 acre in size, but some are as large as 3 or 4 acres. Rock outcrops surround the basins. The moderately shallow Emdent soil generally occurs in the channels or passageways that connect the deeper basins.

This complex is used for grazing. It has free water near the surface. The larger basins can be reseeded with salt-tolerant grasses. In many parts of this complex the soils are so intermingled that separate management of the components is impractical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 1. By components: Emdent silt loam capability unit VIw-1 (nonirrigated), range site 1; moderately shallow Emdent silt loam-capability unit VIw-1 (nonirrigated), range site 1; rock outcrops-capability unit VIIs-1, no range classification.

Endicott Series

The Endicott series consists of well-drained, medium-textured soils underlain by an indurated, lime-silica hardpan (fig. 3). These soils formed in loess, under bunch-



Figure 3.-Profile of an Endicott soil. Indurated lime-silica cemented hardpan is about 20 inches below the surface.

grass. They occupy nearly level to hilly knolls and ridgetops in the eastern part of the county. The elevation ranges from 1,500 to 2,000 feet. The annual precipitation is 12 to 14 inches.

The surface layer is silt loam about 12 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is dark-brown silt loam and is calcareous at a depth of 15 to 24 inches. The depth to the hardpan substratum ranges from 20 to 40 inches.

Endicott soils are used for dryland wheat in a crop-fallow system.

Endicott silt loam, 0 to 5 percent slopes (ENB).-This is a silty soil on knolls and broad ridgetops. Most slopes are about 3 percent. Small eroded areas and areas where the hardpan is within 14 inches of the surface were included in mapping.

Representative profile:

Surface layer-

0 to 12 inches; silt loam, very dark brown in upper part, very dark grayish brown in lower part; granular structure; friable; mildly alkaline; abundant roots; 5 percent small white hardpan fragments.

Subsoil-

12 to 17 inches, dark-brown silt loam; prismatic structure; friable; mildly alkaline; 10 to 15 percent small white hardpan fragments.

17 to 27 inches, dark yellowish-brown silt loam; massive; friable; moderately alkaline; strongly calcareous; 10 to 15 percent small white hardpan fragments.

Substratum-

27 inches +, successive layers of indurated lime-silica hardpan lenses 1 to 12 inches thick. Indurated layers are separated by grayish-brown, limy silt loam.

The thickness of the surface layer ranges from 9 to 14 inches. The depth to lime is 15 to 24 inches. The depth to the hardpan is 20 to 40 inches.

This soil is well drained and moderately permeable. It holds from 4 to 7 inches of water that plants can use. It is easy to work. Roots penetrate the hardpan through cracks. Runoff is slow. The erosion hazard is slight.

This soil is used principally for small grain under a crop-fallow system. It is fertile, except that it is deficient in nitrogen. (Capability unit IIIs-1, nonirrigated; range site 5)

Endicott silt loam, 5 to 15 percent slopes (ENC). -Small eroded areas were included with this soil in mapping. Runoff is medium, and the hazard of water erosion is moderate. Small grain is grown in a crop-fallow system. (Capability unit IIIe-2, nonirrigated; range site 5)

Endicott silt loam, 5, to 15 percent slopes, eroded (ENC2). -From 3 to 6 inches of the original surface layer of this soil has been removed through erosion. Fragments of the white hardpan are common on the surface and throughout the profile. In places the surface layer is calcareous. Runoff is medium, and the erosion hazard is moderate. Small grain is grown under a crop-fallow system, but yields are less than on Endicott silt loam, 0 to 5 percent slopes. (Capability unit IVe-2, nonirrigated; range site 10)

Ephrata Series

The Ephrata series consists of well-drained, moderately coarse textured soils underlain by sand and gravel at a depth of 20 to 40 inches. These soils formed under bunchgrass, in glacial outwash material derived from loess, basalt, and small amounts of quartzite and granite. They occupy nearly level to strongly sloping outwash plains and terraces in the western part of the county. The elevation ranges from 900 to 1,100 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown sandy loam about 6 inches thick. The subsoil is dark-brown fine sandy loam and is gravelly in the lower part. The substratum is basalt sand and gravel. The underside of the gravel is coated with lime and silica.

Ephrata soils are used for many kinds of crops under irrigation.

Ephrata sandy loam, 0 to 2 percent slopes (EpA). -This soil is on out-wash plains and terraces. Most slopes are about 1 percent. Areas that have a gravelly surface layer were included in mapping.

Representative profile:

Surface layer-

0 to 6 inches, dark grayish-brown sandy loam; granular structure; very friable; mildly alkaline; abundant roots.

Subsoil-

6 to 21 inches, dark-brown fine sandy loam, gravelly in lower part; subangular blocky structure; very friable; mildly to moderately alkaline; abundant roots.

21 to 28 inches, dark-brown very gravelly sandy loam; massive; very friable; abundant roots; moderately alkaline.

Substratum-

28 inches +, gravel and sand; lime-silica coatings on underside of gravel.

The surface layer ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. It is up to 6 inches thick in cultivated areas. The depth to sandy gravel is 20 to 40 inches. The percentage of gravel ranges from 15 to 50 percent in the upper part of the subsoil. In places lime occurs a few inches above the gravel. In places the gravelly substratum is underlain by a lime-silica hardpan or by Ringold beds.

This soil is well drained and has moderately rapid permeability. It holds 5 to 7 inches of water that plants can use. Runoff is slow. In places local drainage problems occur in areas underlain by Ringold beds. The hazard of water erosion is slight. The hazard of wind erosion is slight to moderate.

Various crops are grown under irrigation. Beans, peas, sugar beets, corn, potatoes, and wheat are the principal crops, but alfalfa, clover, and grass are grown also. Nonlegumes respond to nitrogen. Beans respond to zinc. Both surface and sprinkler irrigation are suitable. (Capability unit IIs-1, irrigated; range site 8)

Ephrata sandy loam, 2 to 5 percent slopes (EpB). -In irrigated areas of this soil, runoff is medium and the erosion hazard is moderate. The crops are the same as those grown on Ephrata sandy loam, 0 to 2 percent slopes, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-2, irrigated; range site 8)

Ephrata sandy loam, 5 to 10 percent slopes (EpC). -In irrigated areas of this soil, runoff is rapid and the erosion hazard is severe. Sprinkling is the most suitable method of irrigation. Row crops are not generally grown. (Capability unit IIIe-1, irrigated; range site 8)

Ephrata sandy loam, 10 to 15 percent slopes (EpD). -The depth to gravel is more variable in this soil than in Ephrata sandy loam, 0 to 2 percent slopes, and gravel on the surface is more common. Short terrace breaks of more than 15 percent slopes were included in mapping. In irrigated areas, runoff is very rapid and the erosion hazard is very severe. Only sprinkler irrigation is suitable. (Capability unit IVe-1, irrigated; range site 8)

Ephrata gravelly sandy loam, 0 to 5 percent slopes

(ErB).-This soil holds 4 to 5 inches of water that plants can use.

Beans, corn, sugar beets, wheat, potatoes, alfalfa, and grass are the main crops. Both surface and sprinkler irrigation are suitable. Nonlegumes respond to nitrogen. Beans respond to zinc. The gravel causes some difficulty in cultivation. (Capability unit IIIs-1, irrigated; range site 8)

Ephrata very gravelly sandy loam, 0 to 5 percent slopes (EsB). -In many places this soil contains a significant number of cobblestones. The available moisture capacity is 3 to 4 inches.

Crops grown under irrigation are wheat, alfalfa, sugar beets, and grass. Nonlegumes respond to nitrogen. Both surface and sprinkler irrigation are suitable. (Capability unit IVs-2, irrigated; range site 8)

Ephrata very gravelly sandy loam, 5 to 15 percent slopes (EsD). -Some parts of this soil are cobbly. The depth to the gravelly substratum is more variable and is generally less than in Ephrata sandy loam; 0 to 2 percent

slopes. The available moisture capacity is 3 to 4 inches. Runoff is rapid, and the hazard of water erosion is severe.

This soil is best suited to sprinkler irrigation. Alfalfa, grass, and wheat are the main crops. Nonlegumes respond to nitrogen. (Capability unit IVe-4, irrigated; range site 8)

Ephrata stony sandy loam, 15 to 30 percent slopes (EtE).-The depth to the gravelly substratum is variable in this soil and is generally less than in Ephrata sandy loam, 0 to 2 percent slopes. This soil holds 3 to 4 inches of water that plants can use. It is not suitable for cultivation unless the stones are removed. (Capability unit VIe-1, irrigated; VIe-2, nonirrigated; range site 8)

Ephrata loamy sand, 0 to 5 percent slopes, eroded (EuB2).-This soil holds 4 to 5 inches of water that plants can use. It is used for many of the same crops that are grown on Ephrata sandy loam, 0 to 2 percent slopes, but more of its acreage is in grass and legumes. Sprinkling is the most suitable method of irrigation. The hazard of wind erosion is severe. (Capability unit IIIs-1, irrigated; range site 7)

Ephrata sandy loam, 0 to 15 percent slopes (EPC).-This soil is used for grazing. It is not suitable for cultivated crops. (Capability unit VIe-2, nonirrigated; range site 8)

Ephrata cobbly sandy loam, 0 to 15 percent slopes (ERC).-The depth to the gravelly substratum in this soil is more variable and generally is less than in Ephrata sandy loam, 0 to 2 percent slopes. This soil is used for grazing. (Capability unit VIe-2, nonirrigated; range site 8)

Esquatzel Series

The Esquatzel series consists of well-drained, deep and very deep, medium-textured soils. These soils formed under bunchgrass and ryegrass on nearly level bottom land in the central and western parts of the county. Their parent material is alluvium derived from loess. The elevation ranges from 800 to 1,500 feet. The annual precipitation is 8 to 12 inches.

The surface layer is dark brown or very dark grayish brown and is about 7 inches thick. The subsoil and substratum are dark-brown silt loam and are stratified with lenses of fine sandy loam or sandy loam. This soil is calcareous at a depth of 12 to 40 inches. In places it is underlain by gravel or basalt below a depth of 40 inches.

Most of the acreage is cultivated.

Esquatzel silt loam, 0 to 2 percent slopes (EzA)(ESA).-This is a silty soil on the alluvial bottom land. Most slopes are about 2 percent, but slopes of more than 2 percent occur along the edges of the bottom land. Small areas of coarser textured soils, areas high in volcanic ash, and areas where the surface layer is dark grayish brown were included in mapping.

Representative profile:

Surface layer-

0 to 7 inches, dark-brown silt loam; platy structure; very friable; neutral; abundant roots.

Subsoil and substratum-

7 to 60 inches +, dark-brown silt loam; massive; very friable; mildly alkaline; calcareous below a depth of 29 inches; plentiful roots.

The surface layer ranges from dark brown to very dark grayish brown in color and from very fine sandy loam to silt loam in texture. The subsoil is stratified and ranges from silt loam to very fine sandy loam also. The depth to calcareous soil ranges from 12 to 40 inches. In places the lower part of the subsoil is strongly alkaline.

This soil is well drained and moderately permeable. It holds 9 to 11 inches of water that plants can use. It is easily worked. Flooding is sometimes a hazard in winter and early in spring. In many places stream channels form a raided pattern, and cultivation of such areas is often impractical. In the eastern part of the county, frost in spring often damages crops. Consequently, yields of dryland crops vary from year to year. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight to moderate.

In dryland areas small grain is grown in a crop-fallow system. The irrigated crops are potatoes, beans, sugar beets, corn, small grain, alfalfa, and hay and pasture crops. Both surface and sprinkler irrigation are suitable. Drainage problems occur in places where water seeps from higher lying soils that have been overirrigated. Nonlegumes respond to nitrogen. (Capability unit I-1, irrigated; IIIc-1, nonirrigated; range site 2)

Esquatzel fine sandy loam, 0 to 2 percent slopes (EvA)(ETA).-This soil can be used in the same way as Esquatzel silt loam, 0 to 2 percent slopes. Its subsoil is very fine sandy loam. The hazard of wind erosion is moderate but can be reduced by deep plowing, which mixes the subsoil and surface layer. (Capability unit I-1, irrigated; IIIc-1, nonirrigated; range site 2)

Farrell Series

The Farrell series consists of deep, well-drained medium-textured soils. These soils formed under bunchgrass, in glaciofluvial material derived from loess and basalt sand. They occupy nearly level to strongly sloping terraces in the central part of the county. The elevation ranges from 1,500 to 1,700 feet. The annual precipitation is 9 to 12 inches.

The surface layer is fine or very fine sandy loam that is very dark grayish brown in the upper part, dark brown in the lower part, and about 8 inches thick. The subsoil is mostly dark grayish-brown very fine sandy loam stratified with sandy loam; it is calcareous at a depth of about 14 inches. The substratum is basalt sand.

Farrell soils are used primarily for small grain in a crop-fallow system. Some areas are used for range.

Farrell very fine sandy loam, 0 to 5 percent slopes (FAB).-This is a loamy soil on terraces. Most slopes are about 4 percent. Small areas of eroded soils; of Ritzville silt loam, 0 to 5 percent slopes; and of Magallon silt loam, 5 to 30 percent slopes, were included in mapping.

Representative profile:

Surface layer-

0 to 8 inches, very fine sandy loam, very dark grayish brown in upper part, dark brown in lower part; granular structure; soft when dry, very friable when moist; mildly alkaline; plentiful roots.

Subsoil-

8 to 24 inches, dark grayish-brown loam; weak, subangular blocky structure in upper part, massive in lower part; very friable; moderately alkaline and strongly calcareous below a depth of 16 inches; plentiful roots.

24 to 54 inches, dark grayish-brown coarse sandy loam; massive; very friable; moderately alkaline and strongly calcareous; few roots.

Substratum-

54 to 60 inches +, coarse basalt sand.

The surface layer is 7 to 10 inches thick. It is 5 to 15 percent coarse basalt sand. Its texture ranges from silt loam to very fine sandy loam. The depth to the moderately coarse textured stratified layers ranges from 20 to 40 inches. The depth to lime ranges from 14 to 34 inches. Firm concretions are common in the lower part of the profile. In places basalt sand occurs below a depth of 40 inches.

This soil is well drained and moderately permeable. It holds 7 to 9 inches of water that plants can use. It is easy to work. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

This soil is used principally for small grain in a crop-fallow system. Grain crops respond to nitrogen. (Capability unit IIIc-1, nonirrigated; range site 5)

Farrell very fine sandy loam, 5 to 30 percent slopes

(FAD).-This soil can be used in the same way as Farrell very fine sandy loam, 0 to 5 percent slopes. Runoff is medium, and the hazard of wind and water erosion is moderate. There are some limitations to the use of machinery on the steeper slopes. (Capability unit IIIe-3, nonirrigated; range site 5)

Farrell fine sandy loam, 0 to 30 percent slopes, eroded (FFD2).-This soil can be used in the same way as Farrell very fine sandy loam, 0 to 5 percent slopes. Runoff is medium, and the hazard of wind and water erosion is moderate. (Capability unit IVe-3, nonirrigated; range site 5)

Farrell fine sandy loam, 30 to 40 percent slopes, eroded (FFE2).-This soil is not suited to cultivation. It is coarser textured than the Farrell very fine sandy loam because its surface layer has been reworked by wind. Runoff is rapid, and the hazard of water erosion is severe. (Capability unit VIe-1, nonirrigated; range site 5)

Hermiston Series

The Hermiston series consists of very deep, well-drained, medium-textured soils. These soils formed under bunchgrass, in a mixture of reworked loess and alluvium derived from volcanic ash. They occur on low terraces or flood plains in the eastern part of the county. The annual precipitation is 12 to 14 inches. The elevation ranges from 1,500 to 2,000 feet.

The surface soil is very dark brown silt loam about 8 inches thick. The subsoil and substratum, which are mostly very dark brown silt loam, are calcareous below a depth of 15 to 25 inches.

Hermiston soils are used principally for small grain in a crop-fallow system. Pasture crops and hay can be grown without irrigation.

Hermiston silt loam, 0 to 2 percent slopes (HEA). -This is a silty soil on the alluvial bottom land. Most slopes are about 1 percent.

Representative profile:

Surface layer-

0 to 8 inches, very dark brown silt loam; granular structure; very friable when moist; mildly alkaline; plentiful roots.

Subsoil and substratum-

8 to 60 inches +, silt loam, mostly very dark brown; platy structure; friable; moderately to strongly alkaline, calcareous below a depth of 15 inches; plentiful roots.

The depth to calcareous soil ordinarily ranges from 15 to 25 inches, but in places the surface layer is calcareous. In many places the subsoil is stratified with layers of silt loam, very fine sandy loam, or fine sand loam. In places the soil is underlain by sand or gravel at a depth of more than 40 inches.

This soil is well drained and moderately permeable. It holds 9 to 11 inches of water that plants can use. It is easily worked but is subject to frost and to occasional flooding in winter and early in spring. Runoff is slow. The erosion hazard is slight.

This soil is used primarily for small grain in a crop-fallow system. Hay and pasture crops can be grown without irrigation. All crops respond to nitrogen. (Capability unit IIc-1, nonirrigated; range site 3)

Kuhl Series

The Kuhl series consists of well-drained, medium-textured soils underlain by basalt bedrock at a depth of 12 to 20 inches. These soils formed under bunchgrass, in a mixture of loess, alluvium, and colluvium derived from basic igneous rocks. They occupy gently undulating basalt plateaus and steep canyon slopes in the eastern part of the county. The elevation ranges from 1,400 to 2,200 feet. The annual precipitation is 12 to 14 inches.

The surface layer is very dark grayish-brown very stony silt loam or very stony loam 7 to 12 inches thick. The subsoil is dark yellowish-brown stony silt loam. Bedrock basalt is at a depth of 12 to 20 inches.

Kuhl soils are mapped as a complex with Anders soils. They are used for range.

Magallon Series

The Magallon series consists of somewhat excessively drained, moderately coarse textured soils underlain by coarse basalt sand at a depth of 20 to 40 inches. These soils formed under bunchgrass, from glaciofluvial material derived from reworked loess, basalt, and some volcanic ash. They occupy gently sloping to strongly sloping terraces that border glacial outwash plains and major drains in the central part of the county. The elevation ranges from 1,500 to 1,700 feet. The annual precipitation is 9 to 12 inches.

In uneroded areas the surface layer is very dark grayish-brown silt loam about 8 inches thick. Where the soils have been eroded, the surface layer is sandy loam. The subsoil is sandy loam grading to loamy sand and is underlain at a depth of 20 to 40 inches by coarse basalt sand. Coarse basalt sand occurs throughout the profile.

Magallon soils are used for small grain in a crop-fallow system and for grazing.

Magallon silt loam, 5 to 30 percent slopes (MAD). -This is a loamy soil on terraces that adjoin outwash plains. Most slopes are about 10 percent. Small areas of soils reworked by wind and small areas of Farrell soils were included in mapping.

Representative profile:

Surface layer-

0 to 8 inches, very dark grayish-brown silt loam; granular structure; very friable; mildly alkaline; abundant roots.

Subsoil-

8 to 17 inches, dark-brown sandy loam; subangular blocky structure; friable when moist; mildly alkaline; plentiful roots.

17 to 26 inches, dark-brown loamy sand; massive; very friable; mildly alkaline; plentiful roots.

Substratum-

26 to 60 inches +, coarse basalt sand; loose.

The surface layer is loam or silt loam and is 7 to 10 inches thick. The depth to the sand substratum is 20 to 40 inches. In places lime accumulates just above the coarse sand. The content of coarse and very coarse sand increases with depth.

This soil is somewhat excessively drained and has moderately rapid permeability. It holds 4 to 5 inches of water that plants can use. Runoff is medium. The hazard of wind erosion is slight to moderate, and the hazard of water erosion is moderate. There are some limitations on the use of machinery on the steeper slopes.

About 50 percent of the acreage is cultivated. The rest is in range. Small grain is grown in a crop fallow system. This soil is fertile except that it is deficient in nitrogen. Droughtiness limits production. (Capability unit IVe-4, nonirrigated; range site 10)

Magallon sandy loam, 5 to 30 percent slopes, eroded (MGD2).-This soil is used mainly for range. It is lighter colored and coarser textured than Magallon silt loam, 5 to 30 percent slopes, because its original surface layer has been removed or reworked by wind. The hazard of wind erosion is moderate to severe. The available water capacity is 3 to 4 inches. (Capability unit VIe-2, nonirrigated; range site 8)

Neppel Series

The Neppel series consists of well-drained, medium-textured soils underlain at a depth of 20 to 40 inches by rounded rubble and basalt gravel and sand, all cemented with lime and silica. These soils formed under bunchgrass, in glacial outwash materials derived mainly from basalt, volcanic ash, and loess, but including some lacustrine sediments and granitic rock. They occupy nearly level to gently sloping terraces or outwash plains in the western part of the county. The elevation ranges from 1,000 to 1,200 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown fine sandy loam or very fine sandy loam about 4 inches thick. The subsoil is dark-brown very fine sandy loam underlain by calcareous gravelly loam. This gravelly loam, in turn, is underlain by lime-silica cemented rubble, basalt gravel, and basalt sand at a depth of 20 to 40 inches.

Neppel soils are irrigated. All of their acreage lies within the boundaries of the Columbia Basin Irrigation Project.

Neppel very fine sandy loam, 0 to 2 percent slopes (NeA).-This is a loamy soil on outwash plains and terraces. Most slopes are about 1 percent. Some areas of a soil that is only 15 inches deep over the basalt sand and gravel were included in mapping.

Representative profile:

Surface layer-

0 to 4 inches, dark grayish-brown very fine sandy loam; granular structure; very friable; neutral; abundant roots.

Subsoil-

4 to 20 inches, dark-brown very fine sandy loam; subangular blocky structure; very friable; moderately alkaline and slightly calcareous in lower part; abundant root.

20 to 28 inches, dark grayish-brown gravelly loam; massive; weakly cemented; firm; strongly alkaline; strongly calcareous; few roots.

Substratum-

28 inches +, rounded lime-silica cemented rubble, basalt sand, and basalt gravel.

The surface layer ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The calcareous layer is slightly hard to hard when dry and friable to firm when moist. It is 8 to 14 inches thick. The depth to the substratum ranges from 20 to 40 inches. Small fragments of the lime-silica hardpan are scattered on the surface in places and are common within the profile.

This soil is well drained and moderately permeable. It holds 5 to 7 inches of water that plants can use. It has good tilth and is easily worked. Runoff is slow. The hazard of wind erosion is moderate, and the hazard of water erosion is slight. The coarse-textured material in the substratum restricts the movement of moisture. Undercutting and backfilling in preparation for surface irrigation have eliminated the shallow areas that were included in mapping.

The major crops are potatoes, beans, peas, corn, wheat, and hay and pasture crops. Both surface and sprinkler irrigation are suitable. Nonlegumes and beans respond to nitrogen. Beans also respond to zinc. (Capability unit IIs-1, irrigated; range site 4)

Neppel very fine sandy loam, 2 to 5 percent slopes (NeB).-In irrigated areas of this soil, runoff is medium and the erosion hazard is moderate. The crops grown are the same as those grown on Neppel very fine sandy loam, 0 to 2 percent slopes. Irrigation runs should be shorter than on the nearly level soils, or furrows or corrugations should be held to a 2 percent gradient. (Capability unit IIs-2, irrigated; range site 4)

Neppel fine sandy loam, 0 to 2 percent slopes, eroded (NfA2).-This soil is coarser textured than the Neppel very fine sandy loams because the surface layer has been reworked by wind.

The hazard of wind erosion is moderate. The crops grown are the same as those grown on Neppel very fine sandy loam, 0 to 2 percent slopes. Both surface and sprinkler irrigation are suitable. (Capability unit IIs-1, irrigated; range site 8)

Neppel fine sandy loam, 2 to 5 percent slopes, eroded (NfB2).-This soil is coarser textured than the very fine sandy loams because its surface layer has been reworked by wind. In irrigated areas, runoff is medium. The hazard of wind and water erosion is moderate.

The crops grown are the same as those grown on Neppel very fine sandy loam, 0 to 2 percent slopes. Sprinkler and surface irrigation are both suitable. In surface systems, furrows and corrugations should be held to 2 percent gradient, or irrigation runs should be shorter than on the nearly level Neppel soil. (Capability unit IIs-2, irrigated; range site 8)

Onyx Series

The Onyx series consists of deep and very deep, well-drained, medium-textured soils that formed under bunchgrass, in alluvium derived from loess and some ash. These soils occupy nearly level bottom land in the eastern part of the county. The elevation ranges from 1,500 to 2,000 feet. The annual precipitation is 12 to 14 inches.

The surface layer is very dark brown silt loam 21 to 40 inches thick. The subsoil is dark-brown silt loam. The substratum is dark grayish-brown silt loam. These soils are noncalcareous.

Small grain is grown in a crop-fallow system. Hay and pasture crops can be grown without irrigation. Some areas are irrigated from wells.

Onyx silt loam, 0 to 6 percent slopes (ONB).-This is a silty soil on alluvial bottom land. Most slopes are about 2 percent.

Representative profile:

Surface layer-

0 to 8 inches, very dark brown silt loam; granular structure; very friable; neutral; many fine roots.

8 to 30 inches, very dark grayish-brown silt loam; massive; very friable; neutral; plentiful roots.

Subsoil-

30 to 46 inches, dark-brown silt loam; massive; very friable; neutral; plentiful roots.

Substratum-

46 to 60 inches, dark grayish-brown silt loam; massive; friable; neutral; few roots.

In places the lower part of the profile contains strata of very fine sandy loam, thin irregular lenses of very fine sand, and a little fine gravel. Some areas of this soil are underlain by gravel or by basalt bedrock at a depth of more than 40 inches.

This soil is well drained and moderately permeable. It holds 7 to 11 inches of water that plants can use. It is easily worked. Runoff is slow, and the hazard of erosion is slight.

Ninety percent of the acreage is cultivated. Small grain is grown in a crop-fallow system. Alfalfa hay and pasture grass can be grown without irrigation. Crops respond to nitrogen. (Capability unit IIc-1, nonirrigated; range site 3)

Prosser Series

The Prosser series consists of well-drained, medium-textured soils underlain by basalt at a depth of 20 to 40 inches. These soils formed under bunchgrass and sagebrush, in glaciofluvial materials derived from loess, volcanic ash, and basalt. They occupy nearly level to strongly sloping outwash plains and terraces in the western part of the county. The elevation ranges from 700 to 1,000 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown very fine sandy loam or silt loam, about 4 inches thick. The subsoil is dark grayish-brown very fine sandy loam. It rests on bedrock at a depth of 20 to 40 inches.

Prosser soils are used for range and cultivated crops. Some areas within the boundaries of the Columbia Basin Irrigation Project are irrigated.

Prosser very fine sandy loam, 0 to 2 percent slopes (PrA).-This is a loamy soil on outwash plains and terraces

in the western part of the county. Rock outcrops and small areas of soils more than 40 inches deep were included in mapping.

Representative profile:

Surface layer-

0 to 4 inches, dark grayish-brown very fine sandy loam; granular structure; very friable; neutral; abundant roots. Subsoil-

4 to 30 inches, dark grayish-brown very fine sandy loam; massive; friable; moderately alkaline; slightly calcareous at a depth of 24 to 30 inches; abundant roots.

Bedrock-

30 inches +, lime-capped basalt.

The surface layer ranges from 3 to 6 inches in thickness. In some places it is silt loam. A small amount of gravel and a few cobblestones occur in places in the lower part of the subsoil. Also, in spots the soil is calcareous about 6 inches above the basalt. The depth to basalt is 20 to 40 inches.

This soil is well drained and moderately permeable. It has good tilth and is easily worked. It holds 5 to 7 inches of water that plants can use. Runoff is slow. The hazard of water erosion is slight; the hazard of wind erosion is moderate.

This soil is well suited to both surface and sprinkler irrigation. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Because of the variable depth to the substratum, preparation for surface irrigation may be difficult. Excessive irrigation or seepage from higher areas may cause drainage problems. Nonlegumes respond to nitrogen. (Capability unit IIs-2, irrigated; range site 4)

Prosser very fine sandy loam, 2 to 8 percent slopes (PrC).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. Most slopes are between 2 and 5 percent. The crops grown are the same as those grown on Prosser very fine sandy loam, 0 to 2 percent slopes. Irrigation runs should be shorter than on the nearly level soil, or furrows or corrugations should be held to a 2 percent gradient. (Capability unit IIe-3, irrigated; range site 4)

Prosser very fine sandy loam, 0 to 20 percent slopes (PrC).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. It is used for grazing and for dryland grain. Rye or wheat are grown in a crop-fallow system. Low rainfall, drying winds, and limited moisture-holding capacity make this soil submarginal for dryland cultivation. Runoff is medium, and the hazard of erosion is moderate. (Capability unit VIe-2, nonirrigated; range site 4)

Prosser very fine sandy loam, 15 to 30 percent slopes, eroded (PRD2).-From 1 to 3 inches of the surface layer of this soil has been removed by erosion. Areas of soils less than 20 inches deep were included in mapping. Low rainfall, drying winds, and limited moisture-holding capacity make this soil unsuitable for cultivation. (Capability unit VIe-2, nonirrigated; range site 9)

Prosser-Starbuck very fine sandy loams, 0 to 5 percent slopes (PsB)(PSB).-This complex is 60 to 70 percent Prosser very fine sandy loam in the 0 to 2 percent slope range, and 30 to 40 percent Starbuck very fine sandy loam. The topography is slightly undulating. The Starbuck soil generally occupies long stringers 25 to 75 feet wide. These stringers are slightly higher than the areas in between, which are occupied by the Prosser soil.

This complex is suitable for either sprinkler or surface irrigation. The irregular depth to the substratum causes some difficulty in preparing for surface irrigation, and drainage problems are likely if excess irrigation water is applied or if water seeps from higher lying soils. The management needs are like those of Starbuck soils. The major crops are beans, alfalfa, grass, corn, potatoes grain, and mint. Unless irrigated, this complex is used for range.

As a complex: capability unit IVs-1 (irrigated), VIs-1 (nonirrigated) ; range site 4. By components: Prosser very fine sandy loam-capability unit IIs-2 (irrigated), range site 4; Starbuck very fine sandy loam-capability unit IVe-1 (irrigated) and VIs-1 (nonirrigated), range site 9.

Prosser-Starbuck very rocky very fine sandy loams, 0 to 20 percent slopes (PtD)(PTC).-This complex is 15 to 20 percent rock outcrops, 20 to 30 percent Starbuck very stony very fine sandy loam, and 50 to 70 percent Prosser very fine sandy loam. The Prosser soil occupies long, narrow depressions, or valleylike areas. Most areas are less than one-half acre in size, but some are as large as 5 acres. The Starbuck soil occurs along the edges of the Prosser soil and surrounds rock outcrops.

This complex is used for grazing. In years when the moisture supply is favorable, the Prosser soil can be seeded to perennial grasses. In many areas of the complex, the soils are so intermingled that separate management is impractical.

As a complex: capability unit VIIs-1 (nonirrigated and irrigated), range site 4. By components: Prosser very fine sandy loam-capability unit VIe-2 (nonirrigated), range site 4; Starbuck very stony very fine sandy loam-capability unit VIIs-1 (nonirrigated), range site 9; rock outcrops-capability unit VIIs-1, no range classification.

Prosser-Starbuck extremely rocky very fine sandy loams, 0 to 20 percent slopes (PuD).-This complex is 20 to 30 percent rock outcrops, 30 to 40 percent Starbuck very stony very fine sandy loam, and 30 to 50 percent Prosser very fine sandy loam. The Prosser soil occupies long narrow depressions, or valleylike areas. Most areas are less than one-half acre in size, but some are as large as 3 or 4 acres. The Starbuck soil is along the edges of the Prosser soil and surrounds rock outcrops.

This complex is used for grazing. Cultivation is impractical because of stones and rock outcrops. In some areas of the Prosser soil, the range can be improved by reseeding. In most areas the soils are so intermingled that it is not practical to manage them separately.

As a complex: capability unit VIIs-1 (irrigated), range site 9. By components: Prosser very fine sandy loam-capability unit VIe-2 (nonirrigated), range site 4; Starbuck very stony very fine sandy loam-capability unit VIIs-1 (nonirrigated), range site 9; rock outcrops-capability unit VIIs-1, no range classification.

Quincy Series

The Quincy series consists of excessively drained sandy soils. These soils formed under grass, sagebrush, and rabbitbrush, in eolian sands derived from granitic, quartzitic, and basaltic rock. They occupy moderately slop-

ing, hummocky, or dunelike terraces in the western part of the county. The elevation ranges from 700 to 1,500 feet. The annual precipitation is 7 to 10 inches.

Quincy soils are deep, massive fine sands or loamy fine sands. They are used for range and for wildlife habitat. Some areas are irrigated.

Quincy fine sand, 0 to 10 percent slopes, eroded (QuC2).-This is a sandy soil on dunelike terraces. Most slopes are about 8 percent.

Representative profile:

0 to 60 inches, dark-brown fine sand; single grain; loose; moderately alkaline; slight effervescence below a depth of 15 inches; plentiful roots to a depth of 35 inches, few below that depth. The lower part of the subsoil ranges from loamy fine sand to fine sand.

In places this soil is noncalcareous.

This soil is excessively drained and very rapidly permeable. It holds 3 to 4 inches of water that plants can use. Wind erosion is a severe hazard.

This soil is used for pasture and as a wildlife habitat. Irrigated areas are used for grass, alfalfa, and small grain. (Capability unit IVe-3, irrigated; VIle-1, nonirrigated; range site 7)

Quincy loamy fine sand, 0 to 10 percent slopes, eroded (QfC2).-This soil is underlain in many places by gravel, sand, or lacustrine beds below a depth of 40 inches. It holds 4 to 5 inches of water that plants can use. It is suited to sprinkler irrigation but not to surface irrigation. Hay, pasture crops, and wheat are the major crops. The hazard of wind erosion is severe, and soil drifting is a problem. Heavy applications of fertilizer are needed. Leaching also is a problem. (Capability unit IVe-3, irrigated; VIle-1, nonirrigated; range site 7)

Quincy fine sand, 8 to 40 percent slopes (QUE).-This is a sandy soil on glaciofluvial terraces. Most slopes are about 15 percent. The hazard of wind erosion is severe (fig. 4). (Capability unit VIle-1, nonirrigated; range site 7)

Ritzcal Series

The Ritzcal series consists of well-drained, medium-textured soils that are calcareous throughout. These soils formed from calcareous loess, on strongly sloping to steep west-facing and south-facing slopes. The elevation ranges from 1,400 to 2,000 feet. The annual precipitation is 9 to 14 inches.

The surface layer is dark-brown or dark grayish-brown, calcareous silt loam about 8 inches thick. The subsoil is dark grayish-brown, strongly calcareous silt loam. The substratum is dark-brown silt loam. Small white fragments of lime-silica cemented material are common throughout the profile.

Ritzcal soils are used for growing wheat and barley in a crop-fallow system. Yields are low compared with those from the associated Ritzville soils.

Ritzcal silt loam, 15 to 30 percent slopes, eroded (RAD2).-This is a silty calcareous soil on strongly sloping uplands in the central and eastern parts of the county. From 25 to 50 percent of the original surface layer has been removed through erosion. Areas where the strongly calcareous subsoil is exposed (fig. 5) were included in mapping.



Figure 4.-Quincy fine sand, 8 to 40 percent slopes, left foreground, encroaching on Farrell silt loam. Vegetation is stabilizing Quincy soil to some extent.



Figure 5.-Landscape in area of Ritzcal and Ritzville soils. Light-colored material in background is an outcrop of the strongly calcareous subsoil of Ritzcal silt loam, 15 to 30 percent slopes, eroded.

Representative profile:

Surface layer-

0 to 8 inches, dark-brown silt loam; granular structure; very friable; abundant roots; moderately alkaline; calcareous.

Subsoil-

8 to 26 inches, dark grayish-brown silt loam; massive; very friable; abundant roots; moderately alkaline; strongly calcareous.

Substratum-

26 to 60 inches +, dark-brown silt loam; massive; very firm; few roots; moderately alkaline; strongly calcareous.

The color of the surface layer ranges from dark brown to dark grayish brown. The very firm lower part of the subsoil is lacking in many places. In places lime-silica cemented fragments are scattered throughout the profile.

This soil is well, drained and moderately permeable. It holds 5 to 7 inches of water that plants can use. Runoff is medium to rapid, and the hazard of erosion is moderate to severe. Fertility is a problem because of the high lime content. This soil is used for grain and grass. (Capability unit IVe-2, nonirrigated; range site 10)

Ritzcal silt loam, 30 to 40 percent slopes, eroded (RAE2).-This soil is unsuited to cultivation and should be seeded to perennial grass. Runoff is rapid, and the hazard of water erosion is severe. (Capability unit VIe-1, nonirrigated; range site 10)

Ritzville Series

The Ritzville series consists of deep and very deep, well-drained, medium-textured soils. In places these soils are underlain by a lime-silica hardpan, by basalt, or by sandy gravel at a depth of more than 40 inches. They developed under bunchgrass, from loess mixed with volcanic ash. They occupy nearly level to very steep uplands in the central part of the county. The elevation ranges from 1,400 to 2,000 feet. The annual precipitation is 9 to 12 inches.

The surface layer is very dark grayish-brown silt loam 7 to 10 inches thick. The subsoil and substratum are dark-brown silt loam. They are calcareous below a depth of 36 inches. Ritzville soils in the sandhills area are somewhat coarser textured and more susceptible to wind erosion than those elsewhere.

Ritzville soils are used to grow dryland grain.

Ritzville silt loam, 1 to 5 percent slopes (REB).-This is a silty soil on rolling uplands. Most slopes are about 4 percent. Small areas of Willis and Farrell silt loams were included in mapping.

Representative profile:

Surface layer-

0 to 9 inches, very dark grayish-brown silt loam; granular structure; very friable; neutral; abundant roots.

Subsoil and substratum-

9 to 60 inches, dark-brown silt loam; prismatic structure to a depth of 43 inches, massive below this depth; very friable; mildly alkaline to a depth of 18 inches, moderately alkaline from a depth of 18 to 43 inches, and strongly alkaline below a depth of 43 inches; calcareous below a depth of 36 inches; plentiful roots to a depth of 43 inches, few below this depth.

The thickness of the surface layer ranges from 7 to 10 inches. The depth to free lime is commonly more than 36 inches. Firm silt concretions of various shapes, 1/4 inch to 4 inches in diameter, are common in the lower part of the subsoil. In areas that are overcultivated, a crust tends to form on the surface (fig. 6).

This soil is well drained and moderately permeable. It holds 9 to 11 inches of water that plants can use. It has good tilth and is easily worked. Runoff is slow and the hazard of water erosion is slight. There is a slight to moderate hazard of wind erosion.

More than 95 percent of the acreage is cultivated. Small grain is grown in a crop-fallow system. Crops respond to nitrogen. (Capability unit IIIc-1, nonirrigated; range site 5)

Ritzville silt loam, 5 to 30 percent slopes (RED).-In use and management, this soil is the same as Ritzville silt loam, 1 to 5 percent slopes. Runoff is medium, and the hazard of water erosion is moderate. (Capability unit IIIe-3, nonirrigated; range site 5)



Figure 6.-View of Ritzville silt loam, 1 to 5 percent slopes, showing surface crust in which cracks have formed. A soil in this condition is extremely susceptible to erosion.

Ritzville silt loam, 30 to 40 percent slopes (REE).-The surface layer of this soil is 2 to 3 inches thinner than that of Ritzville silt loam, 1 to 5 percent slopes. Runoff is rapid, and the hazard of water erosion is severe. There are limitations on the use of machinery on these steep slopes. Many small eroded areas were included in mapping. (Capability unit IVe-5, nonirrigated; range site 6)

Ritzville silt loam, 40 to 65 percent slopes (REF).-The surface layer of this soil is 2 to 4 inches thinner than that of Ritzville silt loam, 1 to 5 percent slopes. In places 25 to 50 percent of the original surface layer has been removed by erosion. Runoff is very rapid, and the erosion hazard is very severe. This soil is used for range. (Capability unit VIe-1, nonirrigated; range site 6)

Ritzville silt loam, 0 to 1 percent slopes (REA).-This soil has very slow runoff. Small undrained basins were included in the areas mapped.

Small grain is grown on this soil in a crop-fallow system. Grain crops respond to nitrogen. Because of poor drainage in spring and frost damage the growth of crops in the basins is retarded, and yields generally are less than elsewhere. (Capability unit IIIc-1, nonirrigated; range site 5)

Ritzville silt loam, 2 to 30 percent slopes, eroded (RED2).-The original surface layer of this soil has been partly or completely removed by erosion. In some places the finer particles in the surface layer have been blown away by wind, and the texture is now very fine sandy loam. Runoff is slow to medium, and the hazard of water erosion is moderate. This soil is used in the same way as Ritzville silt loam, 1 to 5 percent slopes. It produces lower yields than that soil. (Capability unit III-3, nonirrigated; range site 5)

Ritzville silt loam, 30 to 40 percent slopes, eroded (REE2).-Lime is within 18 to 24 inches of the surface of this soil. Runoff is rapid, and the hazard of water erosion is severe. This soil is not suited to cultivation, but it can be reseeded to perennial grass. (Capability unit VIe-1, nonirrigated; range site 6)

Ritzville silt loam, moderately shallow, 0 to 5 percent slopes (RMB).-This soil is underlain by a lime-silica cemented hardpan or by basalt bedrock at a depth of 40 to 50 inches. It holds 7 to 19 inches of water that plants can use. It is used in the same way as Ritzville silt loam, 1 to 5 percent slopes. (Capability unit IIIc-1, nonirrigated ; range site 5)

Ritzville silt loam, moderately shallow, 5 to 30 percent slopes (RMD).-This soil is underlain by a lime-silica cemented hardpan or by basalt bedrock at a depth of 40 to 50 inches. It holds 7 to 9 inches of water that plants can use. Runoff is medium, and the hazard of water erosion is moderate. This soil is used in the same way as Ritzville silt loam, 1 to 5 percent slopes. (Capability unit IIIe-3, nonirrigated ; range site 5)

Ritzville silt loam, moderately shallow, 30 to 40 percent slopes (RME).-The surface layer of this soil is 2 to 3 inches thinner than that of Ritzville silt loam, 1 to 5 percent slopes. Also, this soil has a lime-silica cemented hardpan or basalt bedrock 40 to 50 inches below the surface. Some small areas on south slopes are less than 40 inches deep over basalt. Runoff is rapid. The hazard of water erosion is severe. This soil is used in the same

way as Ritzville silt loam, 1 to 5 percent slopes. (Capability unit IVe-5, nonirrigated; range site 6)

Ritzville silt loam, moderately shallow, 40 to 65 percent slopes (RMF).-The surface layer of this soil is thinner than that of Ritzville silt loam, moderately shallow, 30 to 40 percent slopes. In places, 25 to 50 percent of the original surface layer has been removed by erosion. Runoff is very rapid, and the erosion hazard is very severe. This soil is used for range. (Capability unit VIe-1, nonirrigated; range site 6)

Ritzville silt loam, moderately shallow, 0 to 15 percent slopes, eroded (RMC2).-The surface layer of this soil has been partially or completely removed by erosion. In places, it has been reworked by wind, and the texture is now very sandy loam. A lime-silica cemented hardpan or basalt bedrock is at a depth of 40 to 50 inches. Runoff is medium, and the hazard of water erosion is moderate. This soil is used in the same way as Ritzville silt loam, 1 to 5 percent slopes. (Capability unit IIIe-3, nonirrigated; range site 5)

Riverwash

Riverwash (Ra) consists of nearly level bars of coarse sand and gravel along rivers and perennial and intermittent streams. Willows and cottonwoods grow in some places, but most areas are nearly bare of vegetation. Riverwash is used as a wildlife habitat. (Capability unit VIIIs-1)

Rock Outcrop

Rock outcrop (RO) (Rc) consists of outcrops of basalt, caliche, or Ringold beds. It occurs throughout the county. (Capability unit VIIIs-1)

Roloff Series

The Roloff series consists of well-drained, medium-textured soils underlain by basalt at a depth of 20 to 40 inches. These soils formed under bunchgrass and sagebrush, in glacial outwash that was derived from basalt rock and from loess that contained some volcanic ash. They occupy nearly level to strongly sloping outwash plains and terraces in the central part of the county. The elevation ranges from 1,500 to 2,000 feet. The annual precipitation is 9 to 12 inches.

The surface layer is very dark grayish-brown silt loam 7 to 10 inches thick. The subsoil is dark-brown silt loam or gravelly silt loam that is 10 to 40 percent coarse sand and grave sized fragments of basalt. Basalt bedrock is at a depth of 20 to 40 inches.

Roloff soils are used principally for range. Some areas have been irrigated and are used to grow hay.

Roloff silt loam, 0 to 15 percent slopes (RPC).-This is a silty soil on outwash plains and terraces. Most slopes are about 4 percent. Small areas of rock outcrops, small areas of soils less than 20 inches deep, small areas of soils more than 40 inches deep, and areas of soils underlain by gravel were included in mapping.

Representative profile:

Surface layer-
0 to 8 inches, very dark grayish-brown silt loam; platy structure; very friable; neutral; abundant roots.

Subsoil-

8 to 24 inches, dark-brown silt loam; subangular blocky structure; massive below a depth of 16 inches; friable; mildly alkaline; plentiful roots; 10 percent gravel-sized fragments of basalt below a depth of 16 inches.

Bedrock-

24 inches +, basalt.

The surface layer ranges from 7 to 10 inches in thickness. The depth to bedrock ranges from 20 to 40 inches. In places a thin calcareous layer occurs just above the basalt or as a coating on it.

This soil is well drained and moderately permeable. It holds 5 to 7 inches of water that plants can use. It has good tilth and is easily worked. Some spots stay wet in spring long enough that tillage has to be delayed. Some stones are present, so care is needed in using certain types of equipment for deep tillage. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

This soil is used mainly for range. Deteriorated areas of range can be summer fallowed and seeded to adapted grays. Water is pumped from wells to irrigate pastures and alfalfa fields. Some areas are cultivated. Wheat and barley are grown in a crop-fallow system. Crops respond to nitrogen. (Capability unit IVe-4, nonirrigated; range site 10)

Roloff-Starbuck stony silt loams, 10 to 30 percent slopes (RSD).-This complex consists of about equal proportions of Roloff stony silt loam and Starbuck stony silt loam. It also includes tracts, 3 or 4 acres in extent, of nonstony Roloff soils.

Most of the acreage is hummocky. The hummocks are 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are generally 1 or 2 feet higher than the areas in between. The Roloff soil occupies the hummocks, and the Starbuck soil the areas in between.

This complex is used for grazing. The stones make cultivation impractical in most places. Some areas can be reseeded, but in places the stones need to be removed.

Both of the components in this complex are in capability unit VIe-1 (nonirrigated), range site 10.

Roloff-Starbuck very rocky silt loams, 10 to 30 percent slopes (RTD).-This complex is 15 to, 20 percent rock outcrops, 20 to 30 percent Starbuck very stony silt loam in the 15 to 30 percent slope range, and 50 to 65 percent Roloff stony silt loam. Also included are some areas of nonstony Roloff soils.

Most of the acreage is hummocky. The hummocks are 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are generally 1 or 2 feet higher than the areas in between. The Roloff soil occupies the hummocks, and the Starbuck soil the areas in between.

This complex is used for grazing. The stones and rock outcrops make cultivation impractical in most places. Small areas can be seeded if stones are removed. In many areas of this complex the soils are so intermingled that separate management is impractical.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Roloff stony silt loam capability unit VIe-1 (nonirrigated), range site 10; Starbuck very stony silt loam capability unit VIIs-1, range site 10; rock outcrops capability unit VIIIs-1, no range classification.

Roloff-Starbuck extremely rocky silt loams, 0 to 15 percent slopes (RUC).-This complex is 20 to 30 percent

rock outcrops, 30 to 40 percent Starbuck very stony silt loam, and 30 to 50 percent Roloff stony silt loam.

Much of the acreage is hummocky. The hummocks are 50 to 100 feet in diameter and 25 to 50 feet apart. The tops of the hummocks are generally 1 to 2 feet higher than the areas in between. The Roloff soil occupies the hummocks, and the Starbuck soil the areas in between. These soils lie in long narrow valleys, generally surrounded by rock outcrops.

This complex is used for grazing. The stones and rock outcrops make cultivation impractical. In some areas of Roloff stony silt loam it is practical to reseed and thus improve the range. In most areas the soils of this complex are so intermingled that it is not practical to manage them separately.

As a complex: capability unit VIIs-1 (nonirrigated), range site 10. By components: Roloff stony silt loam, 0 to 10 percent slopes capability unit VIe-1 (nonirrigated), range site 10; Starbuck very stony silt loam capability unit VIIs-1, range site 10; rock outcrops capability unit VIIIs-1, no range classification.

Royal Series

The Royal series consists of well-drained, medium-textured to coarse-textured soils. These soils formed under bunchgrass and sagebrush, in wind-worked glaciofluvial materials derived from basalt granite, quartzite, and volcanic ash. They occupy nearly level to strongly sloping terraces in the western part of the county. The elevation ranges from 700 to 1,400 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark brown or dark grayish brown, is 3 to 6 inches thick, and ranges from very fine sandy loam to loamy fine sand in texture. The subsoil and substratum are dominantly fine sandy loam or loamy fine sand but in places are very fine sandy loam or loamy sand. These soils are calcareous below a depth of 10 to 24 inches.

Most of the acreage is irrigated under the Columbia Basin Irrigation Project.

Royal fine sandy loam, 0 to 2 percent slopes (RsA).-This is a sandy soil on nearly level terraces. Most slopes are about 1 percent.

Representative profile:

Surface layer-

0 to 5 inches, dark grayish-brown fine sandy loam; weak, fine, granular structure; very friable; mildly alkaline; abundant roots.

Subsoil-

5 to 15 inches, dark grayish-brown fine sandy loam, near loamy fine sand; weak, medium, prismatic structure; very friable; mildly alkaline; plentiful roots.

15 to 46 inches, brown and grayish-brown loamy fine sand in the upper part, dark-brown fine sandy loam in the lower part; massive; very friable; moderately alkaline; calcareous; few roots.

Substratum-

46 to 57 inches, dark grayish-brown loamy fine sand; single grain; loose; calcareous; strongly alkaline; few roots.

57 to 70 inches +, dark-brown loamy fine sand; massive; very friable; strongly alkaline; violent effervescence with dilute HCl; few roots.

The surface layer ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The depth to lime ranges from 10 inches to 24

inches. In places this soil is underlain by basalt sand or gravel at a depth of more than 40 inches. In some areas the profile is less stratified, and the texture is fine sandy loam throughout. In places there is a thin layer of very fine sandy loam just below the surface layer.

This soil is well drained and has moderately rapid permeability. It holds 6 to 8 inches of water that plants can use. It is easily worked. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

Most of the acreage is irrigated. The major crops are corn, wheat, potatoes, beans, sugar beets, and hay and pasture crops. Both surface and sprinkler irrigation are suitable. Wind erosion and soil drifting are problems while this soil is being prepared for surface irrigation. Nonlegumes respond to nitrogen. Beans need zinc and nitrogen. (Capability unit IIs-1, irrigated; range site 8)

Royal fine sandy loam, 2 to 5 percent slopes (RsB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The crops and irrigation methods are the same as those for Royal fine sandy loam, 0 to 2 percent slopes, except that irrigation runs should be shorter. (Capability unit IIe-2, irrigated; range site 8)

Royal fine sandy loam, 5 to 15 percent slopes (RsD).-In irrigated areas of this soil, runoff is rapid and the erosion hazard is severe. Slopes are dominantly between 5 and 10 percent. Sprinkler irrigation is best suited. (Capability unit IIIe-1, irrigated; range site 8)

Royal fine sandy loam, 15 to 30 percent slopes (RsE).-In irrigated areas of this soil, runoff is very rapid and the hazard of water erosion is very severe. Sprinkling is the only suitable method of irrigation. Hay and pasture crops can be grown. (Capability unit VIe-1, irrigated; range site 8)

Royal very fine sandy loam, 0 to 2 percent slopes (RoA).-This soil holds 7 to 9 inches of water that plants can use. The surface layer is moderately permeable. Depressions cause localized drainage problems. Small eroded areas and areas of very deep, medium-textured soils were included in mapping.

More than 95 percent of the acreage is irrigated. Both surface and sprinkler irrigation are well suited. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Nonlegumes respond to nitrogen. Beans need nitrogen and zinc. In places where deep cuts have been made in leveling, fertility problems are likely to occur because of strong concentrations of lime. Generally, these problems can be corrected by applications of fertilizer, mainly phosphate. (Capability unit I-1, irrigated; range site 4)

Royal very fine sandy loam, 2 to 5 percent slopes (RoB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The major crops are the same as those grown on Royal very fine sandy loam, 0 to 2 percent slopes. The irrigation runs should be shorter than on that soil, or the furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 4)

Royal very fine sandy loam, 5 to 10 percent slopes (RoC).-In irrigated areas, runoff is rapid and the hazard of water erosion is severe. Sprinkling is the most suitable method of irrigation. Row crops are not generally grown. (Capability unit IIIe-1, irrigated; range site 4)

Royal very fine sandy loam, 10 to 20 percent slopes (RoD).-In irrigated areas of this soil, runoff is very rapid and the hazard of water erosion is very severe. Sprinkling is the only suitable method of irrigation. (Capability unit IVe-1, irrigated; range site 4)

Royal very fine sandy loam, 0 to 15 percent slopes (RYC).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. The hazard of wind erosion is moderate. Rye or wheat is grown in a crop-fallow system. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVe-6, nonirrigated; range site 4)

Royal fine sandy loam, moderately shallow, 0 to 2 percent slopes (RuA).-This soil is underlain at a depth of 40 to 48 inches by a lime-silica cemented hardpan or by Ringold beds. It holds 5 to 6 inches of water that plants can use. A few areas of soil less than 40 inches deep were included in mapping. Excessive irrigation and seepage from higher lying soils cause drainage problems in places. The crops and irrigation methods are the same as those for Royal fine sandy loam, 0 to 2 percent slopes. (Capability unit IIs-1, irrigated; range site 8)

Royal fine sandy loam, moderately shallow, 2 to 5 percent slopes (RuB).-This soil is underlain by a lime-silica cemented hardpan or by Ringold beds, ordinarily at a depth of 40 to 48 inches but in some places at a depth of less than 40 inches. It holds 5 to 6 inches of water that plants can use. It is suited to the same crops as those grown on Royal fine sandy loam, 0 to 2 percent slopes, but the irrigation runs should be shorter, or the furrows or corrugations should be held to a 2 percent gradient. (Capability unit IIe-2, irrigated; range site 8)

Royal loamy fine sand, moderately shallow, 0 to 5 percent slopes, eroded (RyB2).-This soil is coarser textured than the Royal fine sandy loams because the surface layer has been altered by wind erosion. A lime-silica cemented hardpan or Ringold beds occur at a depth of 40 to 48 inches. Small areas where the slope is more than 5 percent and areas where the hardpan or Ringold beds are at a depth of less than 40 inches were included in mapping. In irrigated areas, runoff is slow to medium and the hazard of water erosion is slight to moderate. Excessive irrigation and seepage from higher lying soils cause drainage problems in places. This soil holds 5 to 7 inches of water that plants can use. The hazard of wind erosion is severe. Drifting soil is a problem in places; it injures young plants and fills irrigation ditches.

The crops are about the same as those grown on Royal fine sandy loam, 0 to 2 percent slopes, but hay and pasture crops are more common. Sprinkling is the most suitable method of irrigation. (Capability unit IIs-3, irrigated; range site 7)

Royal loamy fine sand, 0 to 5 percent slopes, eroded (RvB2).-This soil is coarser textured than the Royal fine sandy loams because the surface layer has been altered by wind erosion. Small areas where the slope is more than 5 percent were included in mapping. In irrigated areas, runoff is slow to medium and the hazard of water erosion is slight to moderate. The hazard of wind erosion is severe. Drifting soil injures young plants and fills irrigation ditches.

The crops are the same as those grown on Royal fine sandy loam, 0 to 2 percent slopes, but more of the acreage

is in hay and pasture. Sprinkling is the most suitable method of irrigation. (Capability unit IIs-3, irrigated; range site 7)

Royal fine sandy loam, loamy subsoil, 0 to 2 percent slopes (RtA).-Below the surface layer and to a depth of 20 to 36 inches, this soil is very fine sandy loam. It holds 7 to 9 inches of water that plants can use. In places depressions cause localized drainage problems.

Most of the acreage is irrigated. Both surface and sprinkler irrigation are suitable. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Nitrogen is needed for nonlegumes. Nitrogen and zinc are needed for beans. In places where deep cuts have been made in leveling, fertility problems are likely to occur because of strong concentrations of lime. Generally, these problems can be corrected by applications of fertilizer, mainly phosphate. (Capability unit I-1, irrigated; range site 8)

Royal fine sandy loam, loamy subsoil, 2 to 5 percent slopes (RtB).-In irrigated areas of this soil, runoff is medium and the hazard of erosion is moderate. The crops are the same as are grown on Royal fine sandy loam, loamy subsoil, 0 to 2 percent slopes, but irrigation runs should be shorter, or corrugations and furrows should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 8)

Royal fine sandy loam, loamy subsoil, 5 to 15 percent slopes (RtD).-In irrigated areas of this soil, runoff is rapid and the hazard of erosion is severe. Most slopes are between 5 and 10 percent. Sprinkling is the only suitable method of irrigation. (Capability unit IIIe-1, irrigated; range site 8)

Royal loamy fine sand, loamy subsoil, 0 to 5 percent slopes, eroded (RwB2).-The surface layer of this soil has been altered by wind erosion. In irrigated areas, runoff is slow to medium and the hazard of water erosion is slight to moderate. The hazard of wind erosion is severe. Drifting soil may injure young plants and fill irrigation ditches.

The crops are the same as those grown on Royal fine sandy loam, loamy subsoil, 0 to 2 percent slopes, but more of the acreage is in hay and pasture. Sprinkling is the most suitable method of irrigation. (Capability unit IIs-3, irrigated; range site 7)

Sagemoor Series

The Sagemoor series consists of well-drained, medium-textured soils underlain by slowly permeable or very slowly permeable lacustrine sediments of the Ringold or Touchet beds at a depth of 20 to 40 inches. These soils formed under bunchgrass and big sagebrush, from loess and lacustrine sediments. They occupy gently sloping to moderately sloping dissected terraces in the western part of the county. The elevation is about 1,200 feet. The annual precipitation is about 8 inches.

The surface layer is dark grayish-brown silt loam. The subsoil to a depth of 15 to 40 inches is uniform silt loam. The substratum consists of stratified lacustrine deposits of silty or very fine sandy loam.

Most of the acreage is irrigated as part of the Columbia Basin Irrigation Project.

Sagemoor silt loam, 0 to 2 percent slopes (SaA).-This is a silty soil on dissected terraces. Most slopes are about 1 percent.

Representative profile:

Surface layer-

0 to 9 inches, dark grayish-brown silt loam; weak, fine, granular structure; very friable; mildly alkaline; plentiful roots.

Subsoil-

9 to 19 inches, dark-brown silt loam; weak, medium and coarse, prismatic structure; very friable; mildly alkaline; plentiful roots.

Substratum-

19 to 46 inches, dark grayish-brown silt loam and very fine sandy loam; finely laminated; firm; moderately alkaline; strongly calcareous; few roots.

46 to 60 inches +, very dark grayish-brown silt loam; finely laminated; firm; strongly alkaline; strongly calcareous; no roots.

The surface layer ranges from dark grayish brown to dark brown. In cultivated areas, the surface layer is thicker than in the profile described. The depth to the laminated silty layers ranges from 15 to 40 inches but commonly is about 22 inches. The laminations are thin and consist of lenses of silt loam, silt, very fine sandy loam, and very fine sand. In places, piles of ice-raftered boulders are on the surface.

This soil is well drained, is easily worked, and holds 7 to 9 inches of water that plants can use. The subsoil is moderately permeable, and the substratum is slowly permeable. Because of the restrictive nature of the substratum, problems of drainage or of alkalinity and salinity may develop if too much irrigation water is applied or if water seeps from higher lying soils. Runoff is slow and the hazard of water erosion is slight. The hazard of wind erosion is slight to moderate.

Corn, sugar beets, peas, potatoes, beans, wheat, and hay and pasture crops are grown. Both surface and sprinkler irrigation are suitable. Nitrogen is needed for nonlegumes. Zinc and nitrogen are needed for beans. (Capability unit IIs-2 irrigated; range site 4)

Sagemoor silt loam, 2 to 5 percent slopes (SaB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate.

The crops are the same as those grown on Sagemoor silt loam, 0 to 2 percent slopes. The same irrigation methods are suitable, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-3, irrigated range site 4)

Sagemoor silt loam, 5 to 15 percent slopes (SaD).-Small areas where the slope is more than 15 percent were included with this soil in mapping. The slope is dominantly between 5 and 10 percent. In irrigated areas, runoff is rapid to very rapid and the hazard of water erosion is severe to very severe. Sprinkling is the most suitable method of irrigation. Row crops are not generally grown. (Capability unit IIIe-3, irrigated; range site 4)

Sagemoor silt loam, compact substratum, 0 to 2 percent slopes (ScA).-This soil is underlain by the compact, semiconsolidated, very slowly permeable lacustrine sediments of the Ringold beds at a depth of 20 to 40 inches. It holds 5 to 7 inches of water that plants can use. It is used for the same crops that are grown on Sagemoor silt loam, 0 to 2 percent slopes, but is less productive of some crops. Also, this soil requires more frequent and more

careful irrigation because its substratum is very slowly permeable. (Capability unit IIs-2, irrigated; range site 4)

Sagemoor silt loam, compact substratum, 2 to 5 percent slopes (ScB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The crops are the same as those grown on Sagemoor silt loam, compact substratum, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIE-3, irrigated; range site 4)

Sagemoor silt loam, compact substratum, 5 to 15 percent slopes (ScD).-The slope of this soil is dominantly between 5 and 10 percent. In irrigated areas, runoff is rapid to very rapid and the hazard of water erosion is severe to very severe. Row crops are not generally grown. Seepage water from higher lying soils is not a hazard. Sprinkling is the most suitable method of irrigation. (Capability unit IIIe-3, irrigated; range site 4)

Sagemoor silt loam, compact substratum, 15 to 30 percent slopes (ScE).-If irrigated, this soil should be used for grass and alfalfa, or for orchards and vineyards that are protected by a permanent cover crop. Sprinkling is the most suitable method of irrigating. In irrigated areas, runoff is very rapid and the hazard of water erosion is very severe. (Capability unit VIe-1, irrigated; range site 4)

Sagemoor silt loam, compact substratum, shallow, 0 to 2 percent slopes (SgA).-This soil is only 15 to 20 inches deep over Ringold beds. It holds 3 to 5 inches of water that plants can use. It is suitable for sprinkler or surface irrigation. Preparation for surface irrigation is difficult because the substratum is so near the surface. Excessive irrigation or seepage from higher areas causes drainage problems in places. Beans, alfalfa, grass, corn, potatoes, grain, and mint are the major crops. (Capability unit IVs-1, irrigated; range site 9)

Scootene Series

The Scootene series consists of well-drained, medium-textured soils that have a gravelly and cobbly subsoil. These soils formed under bunchgrass and sagebrush, in deep, stony, cobbly, and gravelly alluvium that contained some volcanic ash. They occupy nearly level to moderately sloping alluvial fans and terraces in the western part of the county. The elevation ranges from 400 to 1,300 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish brown and is 3 to 6 inches thick. The subsoil is dark-brown very fine sandy loam to a depth of about 18 inches. The substratum is dark-brown cobbly and gravelly sandy loam that is calcareous below a depth of 24 inches.

Most of the acreage lies within the boundaries of the Columbia Basin Irrigation Project and is irrigated.

Scootene loam, 0 to 2 percent slopes (SmA).-This is a loamy soil on alluvial fans and terraces. Most slopes are about 1 percent.

Representative profile:

Surface layer-

0 to 4 inches, dark-brown loam; weak, coarse, platy structure; very friable; neutral; abundant roots.

Subsoil-

4 to 18 inches, dark-brown very fine sandy loam; weak, medium, subangular blocky structure; friable; mildly alkaline; plentiful roots.

Substratum-

18 to 60 inches +, dark-brown gravelly very fine sandy loam in the upper part, grayish-brown very cobbly and gravelly sandy loam below a depth of 29 inches; massive; very friable; moderately alkaline; strongly calcareous; plentiful to few roots, the number of roots decreases with increasing depth.

The surface layer ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The subsoil ranges from very fine sandy loam to silt loam in texture, and from dark brown to dark grayish brown in color. The depth to lime ranges from 18 to 30 inches. In places loose stones and angular basalt chips are common throughout the profile. The content of gravel and cobblestones increases with increasing depth and exceeds 50 percent below a depth of 30 inches.

This soil is well drained and moderately permeable. It is easily worked. It holds 5 to 7 inches of water that plants can use. Water movement is not restricted as it is in soils in which the boundary between the subsoil and the gravelly layer is abrupt. The soil material is well graded as to texture and resists wind and water erosion. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is slight to moderate.

This soil is irrigated and is well suited to both surface and sprinkler irrigation. Beans, peas, corn, potatoes, wheat, sugar beets, and hay and pasture crops are grown. Nitrogen is needed for nonlegumes. (Capability unit IIs-1, irrigated; range site 4)

Scootene loam, 2 to 5 percent slopes (SmB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The crops are the same as those grown on Scootene loam, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIE-2, irrigated; range site 4)

Scootene loam, 5 to 10 percent slopes (SmC).-In irrigated areas of this soil, runoff is rapid and the water erosion hazard is severe. Sprinkling is the most suitable method of irrigation. (Capability unit IIIe-1, irrigated; range site 4)

Scootene loam, 10 to 15 percent slopes (SmD).-This soil is generally shallower over the gravelly subsoil than Scootene loam, 0 to 2 percent slopes. Areas that have a gravelly surface layer and areas on short terrace breaks of more than 15 percent slope were included in mapping. In irrigated areas, runoff is very rapid and the water erosion hazard is very severe. Sprinkling is the only suitable method of irrigation. Row crops are not generally grown. (Capability unit IVe-1, irrigated; range site 4)

Scootene cobbly loam, 0 to 5 percent slopes (SnB).-This soil holds 4 to 6 inches of water that plants can use. Preparation for tillage and surface irrigation is difficult because of the cobblestones, and in places it may be impossible unless cobblestones are removed. Both surface and sprinkler irrigation are suitable. This soil is suited to hay and pasture. Row crops are generally not grown. (Capability unit IVs-2, irrigated; range site 4)

Scooteney stony loam, 0 to 15 percent slopes (SoD).-Some short terrace breaks of more than 15 percent slope were included with this soil in mapping. In irrigated areas, runoff is medium to rapid and the hazard of water erosion is moderate to severe. This soil is not suited to cultivation unless the stones are removed. It is used mainly for range. (Capability unit VIe-1, irrigated; VIe-2, nonirrigated; range site 9)

Shano Series

The Shano series consists of well-drained, medium-textured soils that developed under sagebrush and bunchgrass, from loess that contained volcanic ash. These soils occupy nearly level to steep uplands in the western part of the county. The elevation ranges from 1,000 to 1,700 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown silt loam or very fine sandy loam 3 to 8 inches thick. The subsoil and the upper part of the substratum are dark-brown silt loam. The lower part of the substratum is dark grayish-brown, calcareous silt loam. These soils are normally more than 60 inches deep and in places are underlain by basalt, sandy gravel, or a lime-silica hardpan at a depth of 40 to 48 inches.

Shano soils are mostly cultivated. A large acreage is irrigated under the Columbia Basin Irrigation Project.

Shano silt loam, 0 to 2 percent slopes (SsA).-This is a silty soil on the uplands.

Representative profile

Surface layer-

0 to 8 inches, dark grayish-brown silt loam; granular structure; very friable; mildly alkaline; plentiful roots.

Subsoil and upper substratum-

8 to 33 inches, dark-brown silt loam; prismatic structure; very friable; mildly alkaline; plentiful roots; massive and moderately alkaline below a depth of 18 inches.

Lower substratum-

33 to 67 inches, dark grayish-brown silt loam; massive; friable; moderately alkaline; strongly calcareous; common, hard, concentric nodules; few roots; strongly alkaline below a depth of 42 inches, and firm below a depth of 57 inches.

The surface layer ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. If cultivated, it is thicker than is typical. The depth to calcareous soil ranges from 24 to 36 inches. The hard nodules in the substratum range in number from few to many, and in some places there are none. Basins without external outlets occur in some level areas.

This soil is well drained and moderately permeable. It has good tilth and is easily worked. The available water capacity is 9 to 11 inches. Runoff is slow. The hazard of water erosion is slight; the hazard of wind erosion is slight to moderate.

More than 95 percent of this soil is irrigated. Both surface and sprinkler irrigation are suitable. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Nitrogen is needed for nonlegumes. (Capability unit I-1, irrigated; range site 4)

Shano silt loam, 2 to 5 percent slopes (SsB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The crops are the same as those on Shano silt loam, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs

should be shorter or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 4)

Shano silt loam, 5, to 10 percent slopes (SsC).-In irrigated areas of this soil, runoff is rapid and the hazard of water erosion is severe. Small areas where the surface layer is very fine sandy loam were included in mapping. Sprinkling is the most suitable method of irrigating. (Capability unit IIIe-1, irrigated; range site 4)

Shano silt loam, 10 to 15. percent slopes (SsD).-In irrigated areas of this soil, runoff is very rapid and the hazard of water erosion is very severe. Short breaks of more than 15 percent slope were included in mapping. Sprinkling is the only suitable method of irrigating. (Capability unit IVe-1, irrigated; range site 4)

Shano silt loam, moderately shallow, 0 to 2 percent slopes (StA).-This soil is underlain by basalt, a lime-silica hardpan, or Ringold beds at a depth of 40 to 48 inches. It holds 7 to 9 inches of water that plants can use. It is used for the same crops as Shano silt loam, 0 to 2 percent slopes. Excessive irrigation or seepage from higher areas causes drainage problems in places. (Capability unit I-1, irrigated; range site 4)

Shano silt loam, moderately shallow, 2 to 5 percent slopes (StB).-This soil is underlain by basalt, Ringold beds, or a lime-silica hardpan at a depth of 40 to 48 inches. Some areas that are a few inches less than 40 inches deep were included in mapping.

This soil holds 7 to 9 inches of water that plants can use. In irrigated areas, runoff is medium and the hazard of water erosion is moderate. Excessive irrigation or seepage from higher areas causes drainage problems in places.

The crops are the same as those grown on Shano silt loam, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 4)

Shano silt loam, moderately shallow, 5 to 10 percent slopes (StC).-This soil is underlain by basalt, Ringold beds, or a lime-silica cemented hardpan at a depth of 40 to 48 inches. A few areas of soil less than 40 inches deep were included in mapping.

This soil holds 7 to 9 inches of water that plants can use. Sprinkling is the most suitable method of irrigating. In irrigated areas, runoff is rapid and the hazard of water erosion is severe. Seepage from higher areas is not a problem. (Capability unit IIIe-1, irrigated; range site 4)

Shano silt loam, moderately shallow, 10 to 15 percent slopes (StD). This soil is underlain by basalt, Ringold beds, or a lime-silica hardpan at a depth of 40 to 48 inches. Some areas of soil no more than 36 inches deep were included in mapping.

This soil holds 7 to 9 inches of water that plants can use. In irrigated areas, runoff is very rapid and the hazard of water erosion is very severe. Sprinkling is the only suitable method of irrigating. Orchards and vineyards should be protected by perennial cover crops. (Capability unit IVe-1, irrigated; range site 4)

Shano silt loam, moderately shallow, 15 to 30 percent slopes (StE).-This soil is underlain by basalt, Ringold beds, or a lime-silica cemented hardpan at a depth of 40

to 48 inches. Some areas of soil less than 36 inches deep were included in mapping.

This soil holds 7 to 9 inches of water that plants can use. If irrigated, it should be used for grass and alfalfa or for orchards and vineyards that are protected by cover crops. In irrigated areas, runoff is very rapid and the hazard of erosion is very severe. Sprinkling is the only suitable method of irrigating. (Capability unit VIe-1, irrigated; range site 4)

Shano very fine sandy loam, 0 to 2 percent slopes, eroded (SvA2).-The surface layer of this soil is coarser textured than that of the Shano silt loams because it has been reworked by wind. The hazard of wind erosion is moderate. Both surface and sprinkler irrigation are suitable. The crops are the same as those grown on Shano silt loam, 0 to 2 percent slopes. (Capability unit I-1, irrigated; range site 4)

Shano very fine sandy loam, 2 to 5 percent slopes, eroded (SvB2).-The surface layer of this soil is coarser textured than that of the Shano silt loams because it has been reworked by wind. The hazard of wind erosion is moderate. In irrigated areas, runoff is medium and the water erosion hazard is moderate.

The crops are the same as those grown on Shano silt loam, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 4)

Shano silt loam, 0 to 5 percent slopes (SHB).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. If cultivated, it is slightly to moderately susceptible to wind erosion. It is used principally for dryland grain. Rye or wheat are grown in a crop-fallow system. Low rainfall limits yields. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVc-1, nonirrigated; range site 4)

Shano silt loam, 5 to 30 percent slopes (SHD).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. If cultivated, it is slightly to moderately susceptible to wind erosion. Runoff is medium, and the hazard of water erosion is moderate.

This soil is used principally for dryland grain. Rye or wheat are grown in a crop-fallow system. Low rainfall limits yields. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVe-6, nonirrigated; range site 4)

Shano silt loam, 30 to 45 percent slopes (SHE).-Small eroded areas and short breaks of more than 45 percent slope were included with this soil in mapping. Runoff is rapid, and the hazard of water erosion is severe. This soil is not suitable for cultivation. (Capability unit VIe-2, nonirrigated; range site 4)

Shano very fine sandy loam, 0 to 30 percent slopes, eroded (SMD2).-The surface layer of this soil is coarser textured than that of the Shano silt loams because it has been reworked by wind. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is moderate. Drifting soil creates a problem. Rye, the principal crop, is grown in a crop-fallow system. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVe-6, nonirrigated; range site 4)

Shano silt loam, moderately shallow, 0 to 5 percent slopes (SLB).-This soil is underlain by a lime-silica hardpan or basalt bedrock at a depth of 40 to 48 inches. Small eroded areas of soils that have a surface layer of very fine sandy loam and are calcareous at or near the surface were included in mapping. Also included were small areas of Burke silt loam, 0 to 30 percent slopes, and a few areas of a soil no more than 36 inches deep.

This soil holds 7 to 9 inches of water that plants can use.

Rye and wheat are grown in a crop-fallow system. Low rainfall limits production. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVc-1, nonirrigated; range site 4)

Shano silt loam, moderately shallow, 5 to 30 percent slopes (SLD).-This soil is underlain by a lime-silica hardpan or basalt bedrock at a depth of 40 to 48 inches. Small eroded areas of soils that have a surface layer of very fine sandy loam and that are calcareous at or near the surface were included in mapping. Also included were small areas of Burke silt loam, 0 to 30 percent slopes, and some areas of soils no more than 36 inches deep.

This soil holds 7 to 9 inches of water that plants can use. Runoff is medium, and the hazard of water erosion is moderate.

Rye and wheat are grown in a crop-fallow system. Low rainfall limits production. Crops respond to nitrogen, especially in years when the moisture supply is favorable. (Capability unit IVe-6, nonirrigated; range site 4)

Stanfield Series

The Stanfield series consists of moderately well drained, medium-textured, saline-alkali soils underlain by a hardpan, at a depth of 24 to 40 inches. These soils formed under giant wildrye, salt grass, and greasewood, in alluvium derived from loess, volcanic ash, and basaltic materials. They occupy low terraces and valley bottoms in the central and western parts of the county. The elevation ranges from 800 to 1,500 feet. The annual precipitation is 7 to 12 inches.

The surface layer is dark-brown or dark grayish-brown, very strongly alkaline silt loam or very fine sandy loam about 5 inches thick. The subsoil is dark-brown silt loam. It is underlain by an alkali-soluble hardpan at a depth of 24 to 40 inches.

These soils are used principally for range.

Stanfield silt loam, 0 to 6 percent slopes (SNB).-This is a saline-alkali soil on alluvial bottoms. Most slopes are about 1 percent.

Representative profile:

Surface layer-

0 to 4 inches, dark grayish-brown silt loam; weak, fine, granular structure; very friable; abundant roots; very strongly alkaline.

Subsoil-

4 to 36 inches, dark-brown silt loam; massive breaking to weak, medium, subangular blocky structure; friable; plentiful roots; very strongly alkaline.

Substratum-

36 to 58 inches, brown silt loam; massive; weakly cemented, alkali-soluble hardpan; no roots; very strongly alkaline.

58 inches +, dark-brown silt loam; massive; friable; no roots, strongly alkaline.

The texture of the surface layer ranges from very fine sandy loam to silt loam, and the color from dark grayish brown to dark brown. The hardpan, which is discontinuous, is weakly to strongly cemented, 5 to 20 inches thick, and at a depth of 24 to 40 inches. In places this soil is mostly volcanic ash.

This soil is moderately well drained and moderately permeable as far down as the hardpan, which is slowly to very slowly permeable. It holds about 5 to 7 inches of water that is available to salt-tolerant plants. Runoff is slow, and the hazard of erosion is slight.

This soil is used mainly for range. (Capability unit VI-2, nonirrigated; range site 1)

Starbuck Series

The Starbuck series consists of well-drained, medium-textured soils underlain by basalt bedrock at a depth of 12 to 20 inches. These soils formed under bunchgrass, in mixed loess, colluvium, and alluvium derived from basic igneous rocks and some volcanic ash. They occupy nearly level to steep uplands in the central and western parts of the county. The elevation ranges from 700 to 2,000 feet. The annual precipitation is 7 to 12 inches.

The surface layer is dark-brown or very dark grayish-brown silt loam or very fine sandy loam 6 to 10 inches thick. The subsoil is brown or dark-brown silt loam or very fine sandy loam. Basalt bedrock is at a depth of 12 to 20 inches. In places the profile is gravelly, cobbly, or stony throughout.

Starbuck soils are used mainly for range. Some areas mapped as part of a complex with Prosser soils are irrigated.

Starbuck silt loam, 0 to 15 percent slopes (STC).-This is a silty soil on undulating basalt plateaus. Most slopes are about 10 percent. Small areas of stony soils, rock outcrops, and soils more than 20 inches deep were included in mapping.

Representative profile:

Surface layer-

0 to 9 inches, dark-brown silt loam; platy and granular structure; friable; neutral; plentiful roots.

Subsoil-

9 to 16 inches, brown or dark-brown silt loam; weak prismatic structure; friable; neutral; plentiful roots.

Substratum-

16 inches +, basalt bedrock.

In places this soil is 15 percent gravel. Its surface layer is very dark grayish brown in some areas. The depth to bedrock ranges from 12 to 20 inches. In places there is a layer of lime just above the bedrock or a lime coating on the bedrock.

This soil is well drained and moderately permeable. It holds 2 to 4 inches of water that is available to plants. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

This soil is used only for range. (Capability unit VI-1, nonirrigated; range site 10)

Stratford Series

The Stratford series consists of well-drained, medium-textured soils underlain by gravel at a depth of 20 to 40 inches. These soils formed under bunchgrass, from

gravelly alluvium that was derived partly from basalt and partly from loess containing some volcanic ash. They occupy nearly level to strongly sloping outwash plains and terraces in the central part of the county. The elevation ranges from 1,100 to 1,500 feet. The annual precipitation is 9 to 12 inches.

The surface layer is very dark grayish-brown silt loam 7 to 10 inches thick. In some places it is gravelly or stony. The subsoil is dark-brown, gravelly or very gravelly silt loam; it is 10 to 60 percent gravel. The substratum is basalt sand and gravel. The undersides of the gravel and cobbles are coated with lime and silica.

Stratford soils are used principally for range. Some areas are cultivated and used for dryland grain or irrigated hay and pasture.

Stratford silt loam, 0 to 15 percent slopes (SUC).-This soil is on outwash plains and terraces. Most slopes are about 5 percent. Included in mapping were small areas of rock outcrop, stony and cobbly soils, soils less than 20 inches deep, and short escarpments where slopes are more than 15 percent.

Representative profile:

Surface layer-

0 to 8 inches, very dark grayish-brown silt loam; weak, fine, granular structure; very friable; mildly alkaline; plentiful roots; small amount of fine gravel.

Subsoil-

8 to 18 inches, dark-brown gravelly loam; subangular blocky structure; friable; mildly alkaline; plentiful roots; small amount of gravel.

18 to 23 inches, dark yellowish-brown gravelly loam; massive; very friable; mildly alkaline; plentiful roots.

23 to 28 inches, dark-brown very gravelly loam; massive; friable; mildly alkaline; plentiful roots.

Substratum-

28 inches +, basalt gravel and sand; some lime and silica coatings on undersides of gravel.

The surface layer ranges from 7 to 10 inches in thickness. The subsoil is 10 to 60 percent gravel and cobbles, and the percentage increases with increasing depth. The depth to gravel ranges from 20 to 40 inches. Lime occurs a few inches above the open gravel in places.

This soil is well drained and moderately permeable. It holds 5 to 6 inches of water that plants can use. Wet spots in depressions may make it necessary to delay tillage in spring. Some stones are present, so care is needed in using certain types of equipment for deep tillage. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

About half of the acreage is cultivated. Wheat and rye, grown in a summer-fallow system, are the principal crops. A few areas are irrigated by water pumped from wells, and alfalfa and grass are grown for hay and pasture. Range that is in poor condition can be summer-fallowed and seeded to adapted grass without irrigation. Crops respond to nitrogen. (Capability unit IVe-4, nonirrigated; range site 10)

Stratford cobbly silt loam, 0 to 15 percent slopes (SVC).-As much as 10 percent of this soil is rock outcrops. Escarpments where slopes are more than 15 percent also were included in mapping. The surface layer is 2 to 3 inches thinner than that of Stratford silt loam, 0 to 15 percent slopes. This soil is hummocky, and on the hummocks it is deeper to gravel. It holds 3 to 5 inches of water that plants can use.

This soil is used mainly for range, but small areas are cultivated. Small grain is grown in a crop-fallow system. Tillage is difficult. Removal of some of the rocks and cobblestones is necessary. Small areas have been irrigated for hay and pasture crops. (Capability unit VIe-1, nonirrigated; range site 10)

Stratford very stony silt loam, 0 to 15 percent slopes (SWC).-The surface layer of this soil is 2 or 3 inches thinner than that of Stratford silt loam, 0 to 15 percent slopes. The surface is hummocky, and on the hummocks the depth to gravel is somewhat greater than elsewhere. This soil holds 3 to 5 inches of water that plants can use. Included in mapping were escarpments of more than 15 percent slope, and also rock outcrops to the extent of 10 percent of some areas.

This soil is used mainly for range. A few small areas are irrigated and planted to pasture crops. Neither cultivation nor pasture improvement is possible unless stones and rocks are removed. (Capability unit VIIs-1, nonirrigated; range site 10)

Taunton Series

The Taunton series consists of well-drained, moderately coarse textured soils underlain by a lime-cemented hardpan at a depth of 18 to 40 inches. These soils formed under bunchgrass and sagebrush, in wind-worked alluvial material derived from basalt, granite, and quartzitic rocks. They occupy nearly level to gently sloping terraces in the western part of the county. The elevation ranges from 900 to 1,100 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown or dark-brown fine sandy loam or very fine sandy loam 3 to 6 inches thick. The subsoil is dark-brown fine sandy loam and is calcareous below a depth of 12 inches. It is underlain by a lime-cemented hardpan at a depth of 18 to 40 inches.

These soils lie within the boundaries of the Columbia Basin Irrigation Project.

Taunton fine sandy loam, 2 to 5 percent slopes (TaB).-This is a loamy soil on terraces. Most slopes are about 3 percent. Small areas of loamy fine sand were included in mapping.

Representative profile:

Surface layer-

0 to 5 inches, dark grayish-brown fine sandy loam; weak, fine, granular structure; very friable; mildly alkaline; plentiful roots.

Subsoil-

5 to 18 inches, dark-brown fine sandy loam; weak subangular blocky structure; friable; moderately alkaline; plentiful roots.

18 to 24 inches, dark-brown gravelly (lime-cemented fragments) fine sandy loam; massive; very friable; strongly alkaline; strongly calcareous; plentiful roots.

Substratum--

24 inches +, lime-cemented hardpan.

The color of the surface layer ranges from dark grayish brown to dark brown; the texture ranges from fine sandy loam to very fine sandy loam. The depth to the hardpan is 24 to 40 inches. In many places the surface is littered with lime-cemented fragments; such fragments also occur in variable amounts throughout the profile.

This soil is well drained. It holds 4 to 5 inches of available water. Permeability is moderately rapid as far

down as the fractured, lime-cemented hardpan acid very slow through it. Seepage from higher areas or excessive irrigation causes drainage problems in places. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is also moderate.

The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Both surface and sprinkler irrigation are suitable. Furrows and corrugations should be held to a 2 percent gradient, or irrigation runs should be short. (Capability unit IIIe-2, irrigated; range site 8)

Taunton fine sandy loam, shallow, 0 to 6 percent slopes (TfB).-In this soil the depth to the lime-cemented hardpan is 18 to 24 inches. The available water capacity is 3 to 4 inches. The crops grown and the irrigation methods are much the same as those for Taunton fine sandy loam, 2 to 5 percent slopes. (Capability unit IVs-1, irrigated; range site 8)

Umapine Series

The Umapine series consists of moderately well drained, saline-alkali soils that formed in alluvium derived from loess, volcanic ash, and basalt rock. These soils occupy nearly level bottom land, low alluvial fans, basins, and low terraces in the central and western parts of the county. The native vegetation consists of giant wildrye, greasewood, and saltgrass. The elevation ranges from 800 to 1,500 feet. The annual precipitation is 7 to 12 inches.

The surface layer is very strongly alkaline, gray or dark grayish-brown silt loam or very fine sandy loam. In places subject to overflow, it is loamy sand. The subsoil and substratum are strongly alkaline silt loam that ranges from gray to very dark grayish brown in color.

Umapine soils are used mainly for range.

Umapine silt loam, 0 to 2 percent slopes (UMA)(UmA).-This is a saline-alkali soil on the alluvial bottoms. Most slopes are about 1 percent. Small areas of soils that have a weakly cemented hardpan were included in mapping.

Representative profile:

Surface layer-

0 to 9 inches, dark grayish-brown silt loam; weak platy structure; friable; very strongly alkaline; strongly calcareous, violent effervescence with dilute hydrochloric acid; plentiful roots.

Subsoil-

9 to 19 inches, very dark grayish-brown silt loam; massive; friable; very strongly alkaline; strongly calcareous, violent effervescence with dilute hydrochloric acid; abundant roots.

Substratum-

19 to 60 inches, dark-gray, gray, or dark grayish-brown silt loam; massive; friable; strongly alkaline; strongly calcareous, violent effervescence with dilute hydrochloric acid; few roots.

The surface layer ranges from dark grayish brown to gray in color and from very fine sandy loam to silt loam in texture. In places the lower part of the subsoil is stratified with sandy loam, silt loam, or light clay loam and includes layers of volcanic ash. In some areas, gravel, sand, or bedrock is below a depth of 40 inches.

This soil is moderately well drained and moderately permeable. It holds about 9 to 11 inches of moisture that

is available to salt-tolerant plants. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight to moderate. This soil is used mainly for range. (Capability unit VIs-2, nonirrigated; VIs-2, irrigated; range site 1)

Umapine loamy sand, overwash, 0 to 2 percent slopes (UoA).-This soil has been subject to overflow. Its surface layer is coarser textured than that of Umapine silt loam. The hazard of wind erosion is severe. This soil is used mainly for range. (Capability unit VIs-2, nonirrigated; range site 1)

Wacota Series

The Wacota series consists of well-drained, medium-textured soils that developed from volcanic ash and loess. These soils are nearly level to very steep and occur in the eastern and central parts of the county. The elevation ranges from 1,400 to 2,000 feet. The annual precipitation is 9 to 12 inches.

The surface layer is dark grayish-brown very fine sandy loam or silt loam 4 to 9 inches thick. The subsoil and substratum are dark-brown or brown very fine sandy loam or silt loam and are calcareous below a depth of 36 inches.

Wacota soils are used for grazing and for growing wheat and rye in a crop-fallow system.

Wacota silt loam, 0 to 30 percent slopes, eroded (WAD2).-This is an ash soil of the uplands. Most slopes are about 15 percent. Small areas of volcanic ash and of Ritzville silt loam were included in mapping.

Representative profile:

Surface layer-

0 to 6 inches, dark grayish-brown silt loam; very fine granular structure; very friable; neutral; plentiful roots.

Subsoil-

6 to 43 inches, dark-brown silt loam; massive; very friable; neutral; plentiful roots.

Substratum-

43 to 60 inches +, brown silt loam; massive; friable; moderately alkaline; strongly calcareous; few roots.

The surface layer ranges from very fine sandy loam to silt loam, and the subsoil and substratum from very fine sandy loam to coarse silt loam. The depth to lime ranges from 36 to 60 inches. Pockets of pure volcanic ash are common in the profile.

This soil is well drained and moderately permeable. It holds 9 to 11 inches of available water. It is easily worked. Runoff is slow to medium, and the erosion hazard is slight to moderate. There are some limitations to the use of machinery on the steeper slopes.

Wheat and rye are grown in a crop-fallow system. Crops respond to nitrogen. (Capability unit IVe-3, nonirrigated; range site 5)

Wacota silt loam, 30 to 65 percent slopes, eroded (WAF2).-This soil is not suitable for cultivation. It is used for range. Runoff is rapid to very rapid, and the hazard of erosion is severe to very severe. (Capability unit VIe-1, nonirrigated; range site 6)

Walla Walla Series

The Walla Walla series consists of well-drained, deep and very deep, very dark colored, medium-textured soils.

These soils developed under bunchgrass from loess. They occupy nearly level to steep uplands in the eastern part of the county. The elevation ranges from 1,000 to 2,000 feet. The annual precipitation is 12 to 14 inches.

The surface layer is very dark brown or very dark grayish-brown silt loam 10 to 14 inches thick. The subsoil is brown or dark-brown silt loam that has weak prismatic structure. The subsoil may be calcareous below a depth of 40 inches. The substratum is brown silt loam. In places these soils are underlain by a lime-silica cemented hardpan or basalt bedrock below a depth of 40 inches.

The Walla Walla soils are used for small grain under a crop-fallow system.

Walla Walla silt loam, 0 to 5 percent slopes (WLB).-This is a silty, soil on rolling uplands. Most slopes are about 4 percent. Small areas of Walla Walla silt loam, moderately shallow, 0 to 5 percent slopes, and Chard silt loam, 0 to 5 percent slopes, were included in mapping.

Representative profile:

Surface layer-

0 to 13 inches, silt loam, very dark brown in upper part, very dark grayish brown in lower part; granular and platy structure; friable; neutral; abundant roots.

Subsoil-

13 to 55 inches, brown silt loam; weak prismatic structure; friable; mildly alkaline to a depth of 45 inches, moderately alkaline below this depth; calcareous below a depth of 45 inches; plentiful roots to a depth of 45 inches, few below this depth.

Substratum-

55 to 60 inches +, brown silt loam; massive; friable; strongly alkaline; strongly calcareous; disseminated, lime; few roots.

The thickness of the surface layer ranges from 10 to 14 inches. The depth to free lime ranges from 40 to more than 60 inches. The lower part of the subsoil may contain weakly cemented concentric nodules 1 to 2 inches in diameter.

This soil is well drained and moderately permeable. It holds 9 to 11 inches of water that plants can use. It has good tilth and is easily worked. Runoff is slow, and the hazard of erosion is slight.

More than 95 percent of the acreage is cultivated. Wheat and barley are grown in a crop-fallow system. Crops respond to nitrogen. (Capability unit IIc-1, nonirrigated; range site 5)

Walla Walla silt loam, 5 to 30 percent slopes (WLD).-The surface layer of this soil is 2 to 3 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes. On north-facing slopes, the depth to free lime may be more than 60 inches. Included in mapping were areas where the slope is steeper than 30 percent and where 25 to 50 percent of the original surface layer had been removed by erosion.

Runoff is medium, and the hazard of erosion is moderate. There are some limitations on the use of machinery on the steeper slopes. This soil is used mainly for small grain. (Capability unit IIIe-1, nonirrigated ; range site 5)

Walla Walla silt loam, 30 to 40 percent slopes (WLE).-The surface layer of this soil is 2 to 3 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes. Included in mapping were areas where 30 to 60 percent of the original surface layer had been removed by erosion.

When wet, this soil tends to creep and slip in places, which results in serious losses by erosion (fig. 7). Runoff is rapid, and the hazard of water erosion is severe. Because of excess runoff, less moisture is available to plants. There are limitations on the use of machinery on the steeper slopes. This soil is used mainly for small grain. (Capability unit IVe-1, nonirrigated; range sites 5 and 6)



Figure 7.-Soil slip on Walla Walla silt loam, 30 to 40 percent slopes. This was caused by rain on frozen soil late in winter.

Walla Walla silt loam, 40 to 65 percent slopes (WLF).-The surface layer of this soil is 3 to 4 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes. Included in mapping were areas where 30 to 60 percent of the original surface layer had been removed by erosion.

Runoff is very rapid. The hazard of water erosion is very severe. This soil is not suitable for cultivation. (Capability unit VIe-1, nonirrigated; range site 6)

Walla Walla silt loam, 5 to 30 percent slopes, eroded (WLD2).-The original surface layer of this soil has been partially or completely removed by erosion. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe. The crops are the same as those grown on Walla Walla silt loam, 0 to 5 percent slopes, but because of excessive runoff; less moisture is available to plants. Crops respond to nitrogen. (Capability unit IIIe-1, nonirrigated; range site 5)

Walla Walla silt loam, 3,0 to 40 percent slopes, eroded (WLE2).-The original surface layer of this soil has been partially or completely removed by erosion. Runoff is rapid, and the erosion hazard is severe. (Capability unit VIe-1, nonirrigated; range sites 5 and 6)

Walla Walla silt loam, moderately shallow, 0 to 5 percent slopes (WMB).-This soil is underlain by a lime-silica cemented hardpan or basalt bedrock at a depth of 40 to 48 inches. Its available water capacity is 7 to 9 inches. It is used mainly for small grain in a crop-fallow system. (Capability unit IIc-1, nonirrigated; range site 5)

Walla Walla silt loam, moderately shallow, 5 to 30 percent slopes (WMD).-This soil is underlain by basalt bedrock or a lime-silica cemented hardpan at a depth of 40 to 48 inches. Its surface layer is 2 to 3 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes.

Included in mapping were areas where 25 to 50 percent of the original surface layer had been removed by erosion.

Runoff is medium, and the hazard of water erosion is moderate. This soil holds 7 to 9 inches of water that plants can use. There are some limitations on the use of machinery on the steeper slopes. (Capability unit IIIe-1, nonirrigated ; range site 5)

Walla Walla silt loam, moderately shallow, 30 to 40 percent slopes (WME).-This soil is underlain by basalt bedrock or a lime-silica cemented hardpan at a depth of 40 to 48 inches. Its surface layer is 3 to 4 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes. Included in mapping were areas where 30 to 60 percent of the original surface layer had been removed by erosion.

Runoff is rapid, and the hazard of water erosion is severe. This soil holds 7 to 9 inches of water that is available to plants. There are limitations on the use of machinery. (Capability unit IVe-1, nonirrigated; range sites 5 and 6)

Walla Walla silt loam, moderately shallow, 40 to 65 percent slopes (WMF).-This soil is underlain by a lime-silica cemented hardpan or basalt bedrock at a depth of 40 to 48 inches. Its surface layer is 3 to 4 inches thinner than that of Walla Walla silt loam, 0 to 5 percent slopes. Included in mapping were areas where 30 to 60 percent of the original surface layer had been removed by erosion.

This soil is not suitable for cultivation. (Capability unit VIe-1, nonirrigated; range site 6)

Walvan Series

The Walvan series consists of well-drained, medium-textured soils that developed under bunchgrass, from volcanic ash and loess. These soils occupy undulating to hilly uplands. The elevation ranges from 1,500 to 2,000 feet. The annual precipitation is 12 to 14 inches.

The surface layer is very dark grayish-brown very fine sandy loam about 12 inches thick. The subsoil is dark grayish-brown very fine sandy loam or coarse silt loam. The substratum is grayish-brown very fine sandy loam or coarse silt loam. These soils are generally non-calcareous to a depth of 60 inches or more.

Walvan soils are used for dryland wheat and range.

Walvan very fine sandy loam, 0 to 30 percent slopes, eroded (WND2).-This is a loamy soil of the rolling uplands. Most slopes are about 20 percent. Small areas of ash were included in mapping.

Representative profile:

Surface layer-

0 to 12 inches, very dark grayish-brown very fine sand loam; weak granular and weak subangular blocky structure ; very friable; neutral; abundant roots.

Subsoil-

12 to 29 inches, dark grayish-brown very fine sandy loam massive; very friable; mildly alkaline; plentiful roots.

Substratum-

29 to 60 inches, grayish-brown very fine sandy loam; massive ; very friable; moderately alkaline; few roots.

The subsoil ranges from very fine sandy loam to coarse silt loam in texture and. in places contains lime in the lower part.

This soil is well drained and moderately permeable. It is easily worked. The available water capacity is 9 to 11 inches. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of wind

erosion is moderate. There are some limitations on the use of machinery on the steeper slopes.

Wheat and rye are grown in a crop fallow system. Crops respond to nitrogen. (Capability unit IVe-3, nonirrigated; range site 5)

Walvan very fine sandy loam, 30 to 65 percent slopes, eroded (WNF2).-This soil is not suitable for cultivation. Runoff is rapid to very rapid, and the erosion hazard is severe or very severe. (Capability unit VIe-1, nonirrigated; range site 6)

Warden Series

The Warden series consists of well-drained, medium-textured soils that formed under bunchgrass and sagebrush, from loess, volcanic ash, and lacustrine materials. These soils occupy nearly level to strongly sloping terraces in the western part of the county. The elevation ranges from 900 to 1,200 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish brown or dark brown and ranges from loamy fine sand to silt loam in texture. The subsoil is dark brown to dark grayish brown and is mainly silt loam. The substratum is brown very fine sandy loam or silt loam. In places the profile is calcareous below a depth of 4 inches.

Most of the acreage is cultivated. A large area within the boundaries of the Columbia Basin Irrigation Project is irrigated.

Warden very fine sandy loam, 0 to 2 percent slopes (WaA).-This is a loamy soil on sloping terraces.

Representative profile:

Surface layer-

0 to 6 inches, dark grayish-brown very fine sandy loam; granular structure; very friable; mildly alkaline; abundant roots.

Subsoil-

6 to 19 inches, dark-brown very fine sandy loam; weak subangular blocky structure; very friable; mildly alkaline; plentiful roots.

19 to 40 inches, dark-brown silt loam; massive, with some finely laminated clods; firm; moderately alkaline; strongly calcareous; plentiful roots.

Substratum-

40 to 54 inches, brown very fine sandy loam; massive; very friable; strongly alkaline; strongly calcareous; plentiful roots.

54 to 60 inches +, light brownish-gray silt loam; massive; firm; strongly alkaline; strongly calcareous; few roots.

The surface layer ranges from dark grayish brown to dark brown in color and is very fine sandy loam, or silt loam in texture. In places lime is within 4 inches of the surface, and the lower part of the subsoil is stratified with sandy loam or loamy sand. In a few areas basalt bedrock is within 36 inches of the surface.

This soil is well drained. It has good tilth and is easily worked. It holds 9 to 11 inches of water that plants can use. Permeability is moderate or moderately slow in the subsoil. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

This soil is within the boundaries of the Columbia Basin Irrigation Project and is irrigated. The major crops are beans, sugar beets, corn, small grain, potatoes, and hay and pasture crops. Both surface and sprinkler irrigation are suitable. Seepage from higher areas or excessive irrigation causes drainage problems in places.

Where deep cuts have been made in leveling, a high concentration of lime causes fertility problems. Generally, the fertility problems can be corrected by applications of fertilizer, mainly phosphate. Nitrogen is needed for nonlegumes. (Capability unit I-1, irrigated; range site 4)

Warden very fine sandy loam, 2 to 5 percent slopes

(WaB).-In irrigated areas of this soil, runoff is medium and the hazard of erosion is moderate. The crops are the same as those grown on Warden very fine sandy loam, 0 to 2 percent slopes. The irrigation methods are the same also, but the length of irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIe-1, irrigated; range site 4)

Warden very fine sandy loam, 5 to 10 percent slopes

(WaC).-In irrigated areas of this soil, runoff is rapid and the hazard of water erosion is severe. Sprinkling is the most suitable method of irrigation. Seepage from higher areas is not a problem. (Capability unit IIIe-1, irrigated; range site 4)

Warden fine sandy loam, 0 to 2 percent slopes, eroded

(WfA2).-The surface layer of this soil has been altered by wind erosion. The crops and the irrigation methods are about the same as those for Warden very fine sandy loam, 0 to 2 percent slopes. (Capability unit I-1, irrigated; range site 8)

Warden fine sandy loam, 2 to 5 percent slopes, eroded

(WfB2).-The surface layer of this soil has been altered by wind erosion. In irrigated areas, runoff is medium and the hazard of water erosion is moderate. The crops and the irrigation methods are the same as those for Warden very fine sandy loam, 0 to 2 percent slopes, except that the length of irrigation runs should be shorter or furrows and corrugations should be held to a 2 percent gradient or less. (Capability unit IIe-1, irrigated; range site 8)

Warden fine sandy loam, 5 to 10 percent slopes, eroded

(WfC2).-The surface layer of this soil has been altered by wind erosion. In irrigated areas, runoff is rapid and the erosion hazard is severe. Sprinkling is the most suitable method of irrigation. (Capability unit IIIe-1, irrigated; range site 8)

Warden fine sandy loam, 10 to 15 percent slopes, eroded

(WfD2).-The surface layer of this soil has been altered through wind erosion. Runoff is very rapid, and the erosion hazard is very severe. Sprinkling is the only suitable method of irrigation. (Capability unit IVe-1, irrigated; range site 8)

Warden loamy fine sand, 0 to 5 percent slopes, eroded

(WmB2).-The surface layer of this soil has been altered by wind erosion. In irrigated areas, runoff is slow to medium and the hazard of water erosion is slight to moderate. Drifting soil is a problem in places; it injures young plants and fills irrigation ditches. Crops are about the same as those grown on Warden very fine sandy loam, 0 to 2 percent slopes, but most of the acreage is in hay and pasture. Sprinkling is the most suitable method of irrigation. (Capability unit IIs-3, irrigated; range site 7)

Warden very fine sandy loam, 0 to 5 percent slopes

(WOB).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. Rye or wheat are grown in a crop-fallow system. Crops respond to nitrogen, especially where the moisture supply is favorable. (Capability unit IVc-1, nonirrigated; range site 4)

Warden very fine sandy loam, 5 to 30 percent slopes (WOD).-This soil, is outside the boundaries of the Columbia Basin Irrigation Project. Runoff is medium, and the hazard of water erosion is moderate. Rye or wheat are grown in a crop-fallow system. Crops respond to nitrogen, especially when moisture is favorable. (Capability unit IVE-6, nonirrigated; range site 4)

Warden very fine sandy loam, 0 to 15 percent slopes, eroded (WOC2).-This soil is outside the boundaries of the Columbia Basin Irrigation Project. Its original surface layer has been partially or completely removed by erosion. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is moderate. Rye and wheat are grown in a crop-fallow system. Crops respond to nitrogen, especially when moisture is favorable. (Capability unit IVE-6, nonirrigated; range site 4)

Wiehl Series

The Wiehl series consists of well-drained soils underlain by semiconsolidated lacustrine deposits (Ringold beds) at a depth of 20 to 40 inches. These soils formed under bunchgrass and sagebrush, in glaciofluvial material that was derived from granite, basalt, quartzite, and volcanic ash. They occupy nearly level to moderately sloping terraces in the western part of the county. The elevation ranges from 900 to 1,000 feet. The annual precipitation is 7 to 9 inches.

The surface layer is dark grayish-brown or dark-brown fine sandy loam 3 to 6 inches thick. The subsoil is dark brown and ranges from fine sandy loam to very fine sandy loam in texture. The substratum is laminated silt.

Most of the acreage lies within the boundaries of the Columbia Basin Irrigation Project and is irrigated.

Wiehl fine sandy loam, 0 to 2 percent slopes (WsA).-This is a loamy soil on terraces. Small areas of soils less than 20 inches deep were included in mapping.

Representative profile:

Surface layer-

0 to 5 inches, dark grayish-brown fine sandy loam; weak, fine, platy structure; very friable; mildly alkaline; abundant roots.

Subsoil-

5 to 16 inches, dark-brown fine sandy loam; weak subangular structure; very friable; mildly alkaline; plentiful roots.

16 to 23 inches, dark-brown very fine sandy loam; massive; very friable; moderately alkaline and slightly calcareous; plentiful roots.

Substratum-

23 to 60 inches +, light brownish-gray silt; laminated; firm strongly alkaline and strongly calcareous on surface of laminated plates; no roots.

The surface layer ranges from dark grayish brown to dark brown in color and is 3 to 6 inches thick. The depth to the Ringold sediments is 20 to 40 inches. The Ringold beds are laminated silty layers, interbedded with loose strata of sand, loamy sand, or sandstone.

This soil is well drained and moderately permeable. It is easily worked. It holds 4 to 5 inches of water that plants can use. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate. Both surface and sprinkler irrigation are suitable. Seepage from higher areas or excessive irrigation causes drainage problems in places. The major crops are beans,

sugar beets, corn, small grain, potatoes, and hay and pasture crops. Nitrogen is needed for nonlegumes. (Capability unit IIIs-1, irrigated; range site 8)

Wiehl fine sandy loam, 2 to 5 percent slopes (WsB).-In irrigated areas of this soil, runoff is medium and the hazard of water erosion is moderate. The crops are the same as those grown on Wiehl fine sandy loam, 0 to 2 percent slopes. The irrigation methods are the same also, but irrigation runs should be shorter, or furrows and corrugations should be held to a 2 percent gradient. (Capability unit IIIe-2, irrigated; range site 8)

Wiehl fine sandy loam, 5 to 10 percent slopes (WsC).-In irrigated areas of this soil, runoff is rapid and the erosion hazard is severe. Sprinkling is the most suitable method of irrigation. Seepage from higher areas is not a hazard. (Capability unit IVE-2, irrigated; range site 8)

Willis Series

The Willis series consists of well-drained, medium-textured soils underlain by a lime-silica cemented hardpan at a depth of 15 to 40 inches. These soils formed under bunchgrass, in loess. They occupy nearly level to rolling uplands in the central part of the county. The elevation ranges from 1,000 to 1,900 feet. The annual precipitation is 9 to 12 inches.

The surface layer is very dark grayish-brown silt loam 7 to 10 inches thick. The subsoil is dark brown or dark yellowish brown and is mostly silt loam that is calcareous above the hardpan.

Willis soils are used principally for growing small grain under a crop-fallow system.

Willis silt loam, 0 to 15 percent slopes (WSC).-This is a silty soil on broad ridgetops. Most slopes are about 4 percent.

Representative profile:

Surface layer-

0 to 8 inches, very dark grayish-brown silt loam; granular structure; very friable; mildly alkaline; abundant roots.

Subsoil-

8 to 24 inches, dark-brown silt loam; weak subangular blocky structure; friable; mildly alkaline; plentiful roots.

24 to 29 inches, dark yellowish-brown silt loam; massive; friable; calcareous; strongly alkaline; plentiful roots.

Substratum-

29 inches +, indurated lime-silica cemented hardpan; no roots.

The surface layer is 7 to 10 inches thick. In places the subsoil contains a layer of fine sandy loam or sandy loam. The hardpan is at a depth of 24 to 40 inches. It is underlain in places by bedrock, Ringold sediments or loess, alternating with layers of hardpan. Some hardpan fragments occur on the surface and throughout the profile.

This soil is well drained and moderately permeable. It is easily worked. It holds 5 to 7 inches of water that plants can use. Runoff is slow to medium, and the hazard of wind and water erosion is slight to moderate.

This soil is used principally for small grain under a crop-fallow system. Crops respond to nitrogen. (Capability unit IIIe-4, nonirrigated; range site 10)

Willis silt loam, 0 to 15 percent slopes, eroded (WSC2).-From 50 to 80 percent of the original surface layer of this soil has been removed by erosion. Runoff is medium, and the hazard of erosion is moderate. This

soil holds 4 to 6 inches of water that plants can use. It is suited to the same crops as Willis silt loam, 0 to 15 percent slopes, but is less productive. White, lime-silica hardpan fragments are common on the surface and throughout the profile. In places the surface layer is calcareous. (Capability unit IVe-4, nonirrigated; range site 10)

Willis silt loam, shallow, 0 to 15 percent slopes (WTC).-This soil has a lime-silica cemented hardpan at a depth of 15 to 24 inches. It holds 3 to 4 inches of water that plants can use. It is unsuitable for cultivation. (Capability unit VIe-2, nonirrigated; range site 10)

Use and Management of the Soils

This section explains the capability classification, in which soils are grouped according to their suitability for most kinds of farming. It defines the capability groups in Adams County, describes management of both irrigated and nonirrigated soils by capability units, and gives estimates of yields of crops on different soils under two levels of management. It also contains a subsection on range management and one on engineering uses of the soils.

The names of soil series represented are mentioned in the description of each capability unit and each range site, but this does not mean that all the soils of a given series are in the given unit. To find the names of all the soils in any given capability unit or in any given range site, refer to the guide to mapping units at the back of this report.

Capability Groups of Soils

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

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

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

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

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

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

The eight classes in the capability system, and the subclasses in Adams County, are described in the list that follows. Some of the subclasses contain only nonirrigated soils, which were covered by the medium-intensity survey; some contain only irrigated soils, which were covered by the high-intensity survey; and some contain both.

Class I. Soils that have few limitations that restrict their use.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIc (Nonirrigated). Soils that have moderate limitations because of climate.

Subclass IIe (Irrigated). Soils subject to moderate erosion if they are not protected.

Subclass IIs (Irrigated). Soils that have moderate limitations of moisture capacity or tilth.

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

Subclass IIIe (Nonirrigated and irrigated). Soils subject to severe erosion if they are cultivated and not protected.

Subclass IIIs (Nonirrigated and irrigated). Soil that have severe limitations of moisture capacity or tilth.

Subclass IIIe (Nonirrigated). Soils that have severe limitations because of climate.

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

Subclass IVe (Nonirrigated and irrigated). Soils subject to very severe erosion if they are cultivated and not protected.

Subclass IVs (Irrigated). Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.

Subclass IVc (Nonirrigated). Soils that have very severe limitations because of climate.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove without major

reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

(There are no Class V soils in Adams County.)

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

Subclass VIe (Nonirrigated and irrigated). Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Subclass VIw (Nonirrigated). Soils severely limited by excess water and generally unsuitable for cultivation.

Subclass VIs (Nonirrigated). Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.

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

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

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

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

Subclass VIIIs (Nonirrigated). Rock or soil materials that have little potential for production of vegetation.

Management of nonirrigated soils

The use and management of the nonirrigated soils in Adams County are governed mainly by climate. The same tillage practices are used throughout the county, but the intensity and timing vary from one area to another. Because the annual precipitation is only 7 to 14 inches and occurs mainly in fall and winter, the principal crops are wheat, rye, and barley grown in a crop-fallow system. A good stubble-mulch program has proved to be an efficient means of conserving moisture and minimizing the hazards of wind and water erosion, which are the basic problems of soil management in the county.

CAPABILITY UNIT IIc-1 (NONIRRIGATED)

This unit consists of well-drained soils of the Chard, Hermiston, Onyx, and Walla Walla series. These soils have moderate permeability and high or very high water-holding capacity. They are easily worked. Some are crossed by braided stream channels and are flooded occasionally early in spring. The slope range is 0 to 6 percent. Runoff is slow, and the hazard of wind and water erosion is slight. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, alfalfa, and grass. They are well suited to winter wheat. They are suited to spring wheat but produce lower yields of this than of winter varieties. They produce fair yields of barley in favorable years, but generally the amount of straw is

insufficient for control of erosion. Pubescent wheatgrass and alfalfa are suitable for pasture seedings.

Erosion can be controlled if winter wheat is seeded early in fall, nitrogen is applied, stubble-mulch tillage is used, and waterways are shaped and seeded to perennial grass (fig. 8). Drop structures are needed in paces to control the flow of runoff in waterways. On long slopes chiseling the stubble fields in fall, either on the contour or across the slope, slows runoff and reduces the hazard of erosion in years when snow melts rapidly while the soils are still frozen. Grain crops respond to nitrogen.

CAPABILITY UNIT IIIe-1 (NONIRRIGATED)

This unit consists of well-drained soils of the Chard and Walla Walla series. One of the Walla Walla soils is underlain by a lime-silica cemented hardpan or by basalt bedrock below a depth of 40 inches. All of the soils in this unit have moderate permeability and high or very high water-holding capacity. They are easy worked. The slope range is 5 to 30 percent. Runoff is medium or rapid, and the hazard of water erosion is moderate or severe. There is a slight hazard of wind erosion. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, grass, and alfalfa. They are well suited to winter wheat and produce higher yields of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of straw is insufficient for control of erosion. Pubescent wheatgrass and alfalfa are suitable for pasture seedings.

Erosion can be controlled if winter wheat is seeded early, nitrogen is applied, stubble-mulch tillage is used, waterways are shape and seeded to grass, stubble fields are chiseled in fall, and all tillage operations are on the contour or across the slope. Terraces, diversions, and stripcropping, either singly or in combination, are advisable on long slopes. Grain crops respond to nitrogen. Larger amounts of nitrogen can be used on the eroded Walla Walla soil than on other soils in this unit. Phosphorus and sulfur have proved beneficial on these soils, particularly on the Walla Walla soil.

CAPABILITY UNIT IIIe-2 (NONIRRIGATED)

In this unit are well-drained and somewhat excessively drained soils of the Anders, Beckley, Bengé, and Endicott series. Some of these soils are underlain by a lime-silica cemented hardpan at a depth of 20 to 40 inches, and others are underlain by gravel, basalt bedrock, or coarse sand. All have moderate or moderately rapid permeability and low or moderate water-holding capacity. They are easily worked. The slope range is 5 to 30 percent. Runoff is slow or medium, and the hazard of wind and water erosion is slight or moderate. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, grass, and alfalfa. They are well suited to winter wheat and produce higher yields of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of straw is insufficient for control of erosion. Pubescent wheatgrass and alfalfa are suitable for pasture seedings.

Erosion can be controlled if winter wheat is seeded early, nitrogen is applied, stubble-mulch tillage is used,



Figure 8.-Gully forming in waterway in area of Walla Walla silt loam This is an excellent place to seed perennial grass.

waterways are shaped and seeded to grass, stubble fields are chiseled in fall, and all tillage is on the contour or across the slope. Terraces, diversions, and stripcropping either singly or in combination, are advisable on long slopes. Chiseling is difficult and in places impractical because the substratum is so near the surface.

Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that have a higher water-holding capacity.

CAPABILITY UNIT IIIe-3 (NONIRRIGATED)

This unit consists of well-drained soils of the Farrell and Ritzville series. Two of the Ritzville soils are underlain by a lime-silica cemented hardpan or by basalt bedrock at a depth between 40 and 50 inches. All of the soils in this unit have moderate permeability and high or very high water-holding capacity. They are easily worked. The slope range is 0 to 30 percent. Runoff is medium. The hazard of water erosion is moderate, and the hazard of wind erosion is slight or moderate. The annual precipitation is 9 to 12 inches. The frost-free season is about 130 to 145 days.

These soils are used for small grain and grass. They are well suited to winter wheat and produce higher yields

of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of straw is insufficient for control of erosion. Pubescent and crested wheatgrass are suitable for pasture seedings.

Erosion can be controlled if winter wheat is seeded early, nitrogen is applied, stubble mulch tillage is used, waterways are shaped and seeded to grass, and tillage is on the contour or across the slope. On the Farrell soil and the eroded Ritzville soils of this unit, wind stripcropping of the short, less steep slopes may be more beneficial in controlling erosion than contour or cross-slope farming. Pitting is an effective erosion control measure on slopes up to 15 percent (fig. 9).

Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that receive more rainfall.

CAPABILITY UNIT IIIe-4 (NONIRRIGATED)

This unit consists of a well-drained soil of the Willis series. This soil is underlain by a lime-silica cemented hardpan at a depth of 24 to 40 inches. It has moderate permeability and moderate water-holding capacity. It is easily worked. The slope range is 0 to 15 percent.



Figure 9.-Pitting on Ritzville silt loam, 5 to 30 percent slopes. The pits are filled with snow.

Runoff is slow or medium, and the hazard of wind and water erosion is slight or moderate. The annual precipitation is 9 to 12 inches. The frost-free season is about 130 to 145 days.

This soil is used for small grain and grass. It is fairly well suited to winter wheat and produces higher yields of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of straw is insufficient for control of erosion. Crested wheatgrass is suitable for pasture seedings.

Erosion can be controlled if winter wheat is seeded early; nitrogen is applied; stubble-mulch tillage is used; waterways are shaped and seeded to grass; and, where practical, stubble fields are chiseled in fall. In addition, this soil should either be stripcropped at right angles to the prevailing wind or be tilled on the contour or across the slope. Chiseling may be impractical in places because the pan is so near the surface.

Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on this soil than by crops on soils that have a higher water-holding capacity or receive more precipitation.

CAPABILITY UNIT IIIs-1 (NONIRRIGATED)

In this unit are well-drained soils of the Anders, Bengé, and Endicott series. Some are underlain by a lime-silica cemented hardpan at a depth between 20 and 40 inches, and others by gravel or basalt bedrock. These soils have moderate permeability and low or moderate water-holding capacity. They are easily worked. The slope range is 0 to 5 percent. Runoff is slow. Depressions are often ponded late in winter and early in spring. The hazard of wind and water erosion is slight. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, grass, and alfalfa. They are fairly well suited to winter wheat and produce higher yields of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of stubble is insufficient for control of erosion. Pubescent wheatgrass and alfalfa are suitable for pasture seedings.

Erosion can be controlled if winter wheat is planted early, nitrogen is applied, stubble-mulch tillage is used, and waterways are shaped and seeded to grass. On long slopes chiseling the stubble fields in fall, either on the

contour or across the slope, slows down the rate of runoff and reduces the hazard of erosion in years when the snow melts while the soils are still frozen. Chiseling is likely to be difficult in places because the pan is so near the surface. Soils in depressions remain wet and cold until late in spring; consequently, tillage has to be delayed and yields are reduced.

Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that have a higher water-holding capacity.

CAPABILITY UNIT IIIc-1 (NONIRRIGATED)

This unit consists of well-drained soils of the Esquatzel, Farrell and Ritzville series. The moderately shallow Ritzville soil is underlain by a lime-silica cemented hardpan or by basalt bedrock at a depth between 40 and 50 inches. Some of the soils in this unit have depressions in which water ponds in spring. Some are crossed by braided stream channels and are flooded occasionally early in spring. All have moderate permeability and moderate to very high water-holding capacity. They are easily worked. The slope range is 0 to 5 percent. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is slight or moderate. The annual precipitation is 9 to 12 inches. The frost-free season is about 130 to 145 days.

These soils are used for small grain and grass. They are well suited to winter wheat and produce higher yields of this crop than of spring varieties. Yields of spring and winter barley are low, and the amount of straw is insufficient for control of erosion. Pubescent and crested wheatgrass are suitable for pasture seedings.

Erosion can be controlled if fall grain is seeded early, nitrogen is applied, stubble-mulch tillage is used, and waterways are shaped and seeded to perennial grass. Drop structures are needed in a few places to stabilize the flow of runoff in waterways. On long slopes chiseling the stubble fields in fall, either on the contour or across the slope, slows down the rate of runoff and reduces the hazard of erosion in years when the snow melts rapidly while the soils are still frozen. Soils in depressions remain wet and cold until late in spring; consequently, tillage has to be delayed and yields are reduced. Deep subsoiling in these areas loosens the subsoil and promotes better aeration and internal drainage.

Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that receive more precipitation.

CAPABILITY UNIT IVe-1 (NONIRRIGATED)

This unit consists of well-drained soils of the Walla Walla series. One soil is underlain by a lime-silica cemented hardpan or by basalt bedrock at a depth between 40 and 48 inches. These soils have moderate permeability and high or very high water-holding capacity. They are easily worked, but there are limitations to use of machinery because of steep slopes. The slope range is 30 to 40 percent. Runoff is rapid. The hazard of water erosion is severe, especially if snow melts while the ground is still frozen. Excessive runoff reduces the amount of moisture available for plants. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, alfalfa, and grass. They are fairly well suited to winter wheat grown in rotation with pubescent wheatgrass and alfalfa. They are poorly suited to spring grain. Yields of spring grain are lower than yields of the winter varieties, and the amount of stubble is insufficient for control of erosion.

Erosion can be controlled if grass and alfalfa are grown about half the time; winter wheat is seeded early; nitrogen is applied; stubble-mulch tillage is used; waterways are shaped and seeded to grass; tillage is on the contour or across the slope; and stubble fields are chiseled in fall, either on the contour or across the slope. In addition, stripcropping is needed on long slopes. Grain crops respond to nitrogen.

CAPABILITY UNIT IVe-2 (NONIRRIGATED)

This unit consists of well-drained soils of the Endicott and Ritzcal series. Some of these soils are underlain by a lime-silica cemented hardpan at a depth of 20 to 40 inches, and others have a strongly calcareous substratum. All have moderate permeability and low to moderate water-holding capacity. They are easily worked. The slope range is 5 to 30 percent: Runoff is medium or rapid, and the hazard of water erosion is moderate or severe. The annual precipitation is 9 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat grown in rotation with crested wheatgrass or pubescent wheat grass. They are not suited to spring grain. Yields are low, and the amount of straw is insufficient for control of erosion.

Erosion can be controlled if grass is grown about half the time; winter grain is seeded early; nitrogen is applied; stubble-mulch tillage is used; waterways are shaped and seeded to grass; tillage is on the contour or across the slope; and the soils are chiseled in fall, either on the contour or across the slope. Chiseling may be impractical in places because the pan is so near the surface. Grain crops respond to nitrogen, phosphate, and sulfur. Less nitrogen can be utilized by crops on these soils than by crops on soils that have a higher water-holding capacity.

CAPABILITY UNIT IVe-3 (NONIRRIGATED)

In this unit are well-drained soils of the Farrell, Wacota, and Walvan series. These soils have moderate permeability and high or very high water-holding capacity. They are easily worked. The slope range is 0 to 30 percent. Runoff is slow or medium, and the hazard of water erosion is slight or moderate. The hazard of wind erosion is moderate. The annual precipitation is 9 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat grown in rotation with either crested wheatgrass or pubescent wheatgrass. Crested wheatgrass is suited to Wacota and Farrell soils, and pubescent wheatgrass, to Walvan soils. These soil are not suited to spring grain. Yields are low, and the amount of straw is insufficient for control of erosion.

Erosion can be controlled if grain is grown about half the time, winter grain is seeded early, nitrogen is applied, stubble-mulch tillage is used, waterways are shaped and seeded to grass, and tillage on the steeper slopes is either

on the contour or across the slope. In addition, contour stripcropping is needed on long, steep slopes. In less steep areas, wind stripcropping at right angles to the prevailing wind is advisable. Grain crops respond to nitrogen.

CAPABILITY UNIT IVe-4 (NONIRRIGATED)

This unit is made up of well-drained to somewhat excessively drained soils of the Magallon, Roloff, Stratford, and Willis series. Some of these soils are underlain by a lime-silica cemented hardpan at a depth of 20 to 40 inches, and others are underlain by coarse basaltic gravel. All have moderate or moderately rapid permeability and low or moderate water-holding capacity. They are easily worked. The slope range is 0 to 30 percent. Runoff is slow or medium, and the hazard of water erosion is slight or moderate. There is a moderate hazard of wind erosion. The annual precipitation is 9 to 12 inches. The frost-free season is 130 to 145 days.

These soils are used for small grain and grass. They are fairly well suited to rye and wheat grown in rotation with crested wheatgrass. They are not suited to spring grain. Yields are low, and the amount of straw is insufficient for control of erosion.

Erosion can be controlled if grass is grown about half of the time; winter grain is seeded early; nitrogen is applied; stubble-mulch tillage is used; waterways are shaped and seeded to grass; stubble fields are chiseled in fall either on the contour or across the slope; and tillage on the steeper slopes is on the contour or across the slope. In addition, contour strip-cropping is needed on long, steep slopes. On slopes of less than 5 percent, wind stripcropping at right angles to the prevailing wind is a better erosion control measure than cross-slope or contour tillage. Chiseling may be impractical in places because the pan is so near the surface. Grain crops respond to nitrogen and sulfur.

CAPABILITY UNIT IVe-5 (NONIRRIGATED)

In this unit are well-drained soils of the Ritzville series. These soils have moderate permeability and high or very high water-holding capacity. They are easily worked, but there are limitations in the use of equipment because of slope. The slope range is 30 to 40 percent. Runoff is rapid, and the hazard of water erosion is severe. The annual precipitation is 9 to 12 inches. The frost-free season is 130 to 145 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat grown in rotation with crested wheatgrass or pubescent wheatgrass. They are poorly suited to spring grain. Yields of spring grain are lower than those of the winter varieties, and the amount of stubble is insufficient for control of erosion.

Erosion can be controlled if grass is grown about half the time; winter grain is seeded early; nitrogen is applied; stubble-mulch tillage is used; waterways are shaped and seeded to grass; and, stubble fields are chiseled in fall, either on the contour or across the slope. In addition, contour stripcropping is needed on long slopes. Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that receive more rainfall.

CAPABILITY UNIT IVe-6 (NONIRRIGATED)

This unit consists of well-drained soils of the Royal, Shano, and Warden series. Some of these soils are underlain by a lime-silica cemented hardpan at a depth below 40 inches. All have moderate or moderately slow permeability and high or very high water-holding capacity. The slope range is 0 to 30 percent. The hazard of water and wind erosion is slight or moderate. The annual precipitation is 7 to 9 inches. The frost-free season is about 130 to 150 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat and rye. They are not suited to spring grain. Yields of spring grain are low, and the amount of straw is not sufficient for control of erosion. Crested wheatgrass is suitable for pasture seedings.

Erosion can be controlled if winter grain is seeded early, nitrogen is applied in years when the moisture supply is favorable, stubble-mulch tillage is used, waterways are shaped and seeded to grass, and all tillage is on the contour or across the slope. On the less steep slopes of the eroded soils, stripcropping at right angles to the prevailing wind is a better erosion control measure than cross-slope farming. A sweep is commonly used in stubble fields in fall to control Russian-thistle and to reduce the amount of tillage needed in spring. Grain responds to nitrogen in years when the moisture supply is favorable, but nitrogen is of no benefit and may actually decrease yields in years when the moisture supply is inadequate.

CAPABILITY UNIT IVe-7 (NONIRRIGATED)

This unit consists of well-drained soils of the Burke series. These soils are underlain by a lime-silica cemented hardpan, by gravel, or by salt bedrock at a depth of 20 to 40 inches. They have moderate permeability and moderate water-holding capacity. They are easily worked. The slope range is 0 to 30 percent. Runoff is slow or medium, and the hazard of wind and water erosion is slight or moderate. The annual precipitation is 7 to 9 inches. The frost-free season is about 130 to 150 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat and rye grown in rotation with crested wheatgrass. They are not suited to spring grain. Yields of spring grain are low, and the amount of straw is not sufficient for control of erosion.

Erosion can be controlled if grass is grown about half the time, winter grain is seeded early, nitrogen is applied in years when the moisture supply is favorable, stubble-mulch tillage is used, waterways are shaped and seeded to grass, and tillage on the steeper slopes is on the contour or across the slope. On the less steep slopes, stripcropping at right angles to the prevailing wind is a better erosion control measure than cross-slope farming.

A sweep is commonly used in stubble fields in fall to control Russian-thistle and to reduce the amount of tillage needed in spring. Grain crops respond to nitrogen in years when the moisture supply is favorable, but nitrogen is of no benefit and may actually decrease yields in years when the moisture supply is inadequate.

CAPABILITY UNIT IVe-8 (NONIRRIGATED)

This unit consists of well-drained, gravelly or cobbly soils of the Anders and Bengé series. These soils are

underlain by gravel or basalt bedrock at a depth of 20 to 40 inches. They have moderate permeability and low or moderate water-holding capacity. They are difficult to till because of the gravel and cobblestones. The slope range is 0 to 15 percent. Runoff is slow or medium, and the hazard of water erosion is slight or moderate. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are used for small grain, alfalfa, and grass. They are marginal for winter grain grown in rotation with pubescent wheatgrass and alfalfa and are unsuitable for spring grain. Yields of spring grain are low, and the amount of stubble is insufficient for control of erosion.

Erosion can be controlled if the soils are in grass and alfalfa about half the time, winter grain is seeded early, nitrogen is applied, stubble-mulch tillage is used, and waterways are shaped and seeded to grass. Grain crops respond to nitrogen. Less nitrogen can be utilized by crops on these soils than by crops on soils that have a higher water-holding capacity.

CAPABILITY UNIT IVc-1 (NONIRRIGATED)

In this unit are well-drained soils of the Shano and Warden series. These soils have moderately slow or moderate permeability and high or very high water-holding capacity. The slope range is 0 to 5 percent. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight to moderate. The annual precipitation is 7 to 9 inches. The frost-free season is 130 to 150 days.

These soils are used for small grain and grass. They are fairly well suited to winter wheat and rye but are not suited to spring grain. Crested wheatgrass is suitable for pasture seedings.

Erosion can be controlled if winter grain is seeded early, nitrogen is applied in years when the moisture supply is favorable, stubble-mulch tillage is used, and waterways are shaped and seeded to grass. Stripcropping at right angles to the prevailing wind is needed in some places. A sweep is commonly used in stubble fields in fall to control Russian-thistle and to reduce the amount of tillage needed in spring. Grain crops respond to nitrogen in years when the moisture supply is favorable, but nitrogen is of no benefit and may actually depress yields in years when the moisture supply is inadequate.

CAPABILITY UNIT VIe-1 (NONIRRIGATED)

In this unit are well-drained, gravelly, cobbly, or stony soils of the Benge, Farrell, Ritzcal, Ritzville, Roloff, Starbuck, Stratford, Wacota, Walla Walla, and Walvan series. These soils have moderate permeability and low to very high water-holding capacity. The slope range is 0 to 65 percent. Runoff is slow to very rapid, and the hazard of water erosion is slight to very severe. The annual precipitation is 9 to 14 inches. The frost-free season is 130 to 145 days.

These soils are suitable for grazing. Suggestions on their management as range are given in the section "Rangeland."

CAPABILITY UNIT VIe-2 (NONIRRIGATED)

This unit consists of well-drained or somewhat excessively drained soils of the Burke, Ephrata, Magallon,

Prosser, Shano, and Willis series. Many of these soils are sandy, cobbly, or stony, and one is shallow. All have moderate or moderately rapid permeability and low to very high water-holding capacity. The slope range is 0 to 45 percent. The annual precipitation is 7 to 9 inches. The frost-free season is about 130 to 150 days.

These soils are suitable for grazing. Suggestions on their management as range are given in the section "Rangeland."

CAPABILITY UNIT VIw-1 (NONIRRIGATED)

This unit consists of poorly drained or somewhat poorly drained soils of the Chamber and Emdent series. These soils are either saline-alkali or strongly calcareous. The slope range is 0 to 8 percent. The annual precipitation is 9 to 14 inches. The frost-free season is about 130 to 145 days.

These soils are suitable for grazing. They could be seeded to tall wheatgrass. Before they could be reclaimed, however, they would have to be cleared of brush and drained. Locating drainage outlets would be difficult. Suggestions on management of these soils as range are given in the section "Rangeland."

CAPABILITY UNIT VIe-1 (NONIRRIGATED)

This unit consists of well-drained soils of the Emdent and Starbuck series. These soils are underlain by basalt bedrock at a depth of 12 to 20 inches. The slope range is 0 to 5 percent. Runoff is slow, and the erosion hazard is slight. The annual precipitation is 7 to 9 inches. The frost-free season is about 135 days.

These soils are suitable for grazing. Suggestions on their management as range are given in the section "Rangeland."

CAPABILITY UNIT VIe-2 (NONIRRIGATED)

This unit consists of moderately, well drained, saline-alkali soils of the Emdent, Stanfield, and Umapipe series. These soils have moderate or very slow permeability. They become powdery when tilled and are low in fertility because of alkalinity. The slope range is 0 to 6 percent. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight to severe. The annual precipitation is 9 to 14 inches. The frost-free season is about 130 to 145 days.

These soils are suitable for grazing. They could be seeded to tall wheatgrass and other salt-tolerant grasses. Pastures could be established where irrigation water is available. Brush clearing would be needed. Suggestions on management of these soils as range are given in the section "Rangeland."

CAPABILITY UNIT VIIe-1 (NONIRRIGATED)

This unit consists of excessively drained, sandy soils of the Quincy series. These soils have very rapid permeability and low water-holding capacity. They are subject to blowing and drifting, and the hazard of wind erosion is severe. The slope range is 0 to 40 percent. The annual precipitation is 7 to 10 inches. The frost-free season is about 140 to 150 days.

These soils are used as wildlife habitats and to a limited extent for grazing. Maintaining ground cover and controlling soil drifting are major problems. Prepara-

tion of a seedbed for grasses is impractical, but certain drought-resistant plants can be set out by hand during favorable years. Suggestions on management of these soils as range are given in the section "Rangeland."

CAPABILITY UNIT VIIIs-1 (NONIRRIGATED)

This unit consists of very stony soils of the Benge, Kuhl, Starbuck, and Stratford series. The slope range is 0 to 30 percent. Runoff is slow or medium, and the hazard of water erosion is slight or moderate. The annual precipitation is 12 to 14 inches. The frost-free season is about 135 days.

These soils are suitable only for grazing. Suggestions on their management as range are given in the section "Rangeland."

CAPABILITY UNIT VIIIIs-1 (NONIRRIGATED)

In this unit are two miscellaneous land types-Rock outcrop and Riverwash. Rock outcrop consists of outcrops of basalt bedrock, of the lime-silica cemented hardpan, or of Ringold beds. Riverwash consists of nearly level bars of gravel and coarse sand. Both of these land types are barren. They are suitable only for wildlife and watershed purposes.

Management of irrigated soils

About 40,000 acres in the western part of Adams County is irrigated under the Columbia Basin Irrigation Project. Water for this project is provided from Grand Coulee Dam on the Columbia River and is delivered to the farms through a system of canals and laterals. In other parts of the county, some irrigation water is obtained from wells and applied by sprinkler systems, but only the soils irrigated under the Columbia Basin Irrigation Project are included in the capability units of irrigated soils.

CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of well-drained soils of the Esquatzel, Royal, Shano, and Warden series. These soils have moderate or moderately slow permeability and high or very high water-holding capacity. They are easily worked. Fertility problems are greatest in places where deep cuts have been made in leveling to prepare the soils for irrigation. The slope range is 0 to 2 percent. Runoff is slow, and the hazard of water erosion is slight. Water accumulates in a few localized level areas. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are beans, peas, corn for grain, potatoes, sugar beets, small grain, hay, and pasture crops. The soils also are suitable for orchards and vineyards.

Growing row crops year after year does not cause excessive erosion if the crops that are grown leave residue and all residue is returned to the soils. A winter cover crop should be grown if little or no residue remains after harvest. If residue is not returned to the soils, grass and legumes should be grown about a fourth of the time. Clods help to control wind erosion. They form if the soils are moist when cultivated.

Either surface or sprinkler irrigation is suitable. Irrigation runs can be of maximum length. Water accumu-

lates in low spots unless irrigation water is applied carefully. In some places open ditches are needed to remove excess water. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen. Phosphate and zinc have proved beneficial in some places-for example, on Royal and Warden soils where deep cuts have been made in leveling.

CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of well-drained soils of the Royal, Shano, and Warden series. Some of these soils are underlain by a lime-silica cemented hardpan or by basalt bedrock below a depth of 40 inches. All have moderately slow to moderately rapid permeability and high to very high water-holding capacity. They are easily worked. Fertility problems are most serious where deep cuts have been made in leveling to prepare the soils for irrigation. The slope range is 2 to 5 percent. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are potatoes, corn, beans, small grain, hay and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Growing row crops year after year does not cause excessive erosion if the crops grown leave enough residue, all residue is returned to the soils, and the soils are left rough and cloudy through the winter. Clods do not form unless the soils are moist when cultivated. A cover crop or large amounts of residue on the surface also provide protection in winter.

Either surface or sprinkler irrigation is suitable. Furrows and corrugations in a surface system should be held to a 2 percent gradient, or else runs should be short. To maintain the supply of organic matter, grass and legumes normally are grown a fourth of the time. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IIe-2 (IRRIGATED)

This unit consists of well-drained soils of the Ephrata, Nepal, Royal, and Scooteny series. Some of these soils are underlain by gravel, Ringold beds, or lime-silica cemented rubble and gravel at a depth of 20 to 48 inches. All have moderate or moderately rapid permeability and moderate or high water-holding capacity. They are easily worked. Fertility problems are likely where deep cuts are made in leveling to prepare the soils for irrigation. The slope range is 2 to 5 percent. Runoff is medium, and the hazard of wind and water erosion is moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are beans, peas, corn, potatoes, sugar beets, small grain, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Growing row crops about two-thirds of the time does not cause excessive erosion if the crops grown leave enough residue, all residue is returned to the soils, and the soils are left rough and cloudy through the winter.

Clods do not form unless the soils are moist when cultivated. A winter cover crop should be grown if too little residue remains after harvest.

These soils require more frequent irrigations and smaller amounts of water each time than soils in capability unit I-1. Either surface or sprinkler irrigation is suitable. Furrows and corrugations in a surface system should be held to a 2 percent gradient, or else runs should be short. Care is needed in leveling some of these soils to avoid exposing the substratum. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IIe-3 (IRRIGATED)

This unit consists of well-drained soils of the Burke, Prosser, and Sagemoor series. These soils are underlain by a lime-cemented hardpan, Ringold beds, laminated sediments, or bedrock at a depth of 20 to 40 inches. They have moderate permeability and moderate or high water-holding capacity. They are easily worked. The slope range is 2 to 8 percent. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are beans, peas, corn, potatoes, sugar beets, small grain, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Growing row crops one-half to two-thirds of the time does not cause excessive erosion if the crops grown leave enough residue, all residue is returned to the soils and the soils are left rough and cloddy through the winter. Clods do not form unless the soils are moist when cultivated. A winter cover crop should be grown if too little residue remains after harvest.

Either surface or sprinkler irrigation is suitable. Furrows and corrugations in a surface system should be held to a 2 percent gradient, or else runs should be short. Drainage problems can be avoided if irrigation water is applied carefully. In places drains are needed to pick up water that seeps from higher lying soils. Care is needed in leveling to avoid exposing the substratum. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen. Zinc and iron have proved beneficial in places-for example, on Sagemoor and Burke soils, where orchards and vineyards are subject to chlorosis.

CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of well-drained soils of the Ephrata, Neppel, Royal, and Scootney series. At a depth of 20 to 40 inches, these soils are underlain by gravel or by lime-silica cemented rubble and gravel, which restricts the movement of water somewhat. They have moderate to moderately rapid permeability and moderate to high water-holding capacity. They are easily worked. The slope range is 0 to 2 percent. Runoff is slow, and the erosion hazard is slight or moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are small grain, corn, sugar beets, beans, potatoes, hay, and pasture crops.

Row crops can be grown year after year if the crops grown leave enough residue, all residue is returned to the soils, and cultivation does not leave the surface layer loose and powdery. Clods that resist erosion form if the soils are moist when cultivated. A winter cover crop should be grown if little or no residue remains after harvest. If crop residue is not returned to the soil, grass and legumes should be grown about a fourth of the time.

These soils require more frequent irrigations and smaller amounts of water each time than soils in capability unit I-1. Either surface or sprinkler irrigation is suitable. Care in leveling is needed to avoid exposing the substratum. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IIe-2 (IRRIGATED)

This unit is made up of well-drained soils of the Burke, Prosser, and Sagemoor series. These soils are underlain by a lime-silica cemented hardpan, Ringold beds, or basalt bedrock at a depth of 20 to 40 inches, or by Touchet beds at a depth of 15 to 40 inches. In places water accumulates because of the slowly permeable to impermeable substratum. These soils have moderate permeability and moderate or high water-holding capacity. They are easily worked. The slope range is 0 to 2 percent. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are well suited to intensive use. A wide variety of crops can be grown. The major crops are potatoes, corn, beans, small grain, hay and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Row crops can be grown about two-thirds of the time if the crops grown leave enough residue -all residue is returned to the soils, and the soils are left rough and cloddy when no crop is rowing.

Either surface or sprinkler irrigation is suitable. Care is needed in leveling to avoid exposing the substratum; only shallow cuts can be made. Drainage problems can be controlled if the soils are irrigated carefully and drains are used to remove water that seeps from higher lying soils. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen. Zinc and iron have proved beneficial. In some places-for example, on Sagemoor and Burke soils, where orchards and vineyards are subject to chlorosis.

CAPABILITY UNIT IIe-3 (IRRIGATED)

This unit consists of well-drained soils of the Royal and Warden series. These soils are underlain in places by a lime-silica cemented hardpan, basalt bedrock, or coarse basalt sand below a depth of 40 inches. They have moderate or moderately rapid permeability and moderate or high water-holding capacity. Fertility has been reduced by erosion. The slope range is 0 to 5 percent. Runoff is slow to medium, and the hazard of water erosion is slight or moderate. The hazard of wind erosion is severe; soil blowing and drifting are problems, especially the first few years the soils are farmed. The frost-free season is 150 days.

These soils are suited to a wide variety of crops. The major crops are beans, peas, potatoes, sugar beets, small grain, hay, and pasture crops. Row crops can be grown about two-thirds of the time if a cover crop is grown, large amounts of residue are left on the surface through the winter, and the soils are moist when cultivated so that the surface layer does not become powdery. Sprinkling is the best method of irrigating these soils. Efficient use of water in a surface system is difficult. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

In this unit are well-drained soils of the Ephrata, Royal, Scooteny, Shano, and Warden series. Some of these soils are underlain by gravel below a depth of 20 inches or by a lime-silica cemented hardpan, Ringold beds, or basalt bedrock below a depth of 40 inches. All have moderately rapid to moderately slow permeability and moderate to very high water-holding capacity. All are easily worked. The slope range is 5 to 15 percent. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are suited to a wide variety of crops grown in rotation with grass and legumes. The major crops are beans, peas, potatoes, sugar beets, small grain, alfalfa, and pasture crops.

Row crops can be grown on these soils if grass and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils either are in a winter cover crop or are left rough and cloddy through the winter. Clods form if the soils are moist when tilled. A suggested rotation is 3 to 5 years of alfalfa, 1 year of corn, 1 year of beans (with a cover crop in winter), and 1 year of small grain.

Sprinkling is the only suitable method of irrigation. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. All crops except legumes need nitrogen.

CAPABILITY UNIT IIIe-2 (IRRIGATED)

This unit consists of moderately deep, well-drained soils of the Taunton and Wiehl series. These soils are underlain by very slowly permeable Ringold beds or a lime-cemented hardpan at a depth of 20 to 40 inches. They have moderate or moderately rapid permeability and low water-holding capacity. They are easily worked. The slope range is 2 to 5 percent. Runoff is medium, and the hazard of water and wind erosion is moderate. The frost-free season is about 150 days.

These soils are suited to a wide variety of crops. The major crops are beans, peas, corn, potatoes, sugar beets, small grain, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Row crops can be grown on these soils if grass and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils are protected with a winter cover crop or are left rough and cloddy through the winter. Clods do not form unless the soils are moist when cultivated.

Either surface or sprinkler irrigation is suitable. Furrows and corrugations in the surface system should be held to a 2 percent gradient, or else runs should be short. Overirrigating is likely to cause a perched water table. Only shallow cuts can be made when leveling these soils, because the substratum is so near the surface. In some areas drains are needed to divert water that seeps from higher lying soils. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IIIe-3 (IRRIGATED)

In this unit are well-drained soils of the Burke and Sagemoor series. These soils are underlain by a lime-silica cemented hardpan, laminated lake sediments, or Ringold beds at a depth of 20 to 40 inches. They have moderate permeability and moderate or high water-holding capacity. They are easily worked. The slope range is 5 to 15 percent. Runoff is rapid or very rapid, and the hazard of water erosion is severe or very severe. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are suited to a wide variety of crops grown in rotation with grass and legumes. The major crops are beans, peas, potatoes, sugar beets, small grain, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Row crops can be grown on these soils if grasses and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils either are protected with a winter cover crop or are left rough and cloddy through the winter. Clods do not form unless the soils are moist when cultivated.

Sprinkling is the only suitable method of irrigation. In a few small areas, irrigation may cause localized drainage problems. These problems can be overcome by a plying water carefully and installing interceptor drains where needed. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen. Orchards are subject to chlorosis.

CAPABILITY UNIT IIIs-1 (IRRIGATED)

This unit consists of well-drained soils of the Ephrata and Wiehl series. These soils are underlain by a lime-silica cemented hardpan, Ringold beds, basalt bedrock, or gravel at a depth of 20 to 40 inches. They have moderately rapid permeability and low water-holding capacity. They are easily worked. The slope range is 0 to 5 percent. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate or severe. The frost-free season is about 150 days.

These soils are suited to a wide variety of crops in rotation with grass and legumes. The major crops are potatoes, small grain, beans, sugar beets, corn, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Row crops can be grown on these soils if grass and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils either are protected with a winter cover crop or are left rough and cloddy through the winter. If cultivated when dry, these soils blow readily.

Tillage in spring should be delayed until after irrigation water is available and the soil can be moistened enough that clods form. Light, frequent irrigations during emergence of seedlings help to control wind erosion and wind damage to young plants.

Either surface or sprinkler irrigation is suitable. Furrows and corrugations in a surface system should be held to a 2 percent gradient, or else runs should be short. Deep cuts made in leveling are likely to result in reduction in fertility. Excess water accumulates in places in the Wiehl soil; consequently, careful irrigation is especially important on that soil. Drains may be needed in a few areas to divert water that seeps from higher lying soils. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IVe-1 (IRRIGATED)

This unit is made up of well-drained soils of the Burke, Ephrata, Royal, Scootene, Shano, and Warden series. In some places these soils are underlain by sand or gravel below a depth of 40 inches, in others by gravelly sandy loam below a depth of 18 inches, and in others by basalt, Ringold beds, or a lime-silica cemented hardpan at a depth of 20 to 48 inches. They have moderately slow to moderately rapid permeability and moderate to very high water-holding capacity. They are easily worked. The slope range is 10 to 20 percent. Runoff is very rapid, and the hazard of water erosion is very severe. The hazard of wind erosion is moderate or severe. The frost-free season is about 150 days.

These soils are best suited to small grain grown in rotation with grass and legumes. The major crops are wheat, alfalfa, and grass. Orchards and vineyards are suitable but need to be protected with a cover crop.

Grain can be grown on these soils if grass and legumes are grown about half the time, all residue is returned to the soils, and the soils are protected with a winter cover crop or are left rough and cloddy through the winter. Clods do not form unless the soils are moist when cultivated.

Sprinkling is the only suitable method of irrigation. Crops respond to nitrogen.

CAPABILITY UNIT IVe-2 (IRRIGATED)

This unit consists of a well-drained soil of the Wiehl series. This soil is underlain by very slowly permeable Ringold sediments at a depth of 20 to 40 inches. It has moderate permeability and low water-holding capacity. It is easily worked. The slope range is 5 to 10 percent. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate. The frost-free season is about 150 days.

This soil is suited to a wide variety of crops grown in rotation with grass and legumes. The major crops are beans, peas, potatoes, sugar beets, small grain, hay, and pasture crops. Orchards and vineyards are suitable but need to be protected with a cover crop.

Row crops can be grown on this soil if grass and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soil, and the soil is protected with a winter cover crop or is left rough and cloddy through the winter. Clods do not form unless the soil is moist when cultivated.

This soil needs more frequent irrigations and smaller amounts of water each time than soils that have a higher water-holding capacity. Sprinkling is the only suitable method of irrigation. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IVe-8 (IRRIGATED)

This unit consists of excessively drained soils of the Quincy series. These soils have rapid permeability and low water-holding capacity. The slope range is 0 to 10 percent. The hazard of wind erosion is severe. The frost-free season is about 150 days.

These soils are best suited to grass and alfalfa. Small grain is grown as a clean-up crop between seedings. The major crops are grass, alfalfa, and wheat.

Wheat can be grown about a fourth of the time if it is seeded early in fall, or if a large amount of residue is left on the surface through the winter and the soils are kept moist during tillage and until seedlings are established. If the surface layer dries out, blowing and drifting of soil material may damage young plants.

These soils need more frequent irrigations and smaller amounts of water each time than soils that have a higher water-holding capacity. Light, frequent applications of water will not cause leaching of nutrients. Sprinkling is the only suitable method of irrigation. Crops respond to nitrogen.

CAPABILITY UNIT IVe-4 (IRRIGATED)

This unit consists of well-drained soils of the Burke and Ephrata series. These soils are underlain by a very gravelly layer or a lime-silica cemented hardpan below a depth of 15 inches. They have moderate or moderately rapid permeability and low water-holding capacity. The slope range is 5 to 15 percent. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are best suited to small grain grown in rotation with grass and alfalfa. The major crops are wheat, grass, and alfalfa.

Row crops can be grown on these soils if grass and alfalfa are grown about three-fourths of the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils either are protected with a winter cover crop or are left rough and cloddy through the winter. Clods that resist wind erosion form if these soils are cultivated when moist. Small grain, if seeded early, can be grown safely about half the time.

These soils require more frequent irrigations and smaller amounts of water each time than soils that have a higher water-holding capacity. Sprinkling is the only suitable method of irrigation. Crops respond to nitrogen.

CAPABILITY UNIT IVs-1 (IRRIGATED)

This unit consists of well-drained soils of the Burke, Sagemoor, Starbuck, and Taunton series. These soil are underlain by basalt bedrock, Ringold beds, or a lime-silica cemented hardpan at a depth of 12 to 24 inches. They have moderate to moderately rapid permeability and low water-holding capacity. They are easily worked. The slope range is 0 to 6 percent. Runoff is slow or

medium. The hazard of water erosion is slight or moderate. The hazard of wind erosion is moderate. The frost-free season is about 150 days.

The major crops are beans, peas, mint, small grain, hay, and pasture crops. Row crops can be grown if grass and legumes are grown about half the time, the crops that are grown leave enough residue, all residue is returned to the soils, and the soils either are protected with a winter cover crop or are left rough and cloddy through the winter. Clods do not form unless these soils are moist when cultivated.

These soils need more frequent irrigations and smaller amounts of water each time than soils that have a higher water-holding capacity. Either sprinkler or surface irrigation is suitable, but leveling for surface irrigation is difficult because the substratum is so near the surface. On slopes of more than 2 percent, furrows and irrigations should be held to a gradient of 1 percent or less, or else runs should be short. There are drainage problems in some places. Careful irrigation is important, and in places drains are needed to divert water that seeps from higher lying soils. Plant diseases can be controlled if the same row crop is grown no more than 2 years in succession. Crops respond to nitrogen.

CAPABILITY UNIT IVs-2 (IRRIGATED)

This unit consists of well-drained, gravelly and cobbly soils of the Ephrata and Scootene series. These soils have moderate or moderately rapid permeability and low or moderate water-holding capacity. Because of the gravel and cobbles, cultivation and harvesting are difficult. The slope range is 0 to 5 percent. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight or moderate. The frost-free season is about 150 days.

These soils are best suited to small grain in rotation with grass and alfalfa. Row crops, such as sugar beets, can be grown occasionally. The major crops are wheat, alfalfa, and grass.

Grain can be grown on these soils if grass or legumes

are grown about half the time and all residue is returned to the soils. If row crops are grown, these soils either should be left rough and cloddy through the winter or should be protected with a winter cover crop.

Either sprinkler or surface irrigation is suitable. If a surface system is used on the steeper slopes, the gradient should be held to 2 percent or less, or else runs should be short. Crops respond to nitrogen.

CAPABILITY UNIT VIe-1 (IRRIGATED)

In this unit are well-drained soils of the Burke, Ephrata, Royal, Sagemoor, Scootene, and Shano series. These soils have moderate or moderately rapid permeability and low to high water-holding capacity. The slope range is 0 to 30 percent. Runoff is medium to very rapid, and the hazard of water erosion is moderate to very severe. The frost-free season is about 150 days.

These soils are not suited to row crops or small grain but are suited to grass and legumes under sprinkler irrigation. Also, they are suited to orchards and vineyards that are protected with a perennial cover crop. Crops respond to nitrogen.

Estimated Yields

The estimates of yields in this report are based on the observations of the soil scientists who surveyed the county and on information furnished by farmers in the county and by State and Federal advisors familiar with the soils and the agriculture of Adams County.

The estimates are averages for a period of years. In any given year, the yield of any crop may be more or less than the figure shown.

Table 3 gives estimates of yields for the principal crops grown on nonirrigated soils. These crops are grown in a summer-fallow system. Winter wheat is generally the most suitable crop. Spring wheat is grown only when fall-seeded wheat is winterkilled. Barley and rye are grown mainly because of restrictions on the amount of wheat that can be planted.

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Yields shown in columns A in table 3 are those obtained under average management. Under this level of management, wheat may or may not be fertilized in the 7- to 9-inch precipitation zone. If fertilized, wheat receives 15 to 20 pounds of available nitrogen per acre. Wheat grown on deep soils in the 9- to 12-inch precipitation zone is fertilized with 20 to 35 pounds of available nitrogen per acre, and in the 12- to 14-inch zone, with 35 to 45 pounds. Wheat grown on moderately deep soils may or may not be fertilized. Rye and barley are not fertilized. Tillage consists of plowing and disking in spring and rod weeding several times in summer. Straw is mostly decomposed or broken up by fall. Disk drills

are used for seeding. The time of seeding varies; generally, it is after the first rain.

Yields shown in columns B are those obtained under improved management. Under this level of management, fertilizer rates are determined either by the results of soil tests or by the amount of moisture available at the time of fertilization, the amount of moisture expected during the rest of the season, and the amount of straw residue that is likely to be left after harvest. Wheat grown on all deep and moderately deep soils is fertilized. Generally, about 20 to 30 pounds of available nitrogen is applied in the 7- to 9-inch precipitation zone; about 40 to 50 pounds in the 9- to 12-inch zone; and about 50 to

60 pounds in the 12- to 14-inch zone. Barley is fertilized in the 9- to 14-inch precipitation zone, and rye in the 7- to 9-inch zone. The soils are tilled so that they retain all possible, moisture. They are seeded late in summer or early in fall. Deep-furrow disks are used for seeding. Straw mulch on the surface is managed by fall chiseling, spring sweeping, and skew treading. Rod weeders are used to kill weeds, particularly cheatgrass, but weedings are kept at a minimum.

Table 4 gives estimates of yields for the principal irrigated crops grown in Adams County. Only the soils suitable for cultivation are listed in the table.

Specific management practices, by crops, under which a farmer obtains the yields shown in table 4, follow.

For corn-

Level A : Fertilizes with 200 pounds of nitrogen and 100 pounds of phosphate.

Level B : Fertilizes according to the results of soil tests; plants crops when soil temperature is right; controls weeds; manages water efficiently; and picks corn before danger of field loss, even if corn requires artificial drying.

For mint-

Level A : Tends to over irrigate, which leaches fertilizer from the root zone.

Level B : Irrigates frequently and applies only a small amount of water each time to avoid leaching fertilizer from root zone; fertilizes according to the results of soil tests; and controls weeds.

For alfalfa and orchardgrass pasture-

Level A : Fertilizes with 25 to 50 pounds of nitrogen and 15 to 80 pounds of phosphate, but not in split applications; tends to overgraze pasture.

Level B : Fertilizes with 25 to 100 pounds of nitrogen and 15 to 60 pounds of phosphate, in split applications; applies a large amount of irrigation water; uses cross fences; moves stock at proper time; clips, and spreads manure; supplements forage with hay or straw; and keeps proper grass-alfalfa balance.

For beets-

Level A : Fertilizes with 240 pounds of nitrogen and 100 pounds of phosphate; sidedresses, using a split application.

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Level B : Fertilizes according to the results of soil tests and probably adds potash; sidedresses, using a split application; applies phosphate in fall; prepares seedbed properly; plants early; thins and cultivates at proper time; controls weeds; and carefully manages the first and second irrigations, applying only a small amount of water each time.

For wheat-

Level A : Applies about 100 pounds of nitrogen.

Level B : Fertilizes according to the results of soil tests; applies approximately 120 pounds of nitrogen and 45 pounds of phosphate; seeds at a rate of about 100 pounds per acre; and sprays weeds.

For peas-

Level A : Fertilizes with 40 pounds of nitrogen ,and 100 pounds of phosphate and adds 10 pounds zinc every 4 years.

Level B : Fertilizes according to the results of soil tests; prepares field properly for planting, and seeds early; irrigates efficiently; controls weeds; and swaths peas at right moisture to prevent field loss.

For potatoes-

Level A : Fertilizes with 160 pounds of nitrogen, 130 pounds of phosphate, and 60 pounds of potash.

Level B : Fertilizes according to the results of soil tests, using approximately 200 pounds of nitrogen, 160 pounds of phosphate, and 100 pounds of potash; prepares soil properly for planting; preirrigates and plants early; manages water efficiently; controls weeds and insects; keeps the field above 60 percent capacity; and has efficient digging equipment.

Rangeland

Approximately 29 percent of Adams County is used as rangeland. This acreage consists mainly of uplands that are not suitable for cultivation and of small acreages on bottom land along stream courses and potholes. The largest acreages are in channeled scablands, which are scattered throughout the county, and in the vicinity of the Saddle Mountains, which are in the southwestern part of the county. The range in the southwestern part of the

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county is used the year round, and that in the rest of the county for about 9 months, from April through December.

Livestock enterprises consist mainly of cow-calf operations. Most of the calves are marketed at weaning time, but some are held through winter and then sold in spring to feeders as long yearlings. The size of the ranches ranges from a few hundred acres to more than 100,000 acres, and the size of the herds ranges up to more than 5,000 head. Part of the Saddle Mountain country and the Palouse River breaks are used for grazing sheep in winter and spring.

Soils that produce similar kinds and amounts of native range plants are grouped together for range management purposes. These groups are called range sites.

Each range site has its own distinctive potential for producing native plants. The production of usable forage varies from year to year, depending on the soils and on variations in climate.

Range condition is determined mainly by comparing the kinds and amounts of plants that make up the present vegetative cover with those in the potential native plant cover for the same site. Four classes are used to indicate the degree to which the composition of the present plant community has departed from that of the original. A range is in *excellent* condition if from 76 to 100 percent of the vegetation is characteristic of the original plant community on the same site; in good condition if the

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percentage is 51 to 75 ; in *fair* condition if the percentage is 26 to 50; and in *poor* condition if it is 25 or less.

In addition to the plant composition, such factors as the amount of residue, the degree of erosion, the density of the forage stand, and the yield are all considered when rating range condition.

The ten range sites in Adams County are described in the following paragraphs.

1. Alkali range site

This range site consists of soils of the Chamber, Emdent, Stanfield, and Umapine series. It occupies alkali potholes and bottom lands. The slope range is 0 to 8 percent. The annual precipitation is 7 to 14 inches.

Summers are hot and dry. The optimum growing season for native plants is between May 1 and August 1.

The potential vegetation on this site is 75 percent basin wildrye (*Elymus cinereus*) and inland saltgrass (*Distichlis stricta*); 20 percent alkali cordgrass (*Spartina gracilis*), alkali bluegrass (*Poa juncifolia*), quackgrass (*Agropyron repens*), rushes (*Juncus spp.*), and sedges (*Carex spp.*); 4 percent forbs-yarrow (*Achillea mille-folium*), plantain (*Plantago spp.*), aster (*Aster spp.*), and dandelion (*Traxacum officinale*); and 1 percent shrubs-black greasewood (*Sarcobatus vermiculatus*) and rubber rabbitbrush (*Chrysothamnus nauseosus*).

When the range deteriorates, the proportion of basin wildrye, which is the best of the native plants, decreases,

and the proportion of inland saltgrass and annual weeds increases.

Seeding is advisable if the range is in fair or poor condition. Because of the salinity of the soils in this site, tall wheatgrass is the only species suitable for seeding. The seedbed needs to be well prepared to keep the amount of saltgrass and other low-producing plants to a minimum. Seeding is most likely to be successful if done with a deep-furrow drill.

The total annual yield ranges from 2,000 to 4,000 pounds per acre if this site is in excellent condition.

2. Bottom land range site (7 to 12 inches precipitation)

This range site consists of soils of the Esquatzel series. It occurs on bottom lands along drains in the western part of the county. The slope range is 0 to 2 percent. Summers are hot and dry. The optimum growing season for native plants is between May 1 and August 1.

The potential vegetation on this site is 60 percent bluebunch wheatgrass (*Agropyron spicatum*) and basin wildrye; 30 percent Idaho fescue (*Festuca idahoensis*), big bluegrass (*Poa ampla*), prairie junegrass (*Koeleria cristata*), threadleaf sedge (*Carex filifolia*), needle-and-thread (*Stipa comata*), Thurber needlegrass (*Stipa Thurberiana*), Sandberg bluegrass (*Poa secunda*), and inland saltgrass; 7 percent common forbs-yarrow, lupine (*Lupinus spp.*), phlox (*Phlox spp.*), daisy (*Erigeron spp.*), astragalus (*Astragalus spp.*), arrowleaf balsamroot (*Balsamorhiza sagittata*); 3 percent shrubs-big sagebrush (*Artemisia tridentata*), currant (*Ribes spp.*), and rose (*Rosa spp.*); and 1 percent trees-willows (*Salix spp.*).

When the range deteriorates, the proportion of bluebunch wheatgrass, which is the best of the native plants, decreases, and the proportion of yarrow, lupine, phlox, daisy, astragalus, arrowleaf balsamroot, and big sagebrush usually increases. Undesirable weeds and annual plants become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Tall wheatgrass, Nordan crested wheatgrass, Sherman big bluegrass, Whitmar beardless wheatgrass, and Siberian wheatgrass are suitable. The grasses selected should meet the seasonal requirements of livestock.

The total annual yield ranges from 4,000 to 6,000 pounds per acre if this site is in excellent condition.

3. Bottom land range site (12 to 14 inches precipitation)

This range site consists of soils of the Hermiston and Onyx series. It occurs on bottom lands in the eastern part of the county. The slope range is 0 to 6 percent. Summers are hot and dry. The optimum growing season for native plants is between May 1 and August 15.

The potential vegetation on this site is 70 percent giant wildrye (*Elymus cinereus*), Idaho fescue, and bluebunch wheatgrass; 10 percent Kentucky bluegrass (*Poa pratensis*), needlegrass (*Stipa spp.*), prairie junegrass, bluebunch wheatgrass, rushes, and sedges; 8 percent common forbs-aster, lupine, cinquefoil (*Potentilla spp.*), yarrow, geranium (*Geranium spp.*), dandelion, and daisy; 1 percent shrubs-wormwood (*Artemisia absinthium*), rose,

snowberry (*Symphoricarpos albus*), currant, and willow; and about 10 percent an overstory of trees and tall shrubs.

When the range deteriorates, the proportion of basin wildrye, the best of the native plants, decreases. The proportion of Kentucky bluegrass, needlegrass, yarrow, lupine, wormwood, rose, and snowberry increases. Undesirable weeds and annual plants become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding are pubescent wheatgrass, tall wheatgrass, intermediate wheatgrass, and Sherman big bluegrass, and Ladak alfalfa. The grasses selected should meet the seasonal requirements of livestock forage.

The total annual yield ranges from 6,000 to 10,000 pounds per acre if this site is in excellent condition.

4. Loamy range site (7 to 9 inches precipitation)

This range site consists of soils of the Burke, Neppel, Prosser, Royal, Sagemoor, Scooteney, Shano, and Warden series. It occupies uplands and outwash plains in the western part of the county. The slope range is 0 to 45 percent. Summers are hot and dry. The optimum growing season is between April 1 and June 15.

The potential vegetation on this site is 80 percent bluebunch wheatgrass; 14 percent Sandberg bluegrass, needle-and-thread, Cusick bluegrass (*Poa cusickii*), sixweeks fescue (*Festuca octoflora*), indian ricegrass (*Oryzopsis hymenoides*), and Thurber needlegrass; 4 percent forbs -daisy, yarrow, balsamroot (*Balsamorhiza spp.*), phlox, aster, astragalus, plantain (annual), lupine, eriogonum (*Eriogonum spp.*), and biscuitroot (*Lomatium spp.*); and about 1 percent shrubs-big sagebrush, rubber rabbitbrush, spiny hopsage (*Grayia spinosa*), and horsebrush (*Tetradymia canescens*).

When the range deteriorates, the proportion of blue; bunch wheatgrass, which is the best of the native plants, decreases, and the proportion of yarrow, balsamroot, lupine, big sagebrush, and rubber rabbitbrush increases. Undesirable weeds and annual plants become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding are Whitmar beardless wheatgrass, Sherman big bluegrass, Siberian wheatgrass, and Nordan crested wheatgrass. The grasses selected should meet the seasonal requirements of livestock. All of the soils in this site can be seeded.

The total annual yield is 400 to 1,000 pounds per acre if this site is in excellent condition.

5. Loamy range site (9 to 14 inches precipitation)

This range site consists of soils of the Anders, Benge, Chard, Endicott, Farrell, Ritzville, Wacota, Walla Walla, and Walvan series. It occupies uplands in the eastern part of the county. The slope range is 0 to 40 percent. Summers are hot and dry. The optimum growing season for native plants is between April 1 and June 15.

The potential vegetation on this site is 80 percent bluebunch wheat and Idaho fescue; 15 percent prairie junegrass, Sandberg bluegrass, Thurber needlegrass, threadleaf sedge, needle-and-thread, basin wildrye, and big bluegrass; 4 percent common forbs-yarrow, lupine, arrowleaf balsamroot, hawksbeard (*Crepis spp.*), astrag-

alus, daisy, phlox, eriogonum, and biscuitroot; and 1 percent shrubs-rubber rabbitbrush, big sagebrush, and a little sumac (*Phus glabra*).

When the range deteriorates, the proportion of bluebunch wheatgrass and Idaho fescue, which are the best of the native plants, decreases, and the proportion of eriogonum, lupine, rubber rabbitbrush, and big sagebrush increases. Undesirable weeds and annual plants become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding in the 9 to 12-inch precipitation zone are Siberian wheatgrass, Whitmar beardless wheatgrass, Nordan crested wheatgrass, big bluegrass, and Sherman big bluegrass. These same grasses and pubescent wheatgrass, intermediate wheatgrass, and Ladak alfalfa are suitable for seeding in the 12- to 14-inch precipitation zone. The grasses selected should meet the seasonal requirements of livestock. All of the soils in this site can be seeded.

The total annual yield ranges from 700 to 1,400 pounds per acre if this site is in excellent condition.

6. North Exposure range site

This range site consists of soils of the Ritzville, Wacota, Walla Walla, and Walvan series. It occupies northern exposures on the uplands in the central and eastern parts of the county. The slope range is 5 to 65 percent. The annual precipitation is 9 to 12 inches. Accumulated snow adds to the supply of moisture, and protection from wind and direct sunlight limits the loss of moisture. Summers are hot and dry. The optimum growing season for native plants is between April 15 and July 1.

The potential vegetation on this site is 75 percent Idaho fescue and bluebunch wheatgrass; 20 percent Sandberg bluegrass, big bluegrass, prairie junegrass, threadleaf sedge, and traces of basin wildrye; 4 percent forbs-yarrow, arrowleaf balsamroot, astragalus, daisy, lupine, phlox, hawksbeard, and plantain (annual); and 1 percent shrubs-big sagebrush and rubber rabbitbrush.

When the range deteriorates, the proportion of Idaho fescue decreases, and the proportion of yarrow, arrowleaf balsamroot, lupine, big sagebrush, and rubber rabbitbrush increases. Undesirable weeds and annuals become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding are Nordan crested wheatgrass, Siberian wheatgrass, Sherman big bluegrass, Whitmar beardless wheatgrass, pubescent wheatgrass, and Ladak alfalfa. The grasses selected should meet the seasonal requirements of livestock. Except on slopes of more than 40 percent, machinery can be used for preparing the seedbed and drilling. On steep slopes, broadcast seeding in the snow has been successful, especially where the old vegetation has been burned off in fall.

The total annual yield ranges from 750 to 1,600 pounds per acre if this site is in excellent condition.

7. Sandy range site

This range site consists of soils of the Ephrata, Quincy, Royal, and Warden series. It occupies sand dunes in the central and western parts of the county. The slope range is 0 to 40 percent. The annual precipitation is 7 to 10

inches. Summers are hot and dry. The optimum growing season for native plants is between March 15 and June 1.

The potential vegetation on this site is 80 percent needle-and-thread; 10 percent bluebunch wheatgrass, Sandberg bluegrass, indian ricegrass, thickspike wheatgrass (*Agropyron dasystachyum*), yellow ryegrass (*Elymus flavescens*), prairie junegrass, sand dropseed (*Sporobolous cryptandrus*), bottlebrush squirreltail (*Sitanion hystrix*), sixweeks fescue, and cheatgrass brome (*Bromus textorum*); 10 percent common forbs-yarrow, lupine, balsamroot, phlox, eveningprimrose (*Oenothera spp.*), biscuitroot (*Lomatium spp*) and scurfpea (*Psoralea lanceolata*); and 2 percent shrubs-rubber rabbitbrush and big sagebrush.

When the range deteriorates, the proportion of needle-and-thread, which is the best of the native plants, decreases, and the proportion of yarrow, lupine, scurfpea, eveningprimrose, balsamroot, rubber rabbitbrush, and big sagebrush increases. Undesirable weeds and annuals become more abundant as range condition becomes poorer.

Seeding on this site is in the experimental stage and so far has been about 50 percent successful. There are a few successful plantings of crested wheatgrass, and one trial planting of thickspike wheatgrass. Seedbed preparation is practically useless because the soils erode readily. Direct seeding with a deep-furrow rangeland drill, combined with the use of weed spray, appears to be the best method.

The total annual yield ranges from 800 to 700 pounds per acre if this site is in excellent condition.

8. Sandy Loam range site

This range site consists of soils of the Beckley, Ephrata, Magallon, Neppel, Royal, Taunton, Warden, and Wiehl series. It occupies uplands and outwash plains, mainly in the western part of the county. The slope range is 0 to 80 percent. The annual precipitation is 7 to 9 inches. Summers are hot and dry. The optimum growing season is between March 15 and June 15.

The potential vegetation on this site is 75 percent bluebunch wheatgrass and needle-and-thread; 10 percent indian ricegrass, Sandberg bluegrass, Idaho fescue, thickspike wheatgrass, prairie junegrass, sixweeks fescue, cheatgrass, and Thurber needlegrass; 4 percent forbs-balsamroot, lupine, phlox, biscuitroot, daisy, astragalus, and Indian wheat (*Plantago purshii*); and 2 percent shrubs-rubber rabbitbrush and big sagebrush.

When the range deteriorates, the proportion of bluebunch wheatgrass and needle-and-thread, which are the best of the native plants, decreases, and the proportion of balsamroot, lupine, biscuitroot, rubber rabbitbrush, and big sagebrush increases. Undesirable weeds and annuals become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding are Siberian wheatgrass, Nordan crested wheatgrass, and Sherman big bluegrass. Wheatgrass is best for spring grazing, and bluegrass is best for fall and winter grazing. All of the soils in this site can be seeded, although some need to have the cobblestones and stones removed.

The total annual yield ranges from 400 to 1,000 pounds per acre if this site is in excellent condition.

9. Shallow range site

(7 to 9 inches precipitation)

This range site consists of soils of the Burke, Prosser, Sagemoor, Scootney, and Starbuck series. It occupies shallow upland and outwash plains in the western part of the county. The slope range is 0 to 30 percent. Summers are hot and dry. The optimum growing season is between April 1 and June 1.

The potential vegetation on this site is 80 percent bluebunch wheatgrass; 10 percent Sandberg bluegrass, needle-and-thread, prairie junegrass, cheatgrass; indian ricegrass, Thurber needlegrass, and Idaho fescue; 6 percent forbs-daisy, yarrow, biscuitroot, phlox, astragalus, plantain (annual), eriogonum, lupine, and balsamroot; and 4 percent shrubs-big sagebrush, rubber rabbitbrush, stiff sagebrush, horsebrush, and spiny hopsage.

When the range deteriorates, the proportion of bluebunch wheatgrass, which is the best of the native plants, decreases, and the proportion of, yarrow, lupine, eriogonum, rubber rabbitbrush, and big sagebrush increases. Undesirable weeds and annuals become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Best results have been obtained by seeding Siberian wheatgrass and Nordan crested wheatgrass. All of the soils in this site can be seeded, although some need to have the stones removed.

The total annual yield ranges from 200 to 450 pounds per acre if this site is in excellent condition.

10. Shallow range site

(9 to 15 inches precipitation)

This range site consists of soils of the Anders, Benge, Endicott, Kuhl, Magallon, Ritzcal, Roloff, Starbuck, Stratford, and Willis series. It occurs on upland and outwash plains in the eastern part of the county. The slope range is 0 to 40 percent. Summers are hot and dry. The optimum growing season is between April 1 and June 15.

The potential vegetation on this site is 60 percent bluebunch wheatgrass; 30 percent Idaho fescue, Sandberg bluegrass, Thurber needlegrass, needle-and-thread, and cheatgrass; 7 percent common forbs-arrow leaf balsamroot, yarrow, lupine, daisy, astragalus, eriogonum, and phlox; and 3 percent shrubs-big sagebrush, rubber rabbitbrush, and three-tipped sage.

When the range deteriorates, the proportion of bluebunch wheatgrass and Idaho fescue, which are the best of the native plants, decreases, and the proportion of yarrow, eriogonum, lupine, rubber rabbitbrush, and big sagebrush increases. Undesirable weeds and annuals become more abundant as range condition becomes poorer.

Seeding is advisable if the range is in poor condition. Suitable for seeding are Siberian wheatgrass, Nordan crested wheatgrass, Sherman big bluegrass, and Whitmar beardless wheatgrass. In the 12- to 14-inch precipitation zone, Ladak alfalfa and pubescent wheatgrass also are suitable. All but the very stony soils in this site can be seeded. Removal of the stones and cobblestones may be needed on the stony and cobbly soils. The grasses selected for seeding should meet the seasonal requirements of livestock.

The total annual yield ranges from 400 to 700 pounds per acre if this site is in excellent condition..

Windbreaks

Few trees and shrubs are native to Adams County. There are trees and shrubs that can be grown in this area, however, to control wind erosion, protect livestock and buildings, or provide wildlife cover.

Plantings for farmstead and feedlot windbreaks, generally consist of three or more rows. Field windbreaks in irrigated areas are generally limited to one row because of the limited space available. The most effective arrangement in windbreak plantings is to plant dense, low-growing shrubs on the windward side, taller deciduous trees or shrubs in the center row or rows, and evergreen trees or shrubs in the leeward rows. Such an arrangement makes the windbreak more effective in winter. Also, it makes the evergreens visible from the farmstead. Where only one or two rows are planted, species that give maximum protection should be selected. If protection for a large area is needed, tall trees should be planted. If the planting is to control ground winds for a short distance, dense shrubs or evergreens are the most effective. Generally, there will be an effective reduction of wind movement on the leeward side of the planting to a distance equal to 10 to 20 times the height of the windbreak.

Plantings suitable for windbreaks have been tested at the State Agricultural Experiment Stations at Lind and Prosser. Caragana and lilac are the shrubs most commonly used in the windward row. Russian-olive is the best tall shrub or small tree. Black locust, green ash, and Chinese elm are the most suitable deciduous trees for dryland areas. These same species, and Lombardy poplar as well, are commonly grown under irrigation. Austrian Pine, Scotch pine, ponderosa pine, and Rocky Mountain juniper are the most commonly used evergreens.

The spacing between rows and between the trees and shrubs in the rows is most important. In dryland plantings it is advisable to have the rows 16 to 24 feet apart. In irrigated plantings the rows should be about 15 feet apart. Trees should be 10 to 12 feet apart in the rows, and shrubs 3 to 4 feet apart.

The layout and position of the windbreak are important also. The windbreak should be at right angles to the most damaging winds. The plantings should be at least 100 feet from the farmstead so that there will be some air movement on hot days. Rows should be spaced so that they can be worked with available equipment. Rounded corners in windbreaks are easier to cultivate than square ones. In an irrigated area it is necessary to consider the irrigation system, the location of and possibility of damage to underground pipes, and the effect on overhead powerlines.

Dryland areas should be fallowed before trees are planted. The soil should be deep. A soil that will not grow a good crop of wheat will not grow trees. The areas also should be weed free before planting, for controlling weeds in windbreaks is difficult.

¹ This section was written by **ROBERT J. OLSON**, woodland conservationist, Soil Conservation Service.

In dryland areas the soils should be cultivated for the life of the planting. In irrigated areas a low-growing cover crop can be seeded after the trees and shrubs are well established.

Windbreaks need to be adequately protected from fire. They should not be grazed by livestock; they are much less effective if the lower branches are browsed or broken.

Engineering Properties of the Soils

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, irrigation systems, and sewage disposal systems. The soil properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction (pH). Depth to water table, depth to consolidated materials, and topography also are important.

The information in this report can be used to-

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural, drainage systems, farm ponds, dikes and levees, irrigation systems, waterways, and other structures for conservation of soil and water.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway, airport, pipeline, and cable locations and in planning detailed investigations at the selected locations.
4. Locate probable sources of gravel and other construction materials.
5. Correlate performance of engineering structures with soil mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soil mapping units for cross country movement of vehicles and construction equipment.

² F. M. ROBERTS, engineering specialist, Soil Conservation Service, assisted with the preparation of this section.

7. Supplement the information obtained from other published maps, reports, and aerial photographs to make maps and reports that can be used readily by engineers.

8. Develop other preliminary estimates for construction purposes pertinent to the particular area when definite laboratory data are not available.

With the soil map for identification of soil areas, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depths here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Engineering classification systems

Two systems of classifying soils, the AASHO and the Unified, are in general use among engineers. Both are used in this report. They are described in the PCA Soil Primer (8).

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (1). In this system classification is based on the gradation, liquid limit, and plasticity index of the soil. Highway performance has been related to this system of classification. All soil materials are classified in seven principal groups. The groups range from A1, which consists of gravelly soils that have high bearing capacity and are the best soils for subgrade, to A7, which consists of clayey soils that have low strength when wet and are the poorest soils for subgrade.

Some engineers prefer to use the Unified classification system (12). This system is based on identification of soils according to their texture and plasticity and on their performance as engineering construction material. Soil materials are identified as coarse grained (8 classes) and fine grained (7 classes).

The classification of the soils of Adams County according to both the AASHO and Unified systems is given in table 5.

Italic numbers in parentheses refer to Literature Cited

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All tables have been updated and are available as a separate document.

Soil engineering interpretations

Brief descriptions of the soils of Adams County and estimates of their physical and chemical properties are given in table 5.

The column headed "Permeability" indicates the rate at which water will move through soil material that is not compacted. The estimates are based on soil texture,

structure, and porosity. The column headed "Available water capacity" gives estimates of the amount of water available to plants. The estimates of permeability and available water capacity are particularly significant in planning irrigation and drainage systems.

The column headed "Dispersion" indicates the extent to which soil structure breaks down or slakes in water.

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An easily dispersed soil seals over and resists penetration of water and air. It is readily eroded by wind or water.

The column headed "Shrink-swell potential" indicates the volume change to be expected of the soil material with changes in moisture content, that is, the shrinking of the soil when it dries and the swelling of the soil as it takes up moisture. In general, coarse grained, gravelly or sandy soils classed as GM, SW, and SP in the Unified

system, or as A-1-b, A-2, and A-3 in the AASHTO system, have a very low to low shrink-swell potential.

Table 6 lists, for each soil in Adams County, specific engineering interpretations that might affect the suitability of the soil for various engineering purposes. These interpretations are based on the information in table 5, on test data, and on field experience and performance.

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The interpretations in table 6 are general and will not take the place of examination and evaluation of the soil at the exact site of a planned engineering project.

Piping is frequently mentioned as a soil feature affecting the construction of embankments for dikes, levees, and farm ponds. As used in such instances, the word refers to progressive internal erosion within embankments, foundations, or both. If piping occurs, soil material is removed by water under pressure. If sufficient soil material is removed, failure results.

Cracking, also mentioned as a soil feature affecting the construction of embankments for dikes, levees, and farm ponds, is a result of differential settlement of earth fills. Such settlement is caused by variation in the material. Differences in the height of the embankment or compression of the underlying strata may cause the formation of cracks through the embankment. Such cracks encourage concentration of seepage water, which may attain a velocity high enough to cause piping and consequent embankment failure. Cracking is associated with nonplastic soils that are unable to deform without cracking when settlement occurs.

Some features of a soil may be an advantage in one kind of engineering work and a hindrance in another. For example, a highly permeable substratum would make a soil unsuitable as a site for a farm pond but highly suitable as a disposal field for a domestic sewage disposal system.

Susceptibility to frost action is an important consideration in soil engineering, particularly in selecting sites for roads and airfields. For frost action to occur, there must be water in the soil and low temperatures must persist long enough for the ground to freeze. The water

may come from a high water table, it may be capillary water or water held in voids, or it may be water that infiltrates. The formation of ice is influenced by topographic position, stratification of the parent material, transitions into cut sections, lateral flow of water from side cuts, localized pockets of perched ground water, and drainage conditions. In general, silts and fine silty sands are the most susceptible to frost action. Coarse-grained materials that contain little or no fine material are affected only slightly, if at all. Drainage to prevent the accumulation of water in soil pores helps to prevent accumulation of ice in the subgrade and subbase.

Three major actors that influence the suitability of soils for use in embankments are permeability, strength, and ease of compaction. Gravelly and sandy soils that contain little or no fine material are stable and pervious; they are easily compacted with crawler-type tractors and rubber-tired rollers. These soils are suitable for use in the pervious sections of earth embankments. Gravels and sands that contain fines vary, depending on gradation and on the nature of the fine fraction. These materials may be sufficiently impervious and stable to be used for the impervious sections of embankments. Silts and very fine sandy silts are undesirable for rolled-fill construction and in general must be closely controlled in the field to secure the desired strength.

Frozen soil materials should not be used in constructing embankments. If the material is gravelly or sandy and does not contain more than a small percentage of silt or clay, earthwork may be performed in winter, provided the material is compacted according to the required standards for such construction and no frozen material is included.

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Formation and Classification of the Soils

This section tells how each of the five soil-forming factors have affected the soils of Adams County. It shows the classification of the soils according to both the 1938 system and the current system, describes each of the great soil groups represented in the county, and provides a detailed description of a profile representative of each soil series.

Factors of Soil Formation

Soil results from the interaction of soil-forming processes on materials deposited by geologic agencies. The properties of the soil at any given place are determined by five factors: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the topography, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material. These factors, as they occur in Adams County, are described in the following paragraphs.

Parent material

Most of the soils east of the East Low Canal in Adams County formed from material of the Palouse formation. This formation is generally believed to be loess that was laid down before the last glaciation. This explanation would account for the loessal islands in the channeled

scablands. There is also evidence of two later loessal deposits. Some of this more recent loess may have been derived from the lacustrine Touchet beds and from alluvium along the Snake and Columbia Rivers. The recent loessal deposits differ from earlier ones in having illite rather than vermiculite as the dominant clay. Some parts of the recent deposits are as much as 30 percent volcanic glass. The loess ranges from a few inches to many feet in thickness and shows little evidence of mineral weathering.

Soils of the Shano, Ritzville, and Walla Walla series are examples of soils that formed in loess. These soils are high in silt, low in clay, and high in extractable calcium. Base saturation is more than 70 percent. The percentage of clay is highest in the eastern part of the county and decreases toward the west, and the percentage of very fine sand is highest in the west and decreases toward the east. Some of the soils derived from loess are underlain by a lime-silica hardpan, which is in turn underlain by loess of an earlier age. The pan, ranges from a few inches to many feet in thickness. It appears to be hardest in the western part of the county and is softer and less resistant to pressure toward the east. One theory is that a lime hardpan developed along the edges of lakes that formed after the original loessal deposit. Then with time and a fairly large amount of precipitation; the silica from more recent deposits move downward and formed a lime-silica cemented pan. In most places free calcium carbonates occur just above the pan. Soils of the Burke and Willis series are examples of soils that were derived from loess and are underlain by a hardpan.

Many of the soils in Adams County formed in glacial outwash. During the Pleistocene period the area to the

north and east of the county was invaded by glacial ice sheets. When the glaciers melted, thick beds of sandy and gravelly outwash were deposited over broad areas, thus forming the channeled scablands. This outwash contained considerable basaltic material. In the western part of the county there are remnants of glacial sediments covered by loess or glacial outwash. The soils that formed in glacial outwash, or reworked alluvium, are generally coarser textured than those that formed in loess and in places are underlain by clean sand and gravel. Examples of such soils are those of the Ehprata, Magallon, Royal, Farrell, and Beckley series. Soils that formed mainly in outwash but were influenced somewhat by loess are finer textured than those that formed entirely in loess, but they are cobbly or gravelly in places. Examples of such soils are those of the Prosser, Roloff, Bengé, Stratford, and Anders series.

Most of the soils in Adams County contain some volcanic ash that is dominantly the size of silt and very fine sand. Inextensive but thick deposits occur on the loessal uplands, on flood plains, and in potholes. Soils of the Wacota and Walvan series contain large quantities of volcanic ash. These soils are high in silt and very fine sand. They are low in content of nitrogen. One ashy soil, the Emdent, occurs in basins and potholes and has become saline-alkali because of poor drainage.

The parent material of the soils along streams, in basins, and in potholes was largely recent local alluvium washed from the uplands. For the most part, this alluvium is silty.

A few soils in the county formed in stratified or laminated lacustrine sediments that have slow or very slow permeability. Examples are the soils of the Sagemoor and Warden series. These soils are high in silt, are free of gravel and material larger than gravel, and are capped by loess in places.

Living organisms

Plants, micro-organisms, earthworms, and other forms of life on or in the soil are active in soil-forming processes. They provide organic matter, help to decompose plant residues, affect the chemistry of the soil, and hasten soil development. Living organisms also help to convert plant nutrients to a form that is more readily available to higher plants. Some organisms retard horizon differentiation by churning or mixing the soil.

Vegetation has greatly influenced soil formation in Adams County. Plants draw moisture and mineral nutrients from the soil, and root penetration greatly influences aeration and soil permeability. When the life cycle of a plant is complete, residues are returned to the soil to replenish the supply of organic matter. Also, vegetation provides protection against loss of water and soil through runoff.

Adams County was once completely grass covered. The plant community included deep-rooted bunchgrasses capable of extracting moisture stored deep in the soil and shallow-rooted, short-season grasses that mature, produce seed, and then become dormant early in summer, thus surviving the dry summer. The native plant cover varies in composition, distribution, and density. Some species, like beardless wheatgrass, grow under a wide range of soil and moisture conditions. Others, like Idaho fescue and Indian ricegrass, have a much narrower range.

Indian ricegrass, needle-and-thread, and Sandberg bluegrass decrease as precipitation increases, and yields of Idaho fescue and bluebunch wheatgrass increase.

Differences in vegetation are reflected in the soils. The grass cover on Shano soils is less dense than that on Ritzville soils, and the grass cover on Ritzville soils is less dense than that on Walla Walla soils. The surface layer of Shano soils is typically about 4 inches thick, is dark grayish brown, and is less than 1 percent organic matter. The surface layer of Ritzville soils is typically 7 or 8 inches thick, is very dark grayish brown, and is 1 to 2 percent organic matter. The surface layer of Walla Walla soils is typically about 12 inches thick, is very dark brown, and is 2 to 3 percent organic matter.

Man has changed the vegetation of much of the county. The plowing up, and farming of grasslands and the application of fertilizers and irrigation water will influence the direction of and rate of soil formation in the future. Accelerated erosion and a decrease in organic matter are common evidences of man's influence on soil formation.

Climate

The main climatic factors that influence soil formation are temperature, amount of precipitation, and seasonal distribution of precipitation. Climate directly affects the soil through its influence on weathering, leaching of carbonates, translocation of clay, reduction and transfer of iron, and rate of erosion. Climate is also directly responsible for the kind and amount of vegetation, which influences the amount and distribution of organic matter in the soil profile.

The climate of Adams County is both continental and marine. Summers are hot, dry, and sunny. The hottest weather is often associated with a northward movement of hot, dry air from the southwestern semidesert regions. After a few days of high temperatures, cool marine air from the ocean moves inland and reduces temperatures 5 to 10 degrees. Relative humidity is low in summer; in fact, it is less than 25 percent in midafternoon.

In winter the weather changes frequently. Cold snaps are common but are not of great length. Warm winds and rains are frequent. They melt snow rapidly, and this results in loss of soil and water through runoff. Clouds and fog tend to reduce the loss of heat by radiation at night and are partly responsible for higher minimum temperatures than might be expected at this latitude.

Annual precipitation increases gradually from about 7 inches in the western part of the county to about 14 inches in the eastern part. Precipitation is lightest in summer, increases gradually in fall, and reaches a peak in winter. It decreases in spring, increases in May and June, and drops sharply in July. From December to February, precipitation generally is in the form of snow.

The average January temperature at Ritzville is about 27°F. The soil is generally frozen for short periods in winter. Frost penetrates to a depth of about 6 to 8 inches.

The average July temperature at Ritzville is about 71°F. Because the soils are dry during this period, the soil-forming processes are not accelerated by the high temperatures. Consequently, the soils are less strongly developed and weathered than they would be if more of the precipitation fell during the hot months.

The depth to lime is determined largely by the amount of precipitation. As the annual precipitation increases, lime is leached farther down in the soils. In Shano soils, which formed under 7 to 9 inches annual precipitation, the depth to lime is 24 to 36 inches. In Ritzville soils, which formed under 9 to 12 inches annual precipitation, the depth to lime is commonly 36 inches to more than 48 inches. Walla Walla soils, which formed under 12 to 14 inches annual precipitation, are free of lime to a depth of more than 48 inches in most places, and in many spots, to a depth of 60 inches.

Topography

The topography of Adams County is characterized by nearly level to moderately sloping terraces, steep to hilly uplands, nearly level bottom lands, and basins and potholes.

In the western part of the county there is a series of nearly level to gently sloping outwash terraces and nearly level bottom lands along the major drainageways. The elevation is 600 to 1,500 feet.

The central part of the county, the loessal uplands, has nearly level to steep, hilly topography. The eastern part is made up of nearly level outwash terraces and plains and rolling loessal hills. The elevation ranges from 600 to 2,200 feet. Drainage is good except for small areas along intermittent and perennial streams. Runoff is excessive on frozen ground.

Basins, potholes, and nearly level bottom lands occur throughout the county. Drainage in these areas ranges from moderately good to poor, and the soils have developed distinctive characteristics associated with wetness, such as dull colors, mottles, and accumulations of lime, soluble salts, and alkali.

Time

The length of time required for the formation of a given type of soil depends largely on the other factors of soil formation. An estimate of the age or maturity of a soil is generally based on the kinds, the thickness, and the arrangement of horizons. In general the greater the number of horizons and the thicker and more strongly expressed the horizons are, the more mature the soil is. Most of the soils in Adams County lack strong genetic horizons. The length of time that soil-forming factors have been active has allowed only for accumulation of organic matter and translocation of carbonates and small amounts of clay.

For the most part, soil-forming factors have been acting on the apparent materials since the last glaciation, about 9,000 years ago. Since the last glaciation, however, there has been some deposition of loess and volcanic ash over the entire landscape. The latest volcanic ash fall was about 6,700 years ago.

Soils on the bottom lands along streams periodically receive deposits of fresh materials; consequently, these soils are youthful and have no perceptible horizons other than an A horizon and a C horizon. In such soils as the Onyx and Hermiston, the A horizon may be 40 to 60 inches thick. The thick surface layer is largely inherited from the parent material, which consisted mainly of the eroded A horizons of higher lying soils.

Classification of the Soils

Classification consists of a systematic grouping of soils on the basis of their characteristics. From such grouping it is possible to organize knowledge about defined kinds of soils and to apply the results of experience and research to areas that range in size from several acres to millions of square miles.

Table 7 in this section shows the classification of the soil series in the county according to the current system of classification and according to the 1938 system (3) and supplementary publications (9). The discussion in the text is according to the 1938 system.

Of course, new soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at State, regional, and national levels of responsibility for soil classification results in a judgment that the new series should be established. Most of the soil series described in this publication were established before this survey was made. Fifteen of the series represented in the county, however, are newly proposed and are tentative at present. These are the Anders, Beckley, Benge, Chard, Endicott, Neppel, Ritzcal, Roloff, Royal, Scooteny, Shano, Stratford, Wacota, Wiehl, and Willis series.

Azonal soils

Azonal soils lack well-developed profile characteristics because of their youth, resistant parent material, or relief, all of which prevent the development of normal soil characteristics. The azonal order is represented in Adams County by two great soil groups: Alluvial and Regosol.

ALLUVIAL SOILS

Alluvial soils develop from transported, recently deposited material, or alluvium, that has undergone little or no modification by soil-forming processes. The characteristics of Alluvial soils depend largely on the nature of the parent material. The Alluvial soils in Adams County formed in material derived from either loess or loess mixed with volcanic ash, on nearly level to gently sloping bottom land. The range in elevation is 800 to 2,000 feet. The annual precipitation is 8 to 14 inches, and the mean annual temperature is about 48° F. The native vegetation was dominantly bunch-grass. Soils of the Esquatzel, Hermiston, and Onyx series are Alluvial soils.

The Onyx soils (see detailed profile on page 95) are representative of the Alluvial great soil group. These soils formed in alluvium derived from loess and volcanic ash. The principal evidences of soil development are the weak granular structure in the upper part of the soil and the slightly darker color, which is a result of an accumulation of organic matter. This part of the soil was dark colored originally, because it consisted largely of material from the surface layer of nearby upland soils. Some organic matter has been added in place by the decaying bunchgrass vegetation. In addition, the slightly

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All tables have been updated and are available as a separate document.

lower pH in the upper part of the soil indicates that some bases have been removed by leaching and have been replaced by hydrogen.

REGOSOLS

Regosols form in thick unconsolidated rock, or soft mineral deposits, in which few or no clearly expressed horizons have developed. In Adams County the Regosols formed in eolian sands, calcareous loess, and mixtures of loess and ash, on nearly level to very steep slopes. The range in elevation is 700 to 2,000 feet. The annual precipitation is 7 to 14 inches, and the mean annual temperature is about 49° F. The native vegetation was dominantly grass.

The Quincy, Ritzcal, Wacota, and Walvan soils are classified as Regosols.

The Walvan soils (see detailed profile on page 100) are representative. These soils formed in a mixture of volcanic ash and loess. The principal evidences of soil

development are the weak granular structure in the uppermost 5 to 12 inches; the dark color, which is the result of an accumulation of organic matter; and the removal of line. The slightly lower pH in the uppermost part of the soil indicates that bases have been removed by leaching and have been replaced by hydrogen.

Zonal soils

Zonal soils have well-developed profile characteristics that reflect the influence of the active factors of soil genesis-climate and living organisms, chiefly vegetation. The zonal order is represented in Adams County by three great soil groups: Brown, Chestnut, and Sierozem.

The pattern of zonal soils in Adams County closely parallels the patterns of vegetation and precipitation. As the amounts of precipitation and vegetation increase from the western part of the county toward the east, the A horizon of the soils becomes darker colored, thicker, and higher in organic-matter content. Also, the B horizon

becomes thicker and has a slightly more pronounced prismatic structure than is common. In this county the B horizon of these soils ordinarily has weak structure. In soils that formed in deep permeable materials, both the clay content and the depth to lime are lowest in the Western part of the county and increase gradually toward the east. In soils that formed in stratified parent material or that have a substratum of different texture the depth to lime is influenced by the degree of stratification, by the depth to the substratum, and by the kind of material in this layer.

SIEROZEM SOILS

Sierozem soils have a thin, dark grayish-brown surface layer that grades through lighter colored material to a layer of carbonate accumulation. The Sierozem soils in Adams County developed in a variety of parent materials. The topography is nearly level to very steep. The range in elevation is 1,000 to 1,400 feet. The annual precipitation is 7 to 9 inches, and the mean annual temperature is about 50° F. The native vegetation consisted predominantly of short bunchgrass and big sagebrush.

The Burke, Ephrata, Neppel, Prosser, Royal, Sagemoor, Scootene, Shano, Taunton, Warden and Wiehl series are classified as Sierozem soils. All have weak, or minimal, development. Burke, Shano, Warden, and Sagemoor soils intergrade toward Regosols, and Ephrata, Neppel, Prosser, Royal, Scootene, Taunton, and Wiehl soils intergrade toward Alluvial soils.

Shano soils (see detailed profile on page 98) are representative of the Sierozem great soil group. These soils formed in loess mixed with volcanic ash. The principal evidences of soil development are the weak granular structure in the uppermost 8 inches and the slightly darker color, which is the result of an accumulation of organic matter; the weak prismatic structure in the 8 to 19-inch layer, caused by the shrinking and swelling of the soil material when it is alternately dry and wet; and the layer of carbonate accumulation below a depth of 33 inches. Particle-size distribution is nearly uniform throughout the profile (see table 8). The clay content is low throughout the profile but is slightly higher in the uppermost 19 inches than it is below this depth. This fact indicates that some weathering of silts to clays has taken place in the upper part of the soil, but there has been no appreciable movement of clay downward.

The low shrink-swell potential of the parent material is mainly responsible for the weak structure of Shano soils. Precipitation occurs mostly in winter when evapotranspiration is low and consequently percolates to a greater depth than it would if it fell in summer. This fact accounts for the leaching of carbonates to a greater depth than is typical for Sierozem soils. Shano soils are relatively young, but this alone does not account for their weak development. The fact that they are dry when the temperature is most conducive to weathering would seem to be the dominant factor in the weak horizon development.

The exchange capacity is in the range of 250 to 500 milliequivalents per 100 grams of clay, which indicates either that allophane is present, or that part of the exchange complex is on silt-sized particles, or both. The surface layer is about 0.9 percent organic matter and about 4 inches thick. The base saturation approaches

100 percent throughout the soil. The carbon-nitrogen ratio is low (10.6).

BROWN SOILS

Brown soils have a very dark grayish-brown surface layer that grades through lighter colored material to a layer of carbonate accumulation. The Brown soils in Adams County developed from loess or glacial sediments. The topography is nearly level to very steep. The range in elevation is 1,000 to 2,000 feet. The annual precipitation is 9 to 12 inches, except on Starbuck soils, where it is as low as 7 inches. The mean annual temperature is about 49° F. The native vegetation consisted predominantly of bunchgrass and big sagebrush. Soils of the Farrell, Magallon, Ritzville, Roloff, Starbuck, Stratford, and Willis series are classified as Brown soils. All have weak, or minimal, development. Starbuck soils intergrade toward Lithosols and the others intergrade toward Regosols.

The Ritzville soils (see detailed profile on page 96) are representative of the Brown great soil group. These soils formed in loess mixed with volcanic ash. Typically, they have a very dark grayish-brown Ap horizon, 7 to 8 inches thick, that is about 1.3 percent organic matter, and they have an accumulation of lime at a depth of 36 inches. They differ from Shano soils, which are described under the heading "Sierozem Soils," in color, thickness, organic-matter content of the surface layer, and depth to lime.

These differences in properties reflect mainly the differences in the amount of precipitation and the amount and kind of vegetation under which the soils formed.

CHESTNUT SOILS

Chestnut soils have a dark-brown, very dark brown, or very dark grayish-brown surface layer that grades to a lighter colored subsoil and then to a layer of carbonate accumulation. The Chestnut soils in Adams County developed mainly from loess or glacial sediments. The topography is nearly level to very steep. The range in elevation is 1,400 to 2,200 feet. The annual precipitation is 12 to 14 inches, and the mean annual temperature is about 49° F. The native vegetation was dominantly bunchgrass. Soils of the Anders, Beckley, Benge, Chard, Endicott, Kuhl, and Walla Walla series are, classified as Chestnut soils. All have weak, or minimal, development. The Kuhl soils intergrade toward Lithosols, and the others intergrade toward Regosols.

The Walla Walla soils (see detailed profile on page 100) are representative of the Chestnut great soil group. Typically, they have an accumulation of lime at a depth of 45 inches. They differ from Shano soils, which are described under the heading "Sierozem Soils," and from Ritzville soils, which are described under the heading "Brown Soils," mainly in color, thickness, organic-matter content of the A horizon, and depth to lime. These differences in properties reflect mainly the differences in the amount of precipitation and the amount and kind of vegetation under which the soils formed.

Intrazonal soils

Intrazonal soils have characteristics that reflect the dominant influence of a local factor of relief or parent material over the effects of climate and vegetation.

The intrazonal order is represented in Adams County by two great soil groups: Solonchak and Planosol.

SOLONCHAK SOILS

Solonchak soils have a high concentration of soluble salts. These soils ordinarily are light colored and lack structure. They developed under salt-tolerant grasses or shrubs. Most have impeded drainage. The Solonchak soils in Adams County are either moderately well drained or somewhat poorly drained. They formed in alluvium derived from volcanic ash, loess, and weathered basalt. They occupy nearly level to gently sloping bottom lands and terraces. The range in elevation is 800 to 1,800 feet. The annual precipitation is 7 to 14 inches, and the mean annual temperature is about 49° F. The native vegetation consisted predominantly of salt-tolerant grass and shrubs. Soils of the Emdent, Stanfield, and Umapine series are classified as Solonchak soils. These soils are lower in soluble salts and higher in calcium carbonate and sodium than is typical.

The Emdent soils (see detailed profile on page 92) are representative of the Solonchak great soil group. Organic matter has darkened the uppermost 16 inches of the profile. This along with accumulations of calcium carbonate, soluble salts, and alkali, is the only evidence of soil development. The parent material undoubtedly was nearly neutral, noncalcareous, and free or nearly free of soluble salts and sodium. Seepage carrying dissolved sodium, salts, and lime from adjacent soils is responsible for the present chemical properties of the soils.

PLANOSOLS

Planosols have a strongly leached surface horizon abruptly underlain by one or more horizons in which large quantities of clay from the overlying horizons have accumulated. The Chamber soils (see detailed profile on page 91) are in depressions and basins. They formed from mixed alluvium, under sedges, rushes, and grass. The annual precipitation is 12 to 14 inches, and the mean annual temperature is about 49° F.

Typically, Chamber soils have a 5-inch surface layer of very dark gray, mottled, granular, neutral silt loam; a 4-inch subsurface layer of dark-gray, mottled, massive, neutral silt loam; and a subsoil that is dark gray, mottled, and moderately to strongly alkaline and has medium prismatic structure and moderately thick clay films on ped faces and in pores. The subsoil is 31 inches thick and contains lime in the lower part.

Chamber soils are the most strongly developed soils in Adams County, mainly because they occupy depressions and basins and are wet much of the time. Moisture is necessary for many of the soil-forming processes, for example, clay formation.

Organic matter has accumulated in the uppermost 5 inches of these soils. It is responsible for the dark color and granular structure. The horizon immediately below is lighter colored because water moving downward and also moving laterally, above the slowly permeable subsoil, has stripped iron and organic matter from the surfaces of the mineral grains. Both clay and lime have been removed from the upper part of the soil and deposited in the subsoil, as indicated by the presence of clay films and lime in the subsoil. The reaction increases with

depth; this indicates that bases have been removed from the upper part of the soil and deposited below. The dull colors (low chromas) and mottles throughout are a result of poor drainage. The gleyed conditions and mottles form because the oxygen supply is deficient during periods when the soil is saturated. Organisms that live in the soil obtain some of their oxygen from iron compounds which, along with organic matter, are the main coloring agents in soils. With the loss of oxygen, the iron compounds change from reddish, or yellowish to gray or green and become soluble. Some of the soluble iron has been removed in drainage water. As the soil dries out periodically, some of the iron reoxidizes and becomes segregated, and the bright-colored mottles form. The structure in the subsoil is moderate because the material shrinks and swells appreciably as the moisture content changes.

Descriptions of Soil Profiles

Following are detailed descriptions of representative profiles of different soil series. Most of the profiles described occur in Adams County. A few occur in adjacent counties but are nevertheless typical of the respective series in Adams County. The pH figures shown are for a 1:5 dilution (approximately).

ANDERS SERIES

The following profile of Anders silt loam is located in an area of grassland. The profile is 400 feet north and 200 feet west of the southeast corner of sec. 13, T. 20 N., R. 36 E., W. M., Adams Co.

A11-0 to 5 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many very fine pores neutral (pH 6.8) ; abrupt, smooth boundary. 4 to 6 inches thick.

A12-5 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine and medium, granular structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many very fine pores; neutral (pH 7.0) ; clear, smooth boundary. 6 to 8 inches thick.

B21-12 to 19 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/4) when dry; weak, medium, prismatic structure breaking to subangular blocky; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; few, thin, discontinuous colloidal coatings in pores; mildly alkaline (pH 7.4) ; clear, wavy boundary. 6 to 8 inches thick.

B22-19 to 27 inches, dark-brown (7.5YR 4/2) gravelly silt loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; common, very fine, tubular pores; few, thin, colloidal coatings in pores; mildly alkaline (pH 7.6) ; abrupt, smooth boundary. 4 to 10 inches thick.

IIR-27 inches +, basalt bedrock.

The thickness of the A horizon ranges from 10 to 14 inches. The layer adjacent to the bedrock is from 15 to about 50 percent basalt gravel. The depth to the basalt bedrock is generally between 20 and 40 inches, but in some small included areas it is less than 20 inches or more than 40 inches. Small outcrops of rock are included.

BECKLEY SERIES

The following profile of Beckley coarse sandy loam is located in an area of grassland. The profile is 60 feet east and 100 feet south of the north quarter corner of sec. 22, T. 15 N., R. 37 E., W.M., Adams Co.

- A11-0 to 6 inches, very dark brown (10YR 2/2) coarse sandy loam, dark grayish brown (10YR 4/2) when dry; weak, very coarse, platy breaking to weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; sand is nearly black; neutral to mildly alkaline (pH 7.4) ; clear, smooth boundary. 4 to 7 inches thick.
- A12-6 to 11 inches, very dark grayish-brown (10YR 3/2) coarse sandy loam, dark grayish brown (10YR 4/2) when dry; weak, fine and medium, granular structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; sand is nearly black; mildly alkaline (pH 7.5) ; clear, smooth boundary. 5 to 7 inches thick.
- B2-11 to 23 inches, dark-brown (10YR 3/3) coarse sandy loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; many fine pores; mildly alkaline (pH 7.6) ; abrupt, wavy boundary. 9 to 17 inches thick.
- IIC1-23 to 60 inches +, very dark gray (10YR 3/1) coarse basalt sand, gray with light-gray (10YR 5/1 and 7/2) flecks when dry; single grain; loose; mildly alkaline (pH 7.7).

The thickness of the A1 horizon ranges from 10 to 13 inches. The texture of the B2 horizon ranges from fine sandy loam to coarse sandy loam. The depth to coarse or very coarse sand ranges from 20 to 40 inches. Some gravel or cobblestones occur in the solum.

BENGE SERIES

The following profile of Benge gravelly silt loam is located in an area of grassland. The profile is 2,280 feet east and 1,300 feet south of the northwest corner of sec. 35, T. 19 N., R. 36 E., W.M., Adams Co.

- A11-0 to 6 inches, very dark brown (10YR 2/2) gravelly silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine and medium, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; mildly alkaline (pH 7.6) ; clear, wavy boundary. 5 to 7 inches thick.
- A12-6 to 10 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) when dry; weak, fine and medium, granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; mildly alkaline (pH 7.6) ; clear, wavy boundary. 4 to 6 inches thick.
- B2-10 to 18 inches, dark-brown (10YR 3/3) gravelly silt loam brown (10YR 5/3) when dry; weak, fine, subangular blocky structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; common, very fine, tubular pores; mildly alkaline (pH 7.8) ; clear, wavy boundary. 8 to 18 inches thick.
- C1-18 to 26 inches, dark-brown (10YR 4/3) very gravelly loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; mildly alkaline (pH 7.8) ; clear, wavy boundary. 4 to 12 inches thick.
- IIC2-26 to 56 inches +, basalt gravel and sand; some lime coatings on underside of gravel.

In some places the B2 horizon is gravelly loam or silt loam, and in some there are thin discontinuous clay films

on the peds in this horizon. The depth to gravel ranges from 20 to 40 inches. Gravel makes up 15 to 50 percent of the B horizon and 50 to 80 percent of the C horizon. In places the gravel in the IIC2 horizon is not lime coated.

BURKE SERIES

The following profile of Burke silt loam is located in an area of grassland. The profile is 450 feet west and 150 feet north of the southeast corner of sec. 3, T. 15 N., R. 29 E., W.M., Adams Co.

- A1-0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; mildly alkaline; (pH 7.8) ; abrupt, smooth boundary. 3 to 6 inches thick.
- C1ca-4 to 22 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, very fine, tubular pores; common lime-silica cemented fragments; strongly effervescent; moderately alkaline (pH 8.4) ; abrupt, smooth boundary. 12 to 30 inches thick.
- C2msi-22 inches +, indurated lime-silica cemented hardpan, many feet thick, that does not break down on acid treatment; the upper surface is smooth and finely laminated.

Lime-silica cemented fragments are common on the surface, particularly in windblown areas, and generally occur throughout the profile. The A horizon when moist ranges from dark grayish brown to dark brown. In places, the solum includes a B horizon that has weak, coarse, prismatic structure. The texture of the C1ca horizon ranges from very fine sandy loam to silt loam. In places, the disseminated lime has been leached to a depth of about 10 inches. The depth to the hardpan ranges from 15 to 40 inches. The pan ranges from 6 inches to many feet in thickness and overlies softly consolidated flood-plain or lake sediments, gravelly alluvial deposits, or basalt bedrock. In places the pan is a IIC2msi horizon.

CHAMBER SERIES

The following profile of Chamber silt loam, calcareous variant, is located in an area of grassland. The profile is 200 feet north and 100 feet east of the southwest corner of sec. 16, T. 20 N., R. 36 E., Adams Co.

- A1g-0 to 5 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, fine distinct mottles that are dark brown (7.5YR 4/4) when moist; neutral (pH 6.6) ; abrupt, wavy boundary. 4 to 6 inches thick.
- A2g-5 to 9 inches dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, fine and very fine, tubular pores; common faint mottles; neutral (pH 7.0) ; abrupt, wavy boundary. 1 to 4 inches thick.
- B21tg-9 to 32 inches, dark-gray (5Y 4/1) silty clay, gray (5Y 6/1) when dry; moderate, fine, prismatic structure breaking to subangular blocky; very hard when dry, firm when moist, and sticky and very plastic when wet; abundant roots; common, very fine and fine, tubular pores; few faint mottles; moderately thick, continuous clay films on ped surfaces and in

pores; noncalcareous, except for a few, fine, soft concretions; strongly alkaline (pH 8.4) ; abrupt, smooth boundary. 18 to 30 inches thick.

B22tgca-32 to 40 inches, dark-gray (5Y 4/1) silty clay, gray (5Y 6/1) when dry; moderate, medium, prismatic structure breaking to subangular blocky; very hard when dry, firm when moist, and sticky and very plastic when wet; abundant roots; common, very fine, tubular pores; few faint mottles; moderately thick, continuous clay films on ped surfaces and in pores; strongly effervescent; lime is both disseminated and segregated in fine soft concretions; moderately alkaline (pH 8.6) ; abrupt, smooth boundary. 6 to 20 inches thick.

IIR-40 inches +, basalt bedrock.

The depth to bedrock ranges from 30 to 50 inches or more. There are small stony patches.

CHARD SERIES

The following profile of Chard silt loam is located in a cultivated field. The profile is 1,100 feet west and 540 feet north of the, south quarter corner of sec, 30, T. 15 N., R. 37 E., Adams Co.

Ap1-0 to 5 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine and medium, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; mildly alkaline (pH 7.8) ; abrupt, smooth boundary.

Ap2-5 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium and coarse, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; mildly alkaline (pH 7.8) ; clear, wavy boundary.

B21-12 to 27 inches, dark-brown (10YR 3/3) very fine sandy loam, brown (10YR 5/3) when dry; weak prismatic structure breaking to subangular blocky; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; many, very fine, tubular pores; moderately alkaline (pH 8.0) ; clear, wavy boundary. 10 to 24 inches thick.

IIB22-27 to 37 inches, dark-brown (10YR 3/3) sandy loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; many, very fine, tubular pores; moderately alkaline (pH 8.2) ; clear, wavy boundary. 6 to 15 inches thick.

IICca-37 to 44 inches, dark-brown (10YR 4/3) and dark grayish-brown (10YR 4/2) coarse sandy loam, pale brown (10YR 6/3) and light brownish gray (10YR 6/2) when dry; massive ; slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; few roots; strongly effervescent; strongly alkaline (pH 8.6). 5 to 12 inches thick.

IIIC2-44 to 60 inches, coarse basalt sand; single grain; loose, nonsticky and nonplastic ; strongly effervescent; strongly alkaline (pH 8.8).

The thickness of the A1 horizon ranges from 10 to 13 inches. At a depth between 10 and 40 inches, the soil is dominantly medium textured. The texture of the upper part of the C horizon ranges from silt loam to coarse sandy loam. Lenses and strata of fine gravel and sand are common in the lower part of the C horizon.

EMDENT SERIES

The following profile of Emdent silt loam is located in an area of grassland. The profile is 1,000 feet north of the southeast corner of sec. 30, T. 18 N., R. 38 E., W.M., Adams Co.

A11ca-0 to 5 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; moderate, fine, platy

structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; violently effervescent; very strongly alkaline (pH 9.2) ; abrupt, smooth boundary. 4 to 7 inches thick.

A12ca-5 to 16 inches, very dark gray (10YR 3/1) silt loam,

gray (10YR 5/1) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; common, fine and very fine, tubular pores; violently effervescent; very strongly alkaline (pH 9.2) ; gradual, wavy boundary. 9 to 16 inches thick.

C1ca-16 to 21 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; many, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.4) ; gradual, wavy boundary. 4 to 10 inches thick.

C2-21 to 26 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; many, very fine, tubular pores; slightly effervescent; moderately alkaline (pH 8.2) ; gradual, wavy boundary. 4 to 15 inches thick.

C2-26 to 52 inches, light brownish-gray (10YR 6/2) very fine sandy loam, white (10YR 8/1) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; very few roots; few, very fine, tubular pores; slightly effervescent; moderately alkaline (pH 8.0) ; clear, wavy boundary. 20 to 40 inches thick.

C2-52 to 60 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; no roots; few very fine pores; noneffervescent ; moderately alkaline (pH 8.4) .

The A horizon when moist ranges from very dark gray to black. The C horizon is stratified with silt loam, silty clay loam, or very fine sandy loam. It is mottled in places. The depth to the water table varies, depending on artificial drainage. The A horizon is strongly to very strongly alkaline. The lower part of the C horizon is mildly to moderately alkaline and may be noncalcareous. The depth to bedrock ranges from 3 to more than 6 feet. In places, there is a buried A horizon below a depth of 3 feet. This soil may be saline-alkali or alkali.

ENDICOTT SERIES

The following profile of Endicott silt loam is located in a cultivated field. The profile is 1,400 feet north and 100 feet east of the southwest corner of sec. 17, T. 19 N., R. 37 E., W.M., Adams Co.

Ap-0 to 7 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; common lime-silica cemented fragments; mildly alkaline (pH 7.5) ; abrupt, smooth boundary. 5 to 8 inches thick.

A1-7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, thin, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; common, very fine, tubular pores; common lime-silica cemented fragments; mildly alkaline (pH 7.6) ; abrupt, wavy, boundary. 4 to 6 inches thick.

B2-12 to 17 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, coarse, prismatic structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; common lime-

silica cemented fragments; mildly alkaline (pH 7.6) ; abrupt, wavy boundary. 5 to 15 inches thick.

C1ca-17 to 27 inches, dark yellowish-brown (10YR 3/4) silt loam, brown (10YR 5/3) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; strongly calcareous, the lime segregated in mycelia; common to many lime-silica cemented fragments; moderately alkaline (pH 8.0) ; abrupt, smooth boundary. 6 to 10 inches thick.

C2msi-27 to 60 inches +, successive layers of indurated lime-silica cemented hardpan lenses, 1 inch to 12 inches thick, that do not break down on acid treatment alone. The indurated layers are separated by grayish-brown (10YR 5/2) limy silt loam; few roots extending into cracks. Many feet thick.

Lime-silica cemented fragments are common on the surface and throughout the profile; they increase in quantity with depth, from about 5 percent in the A horizon to 15 percent in the C1ca horizon. The A horizon ranges from 9 to 14 inches in thickness. The depth to the lime-silica cemented hardpan ranges from 14 to 40 inches. The C1ca horizon when moist ranges from 2 to 4 in chroma and from 4 to 6 in value. The lime-silica cemented pans in the C2msi horizon are commonly 1/2 inch to 6 inches apart. In places this horizon is many feet thick and may be underlain by bedrock.

EPHRATA SERIES

The following profile of Ephrata sandy loam is located in a cultivated field. The profile is 900 feet east and 100 feet north of the south quarter corner of sec. 8, T. 15 N., R. 29 E., W.M., Adams Co.

Ap-0 to 6 inches, dark grayish-brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) when dry; weak fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; mildly alkaline (pH 7.4) ; abrupt, smooth boundary. 3 to 6 inches thick.

B1-6 to 14 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; few, very fine, tubular pores; mildly alkaline (pH 7.8) ; clear, wavy boundary. 3 to 9 inches thick.

B2-14 to 21 inches, dark-brown (10YR 4/3) gravelly fine sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; abundant roots; common, very fine, tubular pores; moderately alkaline (pH 8.0) ; clear, wavy boundary. 4 to 7 inches thick.

IIC1-21 to 28 inches, dark-brown (10YR 4/3) very gravelly sandy loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; moderately alkaline (pH 8.0) ; abrupt, smooth boundary. 5 to 9 inches thick.

IIC2-28 inches +, basalt gravel and sand; lime and silica coatings on undersides of gravel.

The A horizon ranges from dark grayish brown to dark brown. The B2 horizon is 15 to 50 percent gravel. The depth to gravel ranges from 20 to 40 inches. In places, the gravelly substratum is underlain by lake sediments.

ESQUATZEL SERIES

The following profile of Esquatzel silt loam is located in a cultivated field. The profile is 100 feet north and 50 feet east of the southwest corner of sec. 16., T. 17 N., R. 33 E., W. M., Adams Co. .

Ap1-0 to 2 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; moderate, fine, platy structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; neutral (pH 7.0) ; abrupt, smooth boundary. 1 to 3 inches thick.

Ap2-2 to 7 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, fine and medium, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, very fine, tubular pores; neutral (pH 7.2) ; clear, wavy boundary. 3 to 6 inches thick.

A1-7 to 29 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, very fine, tubular pores; mildly alkaline (pH 7.4) ; abrupt, boundary. 15 to 25. inches thick.

C1-29 to 44 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, very fine, tubular pores; slightly effervescent; mildly alkaline (pH 7.8) ; abrupt, smooth boundary. 10 to 20 inches thick.

C2-44 to 60 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; slightly effervescent; mildly alkaline (pH 7.8). Many feet thick.

The color of the A and C horizons ranges from dark brown to very dark grayish brown and the texture from very fine sandy loam to silt loam. In places, there are strata of sandy loam or fine sandy loam in the C horizon. The depth to the calcareous layer is normally about 24 inches but ranges from 12 to 40 inches. In places, the lower part of the C horizon is strongly alkaline and effervesces strongly with dilute hydrochloric acid. This soil is in some places underlain by gravel or basalt at a depth below 40 inches.

FARRELL SERIES

The following profile of Farrell very fine sandy loam is located in :an area of grassland 900 feet south and 900 feet west of the north quarter corner of sec. 5, T. 16 N., R. 36 E., Adams Co.

A11-0 to 4 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, fine, platy structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; mildly alkaline (pH 7.6) ; abrupt, smooth boundary. 3 to 5 inches thick.

A12-4 to 8 inches, dark-brown (10YR 3/3) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; mildly alkaline (pH 7.6) ; abrupt, smooth boundary. 4 to 5 inches thick.

B2-8 to 16 inches, dark grayish-brown (10YR 4/2) loam (near very fine sandy loam), light brownish gray (10YR 6/2) when dry; weak, medium, subangular blocky structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, very fine, tubular pores; mildly alkaline (pH 7.8) ; abrupt, smooth boundary. 8 to 20 inches thick.

C1ca-16 to 24 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.0) ; clear, wavy boundary. 8 to 15 inches thick.

- IIC2ca-24 to 33 inches, dark grayish-brown (10YR 4/2) coarse sandy loam (near sandy loam), light grayish brown (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; common, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.2) ; clear, wavy boundary. 6 to 12 inches thick.
- IIC3-33 to 44 inches, dark grayish-brown (10YR 4/2) coarse sandy loam, light grayish brown (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; common, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.4) ; clear, smooth boundary. 8 to, 14 inches thick.
- IIC4-44 to 54 inches, grayish-brown (10YR 5/2) coarse sandy loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; very few roots; strongly alkaline (pH 9.0) ; violently effervescent; abrupt, smooth boundary. 8 to 15 inches thick.
- IIIC5-54 inches +, coarse basalt sand with grains mainly black but ranging to pale brown (10YR 2/1 to 6/3), dark gray to light gray (10YR 4/1 to 7/2) when dry; single grain; loose; strongly effervescent.

The thickness of the A horizon ranges from 7 to 10 inches. The texture of the B2 and C1ca horizons ranges from light loam to very fine sandy loam. The depth to the layer of lime accumulation (C1ca horizon) ranges from 14 to 34 inches. The depth to the stratified, moderately coarse textured layer ranges from 20 to 40 inches. Firm concretions (cicada nodules) are common in the C horizon. Gravelly and sandy strata are common in the lower part of the C horizon.

HERMISTON SERIES

The following profile of Hermiston silt loam is located in a cultivated field. The profile is 500 feet north and 75 feet west of the southeast corner of sec. 24, T. 19 N., R. 38 E., Adams Co.

- Ap1-0 to 4 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; mildly alkaline (pH 7.4) ; abrupt, smooth boundary. 3 to .5 inches thick.
- Ap2-4 to 8 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; common very fine, tubular pores; mildly alkaline (pH 7.4) ; abrupt, smooth boundary. 3 to 5 inches thick.
- A13-8 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; moderately alkaline (pH 8.0) ; gradual, wavy boundary. 9 to 15 inches thick.
- A11b-15 to 45 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, very fine, tubular pores; slightly effervescent; moderately alkaline (pH 8.0) ; clear, wavy boundary. 0 to 36 inches thick.
- A12b-45 to 51 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine; tubular pores; strongly effervescent; strongly alkaline (pH 8.5) ; clear, smooth boundary. 0 to 36 inches thick.
- A13b-51 to 60 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak,

coarse, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; violently effervescent; strongly alkaline (pH 8.6).

The depth to lime ordinarily ranges from 15 to 25 inches. The color value of the A horizon when the soil is dry is 4 to 5 and is generally 2 when the soil is moist. In places the C horizon is stratified with layers of silt loam, very fine sandy loam, or fine sandy loam. The proportion of volcanic ash in the profile varies considerably within short distances and between areas.

KUHL SERIES

The following profile of Kuhl very stony silt loam is located in an area of rangeland. The profile is 1,080 feet west and 450 feet south of the northeast corner of sec. 2, T. 20 N., R. 36 E., Adams Co.

- A11-0 to 2 inches, very dark grayish-brown (10YR 3/2) very stony silt loam, grayish brown (10YR 5/2) when dry; weak, medium, platy and moderate, medium, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; neutral (pH 7.4) ; abrupt, wavy boundary. 1 to 4 inches thick.
- A12-2 to 6 inches, very dark grayish-brown (10YR 3/2) stony silt loam, grayish brown (10YR 5/2) when dry; moderate, medium, platy structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, fine, tubular pores; neutral (pH 7.4) ; abrupt, wavy boundary. 2 to 5 inches thick.
- A13-6 to 11 inches, dark-brown (10YR 3/3) stony silt loam, brown (10YR 5/3) when dry; moderate, fine, platy structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, fine, tubular pores; neutral (pH 7.5) ; abrupt, wavy boundary. 4 to 7 inches thick.
- B2-11 to 15 inches, dark yellowish-brown (10YR 3/4) stony silt loam, yellowish brown (10YR 5/4) when dry; moderate, medium, prismatic structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; neutral (pH 7.6). 4 to 7 inches thick.
- R-15 inches +, basalt bedrock. Many feet thick.

The A1 horizon ranges from loam to silt loam in texture and is cobbly, stony, or very stony. When moist it is very dark grayish brown to dark brown. It is 7 to 12 inches thick. The B2 horizon ranges from loam to silt loam in texture and is 10 to 50 percent stones, cobblestones, and gravel. When moist it is dark yellowish brown to brown. In places there is some lime accumulation on the basalt bedrock. The depth to bedrock ranges from 12 to 20 inches.

MAGALLON SERIES

The following profile of Magallon silt, loam is located in an area of grassland. The profile is 450 feet south and 1,400 feet west of the northeast corner of sec. 28, T. 15 N., R. 36 E., W.M., Adams Co.

- A1-0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, coarse, platy breaking to weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and nonplastic when wet; abundant roots; common coarse basalt sand; mildly alkaline (pH 7.6); clear, wavy boundary. 7 to 10 inches thick.
- B2-8 to 17 inches, dark-brown (7.5YR 4/3) sandy loam, brown (7.5YR 5/3) when dry; weak, subangular blocky

structure; slightly hard when dry, friable when moist, and slightly sticky and nonplastic when wet; plentiful roots; few very fine pores; common coarse basalt sand; mildly alkaline (pH 7/7) ; gradual, wavy boundary. 9 to 15 inches thick.

C1-17 to 26 inches, dark-brown (10YR 3/3) loamy sand, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; porous; mildly alkaline (pH 7.8) ; abrupt, wavy boundary. 3 to 10 inches thick.

IIC2-26 to 60 inches +, loose coarse basalt sand.

The texture of the surface layer ranges from silt loam to sandy loam. The depth to coarse sand ranges from 20 to 40 inches. In places lime has accumulated just above the coarse sand. The content of coarse and very coarse sand increases with depth.

NEPPEL SERIES

The following profile of Neppel very fine sandy loam is located in an area of grassland. The profile is 150 feet west and 800 feet south of the east quarter corner of sec. 3, T. 15 N., R. 29 E., W.M., Adams Co.

A1-0 to 4 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; neutral (pH 7.2) ; abrupt, smooth boundary. 3 to 6 inches thick.

B21-4 to 12 inches, dark-brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) when dry; weak, coarse, subangular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; abundant roots; many, very fine, tubular pores; common gravel and lime-silica cemented fragments; mildly alkaline (pH 7.4) ; clear, wavy boundary. 6 to 12 inches thick.

B22-12 to 20 inches, dark-brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) when dry; weak, coarse, subangular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; abundant roots; many, very fine, tubular pores; common gravel and lime-silica cemented fragments; slightly effervescent; moderately alkaline (pH 8.2) ; abrupt, smooth boundary. 6 to 10 inches thick.

IIC2ca-20 to 28 inches, dark grayish-brown (10YR 4/2) gravelly loam, light brownish gray (10YR 6/2) when dry; massive; hard when dry, firm when moist; weakly cemented; few roots; common, very fine, tubular pores; many gravel and lime-silica cemented fragments; violently effervescent; strongly alkaline (pH 8.6) ; abrupt, smooth boundary. 8 to 12 inches thick.

IIIC-28 to 60 inches +, loose, very porous, lime-silica cemented rubble, basalt gravel, and sand. Many feet thick.

In places there are lime-silica cemented fragments scattered on the surface. When moist the A horizon ranges from dark grayish brown to dark brown. The thickness of the IIC2ca horizon ranges from 8 to 12 inches. The depth to the underlying lime-silica cemented rubble, basalt sand, and gravel ranges from 20 to 40 inches.

ONYX SERIES

The following profile of Onyx silt loam is located in a cultivated field. The profile is 1,000 feet north and 100 feet west of the southeast corner of sec. 29, T. 16 N., R. 38 E., W.M., Adams Co.

Ap-0 to 8 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; neutral (pH 6.8) ; abrupt, smooth boundary. 6 to 10 inches thick.

A1-8 to 30 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; neutral (pH 7.0) ; clear, smooth boundary. 15 to 30 inches thick.

AC-30 to 46 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; neutral (pH 7.0) ; clear, smooth boundary. 10 to 20 inches thick.

C-46 to 60 inches, dark grayish-brown (10YR 4/2) silt loam, brown (10YR 5/3) when dry; massive; slightly hard when dry, friable when moist; few roots; many, very fine, tubular pores; neutral (pH 7.2) .

The color value of the Ap horizon is 2 when the soil is moist and 4 or 5 when the soil is dry. The chroma of the C horizon is 2 or 3. In places there are strata of very fine sandy loam in the C horizon. Irregular lenses of very fine sand and some fine gravel may also occur in the C horizon.

PROSSER SERIES

The following profile of Prosser very fine sandy loam is located in an area of grassland. The profile is 500 feet south and 100 feet east of the northeast corner of sec. 28, T. 16 N., R. 29 E., W.M., Adams Co.

A1-0 to 4 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; neutral (pH 7.2) ; abrupt, smooth boundary. 3 to 6 inches thick.

B2-4 to 15 inches, dark-brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; common, very fine, tubular pores; mildly alkaline (pH 7.6) ; clear, wavy boundary. 6 to 12 inches thick.

C1-15 to 24 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) when dry; massive; slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; abundant roots; common, very fine, tubular pores; moderately alkaline (pH 8.0) ; clear, wavy boundary. 5 to 10 inches thick.

C2ca-24 to 30 inches, dark grayish-brown. (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) when dry; massive; slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; abundant roots; many, very fine, tubular pores; slightly effervescent; moderately alkaline (pH 8.2) ; abrupt, smooth boundary. 0 to 10 inches thick.

IIR-30 inches +, lime-capped basalt bedrock.

The A horizon ranges from 3 to 6 inches in thickness, and when moist, from dark grayish brown to dark brown in color. Gravel and cobblestones occur in places in the C horizon. The depth to basalt bedrock ranges from 20 to 40 inches. In places the lower part of the C horizon is not calcareous, and the only lime that occurs is a thin capping on the unconforming bedrock.

QUINCY SERIES

The following profile of Quincy fine sand is located in an area of grassland. The profile is 100 feet north and 530 feet west of the south quarter of sec. 28, T. 15 N., R. 29 E., W.M., Adams Co.

C1-0 to 15 inches grayish-brown (10YR 5/2) fine sand, dark brown (10YR 3/3) when moist; single grain; loose; abundant roots; moderately alkaline (pH 8.0) ; clear, wavy boundary. 5 to 20 inches thick.

C2-15 to 60 inches +, grayish-brown (10YR 5/2) fine sand, dark brown (10YR 3/3) when moist; single grain; loose; plentiful roots; slightly effervescent with dilute hydrochloric acid; moderately alkaline (pH 8.2).

The surface soil has color values that range from 4 to 7 when the soil is dry and 3 to 5 when the soil is moist; chromas of 2 and 3; and hues of 7.5YR, 10YR, and 2.5Y. The color in the subsoil and substratum is similar to that in the surface soil; the contrast is less than 1 unit of value. The organic-matter content of the surface soil is less than 1 percent. The texture ranges from sand to loamy fine sand throughout the profile. The soil is usually free of lime in the uppermost 20 inches, except for small particles brought up by burrowing insects and animals, but it may be slightly calcareous in the matrix below a depth of 20 inches. The reaction is slightly acid to moderately alkaline in the uppermost 20 inches and neutral to moderately alkaline below this depth. Unconforming materials, including bedrock, underlie the profile below a depth of 40 inches.

RITZCAL SERIES

The following profile of Ritzcal silt loams is located in a cultivated field. The profile is 1,150 feet south and 100 feet east of the northwest corner of sec. 9, T. 18 N., R. 34 E., Adams Co.

- Ap-0 to 8 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, fine and medium, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, small, lime-silica cemented fragments; strongly effervescent; moderately alkaline (pH 8.4); abrupt, smooth boundary. 6 to 10 inches thick.
- C1-8 to 26 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.4); abrupt, wavy boundary. 20 to 30 inches thick.
- C2-26 to 60 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) when dry; massive; very hard when dry, very firm when moist, and nonsticky and nonplastic when wet; weakly cemented; few roots; many very fine pores; moderately alkaline (pH 8.4); lime occurs in veins.

The very hard, weakly cemented C2 horizon is lacking in places. Some lime-silica fragments are scattered throughout the soil.

RITZVILLE SERIES

The following profile of Ritzville silt loam is located in a cultivated field. The profile is 190 feet east and 770 feet north of the southwest corner of sec. 35, T. 20 N., R. 35 E., Adams Co.

- Ap-0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; neutral (pH 6.8); abrupt, smooth boundary. 7 to 13 inches thick.
- B21-9 to 18 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium and coarse, prismatic structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many very fine pores; mildly alkaline (pH 7.8); clear, wavy boundary. 6 to 15 inches thick.

B22-18 to 36 inches, similar to B21 horizon, but dark brown (10YR 4/3) when moist; abrupt, wavy boundary. 6 to 15 inches thick.

C1ca-36 to 43 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many very fine pores; violently effervescent; segregated lime in pores and root channels; moderately alkaline (pH 8.2); gradual, wavy boundary. 6 to 12 inches thick.

C2-43 to 54 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; few roots; common very fine pores; strongly effervescent; strongly alkaline (pH 8.5); abrupt, irregular boundary. 8 to 20 inches thick.

C3-54 to 65 inches, similar to C2 horizon, but hard when dry.

The A horizon ranges from silt loam to very fine sandy loam in texture and from 7 to 13 inches in thickness. When moist, it ranges from dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) in color. This soil is ordinarily more than 60 inches deep, but in places it is underlain by unconforming bedrock, sediments, sandy gravel, or a duripan at a depth between 40 and 60 inches. Depth to lime is ordinarily more than 36 inches but is less where bedrock is at a depth of less than 60 inches. In places the compact C3 horizon is lacking. Firm silt concretions of various shapes (cicada nodules) 1/4 inch to 4 inches in length, and width are common in the C horizon.

ROLOFF SERIES

The following profile of Roloff silt loam is located in an area of grassland. The profile is 700 feet west and 300 feet south of the north quarter corner of sec. 16, T. 18 N., R. 35 E., Adams Co.

- A1-0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium and coarse, platy structure breaking to fine and medium granules; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, very fine, tubular pores; neutral (pH 7.0); clear, smooth boundary. 7 to 10 inches thick.
- B2-8 to 16 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; mildly alkaline (pH 7.6); clear, wavy boundary. 8 to 15 inches thick.
- C1-16 to 24 inches, dark-brown (7.5YR 4/2) silt loam, brown (7.5YR 5/4) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; common small gravel; mildly alkaline (pH 7.8); abrupt, smooth boundary. 3 to 9 inches thick.

IIR-24 inches +, basalt bedrock.

There are stony and cobbly phases of this soil. The C horizon in places is 40 percent coarse sand and gravel-size basalt fragments. Basalt bedrock is at a depth of 20 to 40 inches. In spots a thin calcareous layer occurs just above the basalt or as a coating on the bedrock.

ROYAL SERIES

The following profile of Royal fine sandy loam is located in an area of grassland. The profile is 1,400 feet north and 200 feet west of the southeast corner of sec. 28, T. 11 N., R. 29 E., farm unit 126 of irrigation block 16, Franklin Co.

- A1-0 to 5 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; mildly alkaline (pH 7.6) ; abrupt, smooth boundary. 3 to 6 inches thick.
- B2-5 to 15 inches, pale-brown (10YR 6/3) fine sandy loam (near loamy fine sand), brown (10YR 5/3) when moist; weak, medium, prismatic structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; few, very fine tubular pores; mildly alkaline (pH 7.8) ; clear, wavy boundary. 6 to 18 inches thick.
- Clca-15 to 30 inches, very pale brown (10YR 7/3) loamy fine sand (near fine sandy loam), brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; few, very fine, tubular pores; strongly effervescent; moderately alkaline (pH 8.4) ; abrupt, wavy boundary. 10 to 25 inches thick.
- C2-30 to 40 inches, light-gray (10YR 7/2) loamy fine sand, grayish brown (10YR 5/2) when moist; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; few, very fine, tubular pores; strongly effervescent; moderately alkaline (pH 8.4) ; abrupt, wavy boundary. Variable thickness.
- C3-40 to 46 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; few, fine, tubular pores; strongly effervescent; moderately alkaline (pH 8.4) ; abrupt, wavy boundary. Variable thickness.
- C4-46 to 57 inches, gray (10YR 6/1) loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose, nonsticky, nonplastic ; few roots; only interstitial pores; strongly effervescent; strongly alkaline (pH 8.6) ; abrupt, wavy boundary. Variable thickness.
- C5-57 to 70 inches +, light-gray (10YR 7/2) loamy fine sand (near fine sandy loam), dark brown when moist; massive; slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; few, fine, tubular pores; strongly effervescent; strongly alkaline (pH 8.7) .

The A horizon ranges from dark grayish brown to dark brown when moist and from 3 to 6 inches in thickness. In some areas the profile is less stratified than the one just described and is fine sandy loam throughout. In other areas it is very fine sandy loam to a depth of 20 or 36 inches. Textures of fine sandy loam and loamy fine sand are predominant; textures of loamy fine sand occur in eroded areas. The depth to lime ranges from 10 to 24 inches.

SAGEMOOR SERIES

The following profile of Sagemoor silt loam is located in a cultivated field. The profile is 200 feet south and 700 feet east of the west quarter corner of sec. 7, T. 18 N., R. 30 E., Grant Co.

- Ap-0 to 9 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; noncalcareous ; mildly alkaline (pH 7.4) ; abrupt, smooth boundary. A1 horizon is 3 to 6 inches thick.
- B2-9 to 19 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, medium and coarse, prismatic structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine tubular pores; noncalcareous; mildly alkaline (pH 7.8) ; abrupt, wavy boundary. 6 to 15 inches thick.
- IIC1ca-19 to 25 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; hard when dry, firm when moist, and slightly sticky

and slightly plastic when wet; few roots; many, very fine, tubular pores; finely laminated silts and very fine sand; violently effervescent; lime is concentrated in seams in the surface of the plates; moderately alkaline (pH 8.4) ; abrupt, wavy boundary. 4 to 8 inches thick.

- IIC2-25 to 34 inches, light brownish-gray (2.5Y 6/2) silt loam and very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; finely laminated and stratified with thin lenses of very fine sand; the silt loam is hard when dry, firm when moist, and slightly sticky and slightly plastic when wet; the lenses of very fine sandy loam are slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; few roots; many, very fine, tubular pores; strongly effervescent; moderately alkaline (pH 8.4) ; clear, wavy boundary. Variable thickness.
- IIC3-34 to 40 inches, grayish-brown (2.5Y 5/2) silt loam, stratified with very fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; except for few, very fine, tubular pores, similar to IIC2 horizon; abrupt, wavy boundary. Variable thickness.
- IIC4-40 to 46 inches, grayish-brown (2.5Y 5/2) very fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; massive; slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; no tubular pores; strongly effervescent; moderately alkaline (pH 8.4) ; abrupt, wavy boundary. Variable thickness.
- IIC5-46 to 60 inches +, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; finely laminated; hard when dry, firm when moist, and slightly sticky and slightly plastic when wet; no observable roots; few, very fine, tubular pores; strongly effervescent; strongly alkaline (pH 8.7) ; variable thickness.

The A horizon ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The B and C horizons range from very fine sandy loam to silt loam in texture. The firm, laminated silt layers are at a depth that ranges from 15 to 40 inches but commonly is at about 22 inches. The laminations are very thin and consist of lenses of silt loam, silt, very fine sandy loam, and very fine sand. A few piles of ice-rafted boulders occur on the surface.

SCOOTENEY SERIES

The following profile of Scootene loam is located in an area of grassland. The profile is 30 feet north and 400 feet east of the south quarter corner of sec. 11, T. 15 N., R. 28 E., Adams Co.

- A1-0 to 4 inches, dark-brown (10YR 4/3) loam, brown (10YR 5/3) when dry; weak, coarse, platy structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; neutral (pH 7.2) ; abrupt, wavy boundary. 3 to 6 inches thick.
- B2-4 to 18 inches, dark-brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist and nonsticky and nonplastic when wet; plentiful roots; few, very fine, tubular pores; mildly alkaline (pH 7.4) ; clear, wavy boundary. 6 to 15 inches thick.
- IIC1ca-18 to 29 inches, dark-brown (10YR 4/3) gravelly very fine sandy loam, light grayish brown (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; porous; moderately alkaline (pH 8.0) ; violently effervescent; clear, wavy boundary. 6 to 15 inches thick.
- IIIC2-29 to 60 inches, grayish-brown (10YR 5/2) very cobbly and gravelly sandy loam, light brownish gray (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; very porous; very cobbly in lower part; strongly effervescent; moderately alkaline (pH 8.2).

The A horizon ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The depth to lime ranges from 18 to 30 inches. The B2 horizon ranges from very fine sandy loam to silt loam in texture, and where moist, from dark brown to dark grayish brown in color. Its structure ranges from weak, medium, subangular blocky to weak, medium, prismatic. In places, loose stories and angular basalt chips are common throughout the soil. The content of gravel and cobblestones increases with depth and, exceeds 50 percent below a depth of 30 inches.

SHANO SERIES

The following profile of Shano silt loam is located in a cultivated field. The profile is 150 feet south and 1,000 feet east of the northwest corner sec. 19, T. 19 N., R. 30 E., Grant Co.

- Ap-0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; mildly alkaline (pH 7.6) ; abrupt, smooth boundary. 3 to 6 inches thick where undisturbed.
- B2-8 to 19 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; weak, coarse and medium, prismatic structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; common, very fine, tubular pores; mildly alkaline (pH 7.6) ; gradual, wavy boundary. 8 to 18 inches thick.
- C1-19 to 33 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist and slightly sticky and slightly plastic when wet; plentiful roots; common, very fine, tubular pores; moderately alkaline (pH 8.0) ; clear, wavy boundary. 8 to 15 inches thick.
- C2ca-33 to 42 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; violently effervescent; moderately alkaline (pH 8.2) ; common, concentric, hard (cicada) nodules; gradual, wavy boundary. 7 to 15 inches thick.
- C3-42 to 57 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few roots; few, concentric, hard (cicada) nodules; strongly effervescent; strongly alkaline (pH 8.6) ; gradual, wavy boundary. 10 to 20 inches thick.
- C4-57 to 67 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) when dry; massive; hard when dry, firm when moist, and slightly sticky and slightly plastic when wet; few roots; strongly effervescent; strongly alkaline (pH 9.0) ; contains intermixed pockets of soft, very friable material of same texture and structure. Many feet thick.

The A horizon ranges from 3 to 6 inches in thickness, and when, moist, from dark grayish brown to dark brown in color. The depth to lime ranges from 24 to 36 inches. The hard concentric (cicada) nodules are lacking in some places, and in other places there are few to many. This soil is ordinarily more than 60 inches deep, but in places it is underlain by basalt bedrock, sediments, sandy gravel, or a duripan at a depth between 40 and 60 inches. The hard firm layer in the lower part of the C horizon is lacking in most places.

STANFIELD SERIES

The following profile of Stanfield silt loam is located in an area of grassland. The profile is 750 feet north and

910 feet east of the southwest corner of sec. 30, T. 20 N., R. 31 E., Adams Co.

- A1-0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, very fine granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; violently effervescent with dilute hydrochloric acid; very strongly alkaline (pH 9.2) ; abrupt, smooth boundary. 3 to 5 inches thick.
- C1-4 to 36 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive breaking to weak, coarse, subangular blocky; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, fine, tubular pores; violently effervescent with dilute hydrochloric acid; very strongly alkaline (pH 9.6) ; abrupt, wavy boundary. 20 to 40 inches thick.
- C2m-36 to 58 inches, brown (10YR 5/3) silt loam, very pale brown (10YR 8/3) when dry; massive; weakly cemented; no roots; many, fine, tubular pores; violently effervescent with dilute hydrochloric acid; very strongly alkaline (pH 9.2) ; abrupt, smooth boundary. 5 to 23 inches thick.
- C3-57 inches +, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; no roots; slightly effervescent with dilute hydrochloric acid; strongly alkaline (pH 8.8) . Many feet thick.

The texture of the surface layer ranges from fine sandy loam to silt loam, and the color ranges from dark grayish brown (10YR 4/2) to dark brown (10YR 4/3). Ordinarily, the surface layer is very strongly alkaline, but where the soil is better drained, the surface layer may be strongly alkaline. The hardpan, discontinuous in places, is weakly cemented to strongly cemented and occurs at a depth of 24 to 40 inches. In places the soil is mostly volcanic ash.

STARBUCK SERIES

The following profile of Starbuck silt loam is located in an area of grassland. The profile is 1,050 feet south and 1,300 feet west of the northeast corner of sec. 4, T. 17 N., R. 34 E., Adams Co.

- A11-0 to 3 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, platy and weak, medium, granular structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, fine and very fine, tubular pores; neutral (pH 6.6) abrupt, smooth boundary. 2 to 4 inches thick.
- A12-3 to 9 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, fine, tubular pores; neutral (pH 6.8) ; clear, smooth boundary. 4 to 8 inches thick.
- B2-9 to 16 inches, brown or dark-brown (10YR 4/3) silt loam pale brown (10YR 6/3) when dry; weak, medium prismatic structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, fine, tubular pores neutral (pH 7.0) ; abrupt, wavy boundary. 5 to 10 inches thick.
- R-16 inches +, basalt bedrock.

The A1 horizon when moist has color value and chroma of 2 or 3. The All horizon when moist is very dark brown (10YR 2/2) in some areas. The texture of the solum is fine sandy loam, loam, or silt loam. The depth to bedrock ranges from 12 to 20 inches. In places a layer of lime occurs just above the bedrock or there is lime coating on the bedrock. In places the soil is gravelly,

cobbly, stony, or rocky. The content of gravel, cobblestones, and stones throughout the profile ranges from 5 to 50 percent.

STRATFORD SERIES

The following profile of Stratford silt loam is located in an area of grassland. The profile is 800 feet east and 100 feet north of the southwest corner of sec. 16, T. 17 N., R. 36 E., W.M., Adams Co.

- A11-0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, coarse, platy structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; common fine gravel; mildly alkaline (pH 7.6); abrupt, smooth boundary. 3 to 5 inches thick.
- A12-4 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; few, very fine, tubular pores; common fine gravel; mildly alkaline (pH 7.6); abrupt, smooth boundary. 4 to 5 inches thick.
- B2-8 to 18 inches, dark-brown (10YR 3/3) gravelly loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; soft when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; common, very fine, tubular pores; mildly alkaline (pH 7.6); abrupt, smooth boundary. 6 to 15 inches thick.
- C1-18 to 23 inches, dark yellowish-brown (10YR 3/4) gravelly loam, yellowish brown (10YR 5/4) when dry; massive; soft when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; mildly alkaline (pH 7.8); abrupt, smooth boundary. 6 to 8 inches thick.
- IIC2-23 to 28 inches, dark-brown (10YR 4/3) very gravelly loam, yellowish brown (10YR 5/4) when dry; massive; soft when dry, friable when moist, and nonsticky and nonplastic when wet; plentiful roots; few, very fine, tubular pores; mildly alkaline (pH 7.8); abrupt, smooth boundary. 3 to 5 inches thick.
- IIIC3-28 inches +, loose basalt gravel and sand, lime- and silica-coated on undersides.

The surface layer ranges from silt loam to gravelly silt loam. The B2 horizon is 10 to 50 percent gravel and cobblestones, and the percentage increases with depth. In places very thin patchy clay or silt films are evident on peds or in cracks or pores. The depth to underlying gravel ranges from 20 to 40 inches. In places lime occurs a few inches above the open gravel.

TAUNTON SERIES

The following profile of Taunton fine sandy loam is located in a cultivated field. The profile is 250 feet south and 50 feet east of the center of the northwest quarter of sec. 16, T. 15 N., R. 28 E., W.M., Adams Co.

- Ap-0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; moderately alkaline (pH 8.0); abrupt, smooth boundary. 3 to 6 inches thick.
- B2-5 to 18 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; few, very fine, tubular pores; moderately alkaline (pH 8.0); clear, wavy boundary. 6 to 14 inches thick.
- C1ca-18 to 24 inches, dark-brown (10YR 4/3) gravelly (lime-cemented fragments) fine sandy loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic

when wet; plentiful roots; few, very fine, tubular pores; violently effervescent; strongly alkaline (pH 8.6); abrupt, smooth boundary. 4 to 16 inches thick.

C2cam-24 inches +, white (10YR 9/2) strongly cemented hardpan that decomposes in acid; upper surface has thin smooth crust; crust and matrix are violently effervescent. Many feet thick.

Where wind eroded, the surface is likely to be littered with lime-cemented fragments. These fragments are common throughout the profile. The A horizon ranges from dark grayish brown to dark brown in color and from 3 to 6 inches in thickness. The lower part of the C1ca horizon ranges from fine sandy loam to very fine sandy loam. The depth to the lime-cemented hardpan ranges from 18 to 40 inches.

UMAPINE SERIES

The following profile of Umapine silt loam is located in an area of grassland. The profile is 600 feet north and 540 feet east of the west quarter corner of sec. 6, T. 15 N., R. 28 E., Adams Co.

- Alca-0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, coarse, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; vesicular pores; violently effervescent; very strongly alkaline (pH 9.2); abrupt, smooth boundary. 5 to 12 inches thick.
- C1ca-9 to 19 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; violently effervescent; very strongly alkaline (pH 9.6); gradual, wavy boundary. 0 to 15 inches thick.
- C2ca-19 to 28 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; many, very fine, tubular pores; few faint mottles; violently effervescent; strongly alkaline (pH 9.0); gradual, wavy boundary. 6 to 15 inches thick.
- C3ca-28 to 41 inches, gray (10YR 5/1) silt loam, light gray (10YR 7/1) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; many, fine, tubular pores; few faint mottles; violently effervescent, as lime is both disseminated and segregated in fine, soft, masses and threads; strongly alkaline (pH 8.8); clear, wavy boundary. 10 to 16 inches thick.
- C4ca-41 to 60 inches, dark grayish-brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) when dry; massive; slightly hard when dry, friable when moist, and nonsticky and nonplastic when wet; very few roots; few faint mottles; violently effervescent; strongly alkaline (pH 8.6).

The A horizon when moist ranges from dark grayish brown to gray in color. The C horizon when moist has values of 3 to 5 and chromas of 1, 2, or 3. The dry values are 1 or 2 units higher. The soil is likely to be strongly effervescent, but in places at a depth below 30 inches, it is noncalcareous and moderately alkaline. In places the C horizon is stratified with layers of sandy loam, silt loam, or light clay loam, volcanic ash, or diatomite. The soil may be underlain with gravel, sand, or bedrock at a depth of more than 40 inches. Under irrigation, the upper part of this soil becomes noncalcareous in places.

WACOTA SERIES

The following profile of Wacota silt loam is located in a cultivated field. The profile is 200 feet south and 300

feet west of the center of sec. 31, T. 15 N., R. 95 E., Adams Co.

- Ap-0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; very fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; neutral (pH 7.0); abrupt, smooth boundary. 4 to 10 inches thick.
- C1-6 to 18 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; many, very fine, tubular pores; neutral (pH 7.0); clear, wavy boundary. 10 to 14 inches thick.
- C2-18 to 43 inches, dark-brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, very fine, tubular pores; neutral (pH 7.2); clear, smooth boundary. 20 to 30 inches thick.
- C3ca-43 to 60 inches, brown (10YR 5/3) silt loam, light gray (10YR 7/2) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; common, very fine, tubular pores; strongly effervescent; moderately alkaline (pH 8.0).

The texture of the C horizon ranges from very fine sandy loam to coarse silt loam. The depth to lime ranges from 3 to 5 feet.

WALLA WALLA SERIES

The following profile of Walla Walla silt loam is located in a cultivated field. The profile is 1,600 feet north and 100 feet east of the southeast corner of sec. 31, T. 20 N., R. 37 E., Adams Co.

- Ap-0 to 6 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak, fine, granular structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; roots abundant; many, very fine, tubular pores; neutral (pH 6.8); abrupt, smooth boundary. 5 to 7 inches thick.
- A2-6 to 13 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, platy structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; roots abundant; many, very fine, tubular pores; neutral (pH 6.8); clear, smooth boundary. 5 to 7 inches thick.
- B1-13 to 18 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/2) when dry; weak, coarse, prismatic breaking to weak, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; roots plentiful; many, very fine, tubular pores; neutral (pH 7.4); clear, wavy boundary. 5 to 10 inches thick.
- B2-18 to 45 inches, brown (10YR 4/3) silt loam, brown (10YR 5/3) when dry; weak, coarse, prismatic structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; roots plentiful; common, very fine, tubular pores; mildly alkaline (pH 7.6); gradual, wavy boundary. 20 to 30 inches thick.
- C1-45 to 55 inches, brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; weak, coarse, prismatic structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; few, very fine, tubular pores; weakly calcareous, as there is lime in old root channels; moderately alkaline (pH 8.3); gradual, wavy boundary. 8 to 15 inches thick.
- C2ca-55 to 65 inches +, brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; few roots; few, very fine, tubular pores; strongly calcareous, because of disseminated lime; strongly alkaline (pH 8.8).

The thickness of the A horizon ranges from 10 to 14 inches. The color value is 2 or 2.5 in the A1 or Ap horizon and 2 or 3 in the A2 horizon. The chroma is 2 or 3. The depth to lime accumulation ranges from 40 to 60 inches, and in places on north-facing slopes it is more than 60 inches. In spots the C horizon contains weakly cemented loess nodules, 1 or 2 inches in diameter, that effervesce with dilute HCl. In places an unconforming substratum, commonly basalt, occurs at a depth of more than 40 inches.

WALVAN SERIES

The following profile of Walvan very fine sandy loam is located in a cultivated field. The profile is 800 feet north and 50 feet west of the southeast corner of sec. 29, T. 16 N., R. 38 E., Adams Co.

- A1p-0 to 5 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; neutral (pH 7.0); abrupt, smooth boundary. 4 to 6 inches thick.
- A12-5 to 12 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure to massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; common, fine, tubular pores; neutral (pH 7.2); clear, wavy boundary. 5 to 9 inches thick.
- C1-12 to 29 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, fine, tubular pores; mildly alkaline (pH 7.6); clear, wavy boundary. 15 to 20 inches thick.
- C2-29 to 38 inches, grayish-brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; moderately alkaline (pH 8.2); abrupt, smooth boundary. 7 to 12 inches thick.
- C3-38 to 60 inches, grayish-brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) when dry; massive; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; few roots; moderately alkaline (pH 8.2).

The texture of the C horizon ranges from very fine sandy loam to coarse silt loam. In places there may be lime in the lower part of the C horizon.

WARDEN SERIES

The following profile of Warden very fine sandy loam is located in a cultivated field. The profile is 100 feet south and 500 feet east of the northwest corner of sec. 19, T. 16 N., R. 30 E., Adams Co.

- Ap-0 to 6 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist and nonsticky and nonplastic when wet; abundant roots; mildly alkaline (pH 7.8); abrupt, smooth boundary. 3 to 6 inches thick if undisturbed.
- B2-6 to 19 inches, dark-brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, very fine, tubular pores; mildly alkaline (pH 7.8); abrupt, smooth boundary. 10 to 15 inches thick.
- IIC1ca-19 to 40 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive but irregularly finely laminated; hard when dry, firm when

moist, and slightly sticky and slightly plastic when wet; plentiful roots; many, very fine, tubular pores; violently effervescent; moderately alkaline (pH 8.4); clear, wavy boundary. 15 to 30 inches thick.

IIC2-40 to 54 inches, brown (10YR 5/3) very fine sandy loam, pale brown (10YR 6/3) when dry; massive, soft when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; common, very fine, tubular pores; violently effervescent; strongly alkaline (pH 8.6); clear, wavy boundary. Few to many inches thick.

IVC3-54 to 60 inches, light brownish gray (10YR 6/2) silt loam, light gray (10YR 7/2) when dry; massive; hard when dry, firm when moist, and slightly sticky and slightly plastic when wet; few roots; few, very fine, tubular pores; violently effervescent; strongly alkaline (pH 8.6).

The A horizon ranges from dark grayish brown to dark brown in color, from 3 to 9 inches in thickness, and from very fine sandy loam to silt loam in texture. The B2 horizon when moist ranges from dark brown to dark grayish brown. The depth to the firm calcareous layer is commonly about 20 inches but ranges from 8 to 40 inches. The soils are noncalcareous above the lake sediments. In places the lower part of the C horizon is stratified with sandy loam or loamy sand. In many spots it is dissected by laminated, vertical, or diagonal elastic dikes extending from an undetermined depth. The C horizon ranges from 10YR to 2.5Y in hue. In consistence it ranges from hard to slightly hard and firm to friable.

WIEHL SERIES

The following profile of Wiehl fine sandy loam is located in a cultivated field. The profile is near the northeast corner of farm unit 133, block 14, 630 feet southwest of the center of sec. 32, T. 13 N., R. 30 E., Franklin Co.

Ap-0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam, pale brown (10YR 6/3) when dry; weak, fine, platy structure soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; mildly alkaline (pH 7.6); abrupt, smooth boundary. (The A1 horizon is 3 to 6 inches thick where soil has not been cultivated.)

B2-5 to 16 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; abundant roots; many, very fine, tubular pores; mildly alkaline (pH 7.8); clear, wavy boundary. 6 to 12 inches thick.

C1-16 to 23 inches, dark-brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) when dry; massive slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; plentiful roots; many, very fine, tubular pores; very slightly effervescent in places; moderately alkaline (pH 8.0); abrupt, smooth boundary. 5 to 12 inches thick.

IIC2-23 to 60 inches, light brownish-gray (2.5Y 6/2) silt, white (2.5Y 8/2) when dry; laminated; hard when dry, firm when moist, and slightly sticky and slightly plastic when wet; roots penetrate this layer only a few inches; strongly effervescent on surface of laminated plates, otherwise sediments are noncalcareous; strongly alkaline (pH 8.8). Several hundred feet thick. This layer is part of the Ringold sediments.

The A horizon ranges from dark grayish brown to dark brown in color. The depth to the Ringold sediments ranges from 20 to 40 inches. Stratification is common in the lower horizons. The Ringold beds consist of laminated silty layers interbedded with loose strata of sand, loamy sand, or sandstone.

WILLIS SERIES

The following profile of Willis silt loam is located in a cultivated field. The profile is 500 feet south and 100 feet west of the northeast corner of sec. 18, T. 20 N., R. 36 E., Adams Co.

Ap-0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; soft when dry, very friable when moist, and slightly sticky and slightly plastic when wet; abundant roots; mildly alkaline (pH 7.4); abrupt, smooth boundary. 7 to 10 inches thick.

B2-8 to 24 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; mildly alkaline (pH 7.6); abrupt, wavy boundary. 8 to 17 inches thick.

C1ca-24 to 29 inches, dark yellowish-brown (10YR 4/4) silt loam, pale brown (10YR 6/3) when dry; massive; hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; plentiful roots; few, very fine, tubular pores; violently effervescent; strongly alkaline (pH 8.6); abrupt, smooth boundary. 3 to 10 inches thick.

C2msi-29 inches +, indurated lime-silica cemented hardpan, many feet thick, that does not break down in acid.

The lime-silica cemented hardpan is at a depth of 15 to 40 inches. It may be underlain by bedrock, Ringold sediments, or alternating layers of hardpan and loess. In places small fragments of the pan are scattered throughout the profile. In places the pan is a IIC2msi horizon.

Laboratory Data

The physical and chemical properties of two selected soils in Adams County and two in Grant County are shown in table 8, page 102, and table 9, page 104. The soils sampled are those of the Benge, Ritzville, Sagemoor, and Shano series. They were sampled in 1961 and analyzed by the Soil Survey Laboratory, Soil Conservation Service, Riverside, Calif.

Methods of Sampling and Analysis

All samples were collected from selected pits. The fragments larger than 1 inch were discarded. The samples were air dried, rolled or crushed, and then passed through a 2-millimeter, round-hole sieve. The material larger than 2 millimeters in diameter was reported as a weight percentage of the total sample. The analyses were made on material less than 2 millimeters in diameter. The results were reported on an oven-dry basis.

Particle-size was determined by the pipette method, with dispersion by sodium hexametaphosphate, and by shaking, using the procedure developed by Kilmer and Alexander (4) and by Kilmer and Mullins (5).

Reaction was measured with a glass electrode, using the soil-water and soil-salt ratios indicated in the table (6,11).

Organic carbon was determined by a modification of the Walkley-Black wet-combination method (6). Total nitrogen was determined by the AOAC modified Kjeldahl procedure (2).

Cation-exchange capacity was determined by displacement with ammonium acetate (11).

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All tables have been updated and are available as a separate document.

Extractable cations (exchangeable cations in nonsaline, noncalcareous horizons) were determined by extraction with neutral normal ammonium acetate (6). Electrical conductivity is expressed as millimhos per centimeter of saturation extract at 25° C. (11).

The percentage of base saturation equals the sum of extractable bases, in milliequivalents per 100 grams of soil, divided by the sum of extractable cations, in milliequivalents per 100 grams of soil, multiplied by 100.

The percentage of exchangeable sodium is equal to 100 times the exchangeable-sodium content divided by the cation-exchange capacity, both expressed by the same units (11) . The content of exchangeable sodium was calculated by subtracting the amount of sodium in the saturation extract from the amount extracted by the ammonium acetate solution.

The calcium carbonate equivalent was calculated by measuring the volume of carbonates produced when acid is added to the sample (7, 13) .

Bulk density was determined with a 4.7 x 3.5 centimeter tube and an Uhland-type core sampler (10) .

Moisture retention at a tension of 15 atmospheres was determined by testing fragmented samples in pressure membrane apparatus (11) .

Additional Facts About the County

The first settlement in Adams County was along Cow Creek in the 1860's. The county was largely grassland, and the early settlers raised livestock. Grain crops were planted in the 1880's, and by the 1890's and early 1900's, a large acreage was under cultivation.

Adams County was officially established in 1883. Benge, Washtucna, Hatton, Ralston, Lind, Othello, and Ritzville were among, the largest towns in the early 1900's. Now the population is more centralized, and Ritzville, Washtucna, Lind, and Othello are the only incorporated towns or cities. All that remains of the others are a few houses and grain elevators.

Adams County has a land area of 1,895 square miles and a population of 9,929. Ritzville is the county seat. It is located on the Northern Pacific Railroad and serves as a shipping point for wheat. Its population was 2,173, according to the 1960 census.

Climate

The location of Adams County in the large inland basin between the Cascade and the Rocky Mountains results in a climate that is partly continental and partly marine. The Rocky Mountains shield this basin from the snore severe winter storms and the cold continental air that moves southward across Canada and the Cascades obstruct the easterly movement of moist air from the Pacific Ocean.

Summers are hot, dry, and sunny. Afternoon temperatures in the warmest summer months range from the upper eighties to the mid nineties. Nighttime temperatures are in the fifties or lower sixties. In a typical summer, the temperature exceeds 90° F. on 30 to 40 days. The number of days on which the temperature exceeds 90° has ranged from less than 20 in the coolest summers to more than 60 in the warmest summers. The number decreases slightly as the elevation increases in an easterly direction across the county. The columns under the heading "Temperature" in tables 10, 11, and 12, show data from three different weather stations, at elevations of 1,110 feet, 1,625 feet, and 1,825 feet, respectively. The hottest weather is often associated with a northward movement of hot, dry air from the southwestern semi-desert regions. Cooler marine air from the ocean moves inland after a few days of exceptionally high temperatures, and afternoon readings are likely to decrease from near 100° to the upper eighties or lower nineties. The average relative humidity during the warmest months ranges from about 60 percent at sunrise to 25 percent or less in midafternoon.

The nearness of this area to the path of low-pressure and high-pressure weather systems moving eastward from the North Pacific or southward across Canada results in frequent changes in winter weather. Cold snaps are not infrequent, but cold spells of any length are an exception. Afternoon temperatures in the coldest winter months range from the upper twenties to the upper thirties, and nighttime readings range from 15° to 25°. The maximum temperature is below freezing on 30 to 40 days during an average winter. It is below freezing on fewer than 15 days in the warmest winters and on more than 50 days in the coldest winters. The minimum temperature is ordinarily below freezing on 130 to 150 days but occasionally on as few as 100 days and occasionally on as

many as 170. A minimum temperature of zero or lower occurs on a few days in three out of four winters. During some of the colder winters, the minimum temperature has dropped to zero on 15 to 25 nights to -10° on 5 to 10 nights, and to -20° or lower on a few nights. The coldest weather occurs when extremely cold air moves southward across Canada spills over the Rockies, and fills the inland basin. Clear skies usually accompany these outbreaks of cold air, and additional heat is lost by radiation at night. Outbreaks of cold air late in spring or early fall occasionally result in a freeze. Table 13 (page 108) shows the probability of specified temperatures of 32° and lower in spring and fall, and the period between the last occurrence in spring and the first. in fall, at Ritzville, Lind, and Othello.

Within a few days after a cold outbreak from the north, warmer air from the ocean moves inland and brings relief from low temperatures. A chinook wind sometimes brings a rapid rise in temperature. The mixing of the warm moist air from the ocean with the cold air results in considerable cloudiness and some fog. Clouds and fog tend to reduce the loss of heat by radiation at night and are partly responsible for higher minimum temperatures than might be expected at this latitude.

The number of cloudy days each month ranges from more than 20 in winter to fewer than 5 in summer. The average relative humidity in the coldest months ranges from 75 percent to 95 percent.

The annual precipitation ranges from 7 to 10 inches along, the western edge of the county and gradually increases to between 12 and 14 inches in the higher elevations of the eastern section (see columns under the heading "Precipitation" in tables 10, 11, and 12). Precipitation is very light in summer, increases gradually in fall, and reaches a peak of 1 to 1 1/2 inches each month during the winter. It decreases in spring, increases again in May and June, and then drops sharply in July. In midsummer it is not unusual for 2 to 4 weeks to pass without any measurable rainfall. Spring and summer precipitation frequently occurs as showers, and a few thunderstorms can be expected. Occasionally, hail and rainfall occur during thunderstorms. The number of days each month with 1/10 of an inch or more of precipitation ranges from about one in summer to four or five in winter.

Winter precipitation may be either rain or snow, but most precipitation between the first of December and the last of February is snow. Total snowfall in a winter has ranged from less than 10 inches to more than 40 inches. Snow accumulates to a depth of 4 to 10 inches almost every winter and to a depth of 18 to 24 inches in years when snowfall is unusually heavy.

The length of time a snow cover remains on the ground varies. During a few of the colder winters, snow has remained on the ground from the first of December to the last of February; in other winters, it has remained on the ground only a few days after each snowfall. Sometimes a chinook wind melts a snow cover very rapidly. If the ground is frozen when this happens, most of the moisture is lost as runoff; if the ground is thawed, erosion is likely in hilly areas that have been cultivated.

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All tables have been updated and are available as a separate document.

In spring and summer, the prevailing direction of the wind is southwest; in winter, it is northeast. The strongest winds throughout the year are from the southwest or west and generally occur as storm systems move eastward across the State. Winds of high velocity result in considerable blowing of dust and soil.

The percentage of the possible sunshine received in this section of the State ranges from approximately 25 percent in winter to 60 percent in spring and fall, and to 80 percent or more in midsummer. The number of hours of sunshine possible each day at this latitude increases from 8 in December to 16 in June.

Records at the Dry Land Experiment Station near Lind showed an average water loss through evaporation from a Class A evaporation pan to be 5.9 inches in April, 8.2 inches in May, 9.9 inches in June, 12.5 inches in July, 10.2 inches in August, and 6.9 inches in September.

The potential evapotranspiration, or the maximum amount of moisture which, if available, could be used by plants, has been computed from temperature and precipitation data recorded at the Dry Land Experiment Station. The following gives the potential evapotranspiration in inches of water each month.

Month:	<i>Inches</i>	Month:	<i>Inches</i>
January	0	August	5.0
February	.1	September	3.2
March	1.7	October	1.7
April	1.9	November	3
May	3.3	December	0
June	4.3	Annual	27.2
July	5.7		

Techniques developed by Palmer-Havens for applying the Thornthwaite method (1948) were used in arriving at the estimated potential evapotranspiration.

Also recorded at the Dry Land Station and shown in table 14 are average wind velocities in miles per hour, for each month, at 18 inches and 60 inches above the ground.

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table in this space.
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available as a separate document.

Farming

The climate of Adams County limits the selection of crops. Wheat is the main crop. Rye and barley are grown also, and beans, corn, potatoes, sugar beets, and alfalfa are grown in areas irrigated under the Columbia Basin Project. The following tabulation shows the acreages of the principal irrigated and nonirrigated crops in 1959.

	Acres
Winter wheat harvested for grain	192,435
Spring wheat harvested for grain	61,062
Barley harvested for grain	77,702
Rye harvested for grain	28,625
Corn for all purposes	3,542
Dry field and seed beans	13,025
Dry field and seed peas	2,371
Alfalfa hay	8,267
Potatoes	2,964
Sugar beets	1,236

In 1959 there were 786 farms in the county. The average size was 1,370 acres. All the farms were highly mechanized, and only 15 were more than a mile from a hard-surfaced road. There were several large range operations and several purebred herds, but only one dairy farm.

Literature Cited

- (1) AMERICAN, ASSOCIATION OF STATE HIGHWAY OFFICIALS.
1961. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 v., illus.
- (2) ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.
1955. OFFICIAL METHODS OF ANALYSIS. Ed. 8, pp. 805-806, illus.
- (3) BALDWIN, M., KELLOGG, C. E., and THORP, J.
1938. SOIL CLASSIFICATION. U.S. Dept. Agr. Ybk., pp. 979-1.001.
- (4) KILMER, V. J. and ALEXANDER, L. T.
1949. METHODS OF MAKING MECHANICAL ANALYSES OF SOILS. Soil Sci. 68: 15-24..
- (5) KILMER, V. J. and MULLINS, J. F.
1954. IMPROVED STIRRING AND PIPETTING APPARATUS FOR MECHANICAL ANALYSIS OF SOILS. Soil Sci. 77: 437-441.
- (6) PEECH, MICHAEL, ALEXANDER, L. T., and others.
1947. METHODS OF SOIL ANALYSIS FOR SOIL-FERTILITY INVESTIGATIONS. U.S. Dept. Agr. Cir. 757, 25 pp.
- (7) PIPER, C. S.
1944. SOIL AND PLANT ANALYSIS. pp. 132-135.
- (8) PORTLAND CEMENT ASSOCIATION.
1956. PCA SOIL PRIMER. 86 pp., illus.
- (9) THORP, J., and SMITH, GUY D.
1949. HIGHER CATEGORIES OF SOIL CLASSIFICATION: ORDER, SUBORDER, AND GREAT SOIL GROUPS. Soil Sci. 67: 117-126, illus.
- (10) UHLAND, R. E., and O'NEAL, A. M.
1951. SOIL PERMEABILITY DETERMINATIONS FOR USE IN SOIL AND WATER CONSERVATION. U.S. Dept. Agr., Soil Conserv. Serv. Tech. Pub. 101, 36 pp., illus.
- (11) UNITED STATES DEPARTMENT OF AGRICULTURE.
1954. DIAGNOSIS AND IMPROVEMENT OF SALINE AND ALKALI SOILS. U.S. Dept. Handbk. 60, 160 pp., illus.
- (12) WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS.
1953. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. 3-357, 2 v. and appendix, 44 pp., illus.
- (13) WILLIAMS, D. E.
1949. A RAPID MANOMETRIC METHOD FOR THE DETERMINATION OF CARBONATE IN SOILS. Soil Sci. Amer. Proc. (1948) 13: 127-129, illus.

Glossary

- Aggregate, soil.** Many fine particles held in a single mass or cluster, such as a clod, a crumb, a block, or a prism.
- Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil that has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.
- Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Bottom land. Low land formed by alluvial deposits along a stream or in a lake basin; a flood plain.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche outcrop or lime spot. A more or less cemented deposit of calcium carbonate exposed at the surface by erosion, or an accumulation of small, white limestone fragments exposed by erosion. In this survey, exposures of both kinds are marked by the same symbol on the soil map.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (See also Texture, soil).

Cobblestone. A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.

Concentrations. Grains, pellets, or nodules of various sizes, shapes, and colors that consist of concentrations of compounds of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soils. 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 ; soil will not hold together in a mass.

Friable.-When moist, soil crushed easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger and can be pressed together into a lump.

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; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard and brittle; little affected by moistening.

Gravelly soil material. From 15 to 50 percent of the material, by volume consists of rounded or angular rock fragments that are not prominently flattened and are as much as 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance-*few, common, and many*; size-*fine, medium, and coarse*; and contrast-*faint, distinct and prominent*. The size measurements are these: fine, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. A quality that enables the soil to transmit air or water. Terms used to describe permeability are as follows very slow, slow, moderately slow, *moderate, moderately rapid, rapid, and very rapid*.

Profile, soil. A vertical section of the soil through all of its, horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH or words as follows

	pH		pH
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction.

Sand. As a soil separate, individual rock or mineral fragments 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay. (See also Texture, soil.)

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes 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 characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are platy (laminated), prismatic vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are (1) single grain (each grain by itself, as in dune sand) or (2) massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum or true soil.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."