SOIL SURVEY OF

Logan County, Colorado

United States Department of Agriculture
Soil Conservation Service

in cooperation with

Colorado Agricultural Experiment Station

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

Major fieldwork for this soil survey was completed in the period 1965-1974. Soil names and descriptions were approved in July 1974. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the Centennial and South Platte Soil and Water Conservation Districts.

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

Cover: Furrow irrigation on Satanta loam.

U. S. DEPARTMENT OF AGRICULTURE

Soil Conservation Service

Washington, D. C. 20013

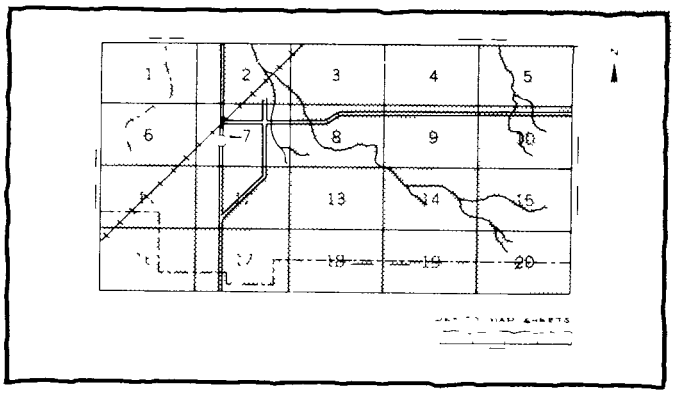
Soil Survey of Logan County, Colorado

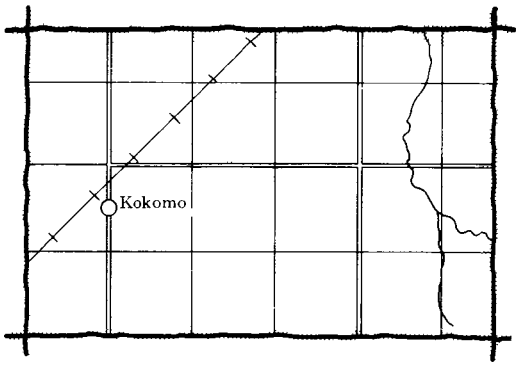
E R R A T U M

The pages describing "How To Use This Soil Survey" were omitted from this survey. The attached pages should be inserted in the publication inside the front cover.

HOW TO USE

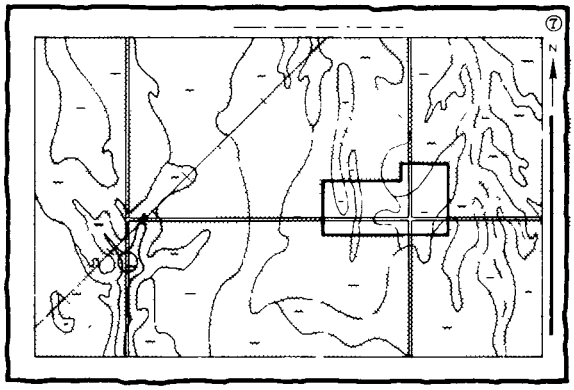
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

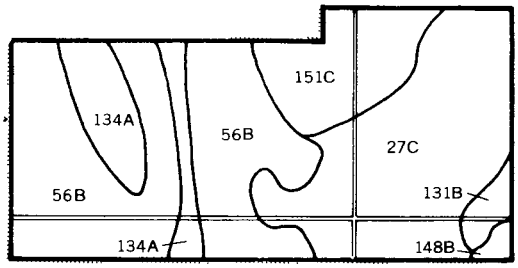




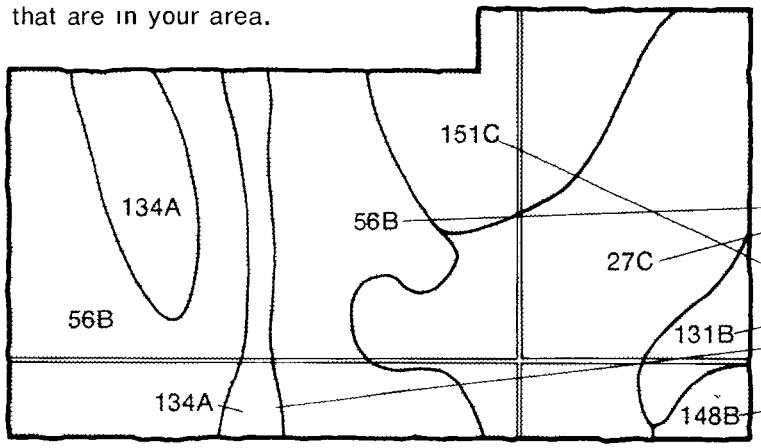
2. Note the number of the map sheet and turn to that sheet.

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





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

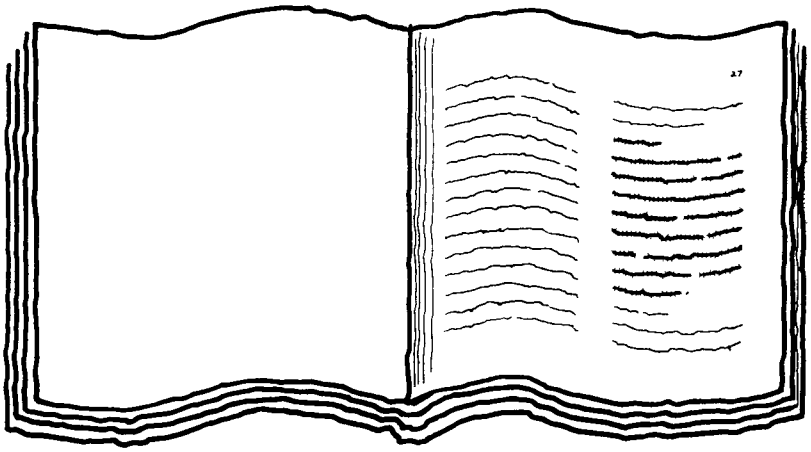


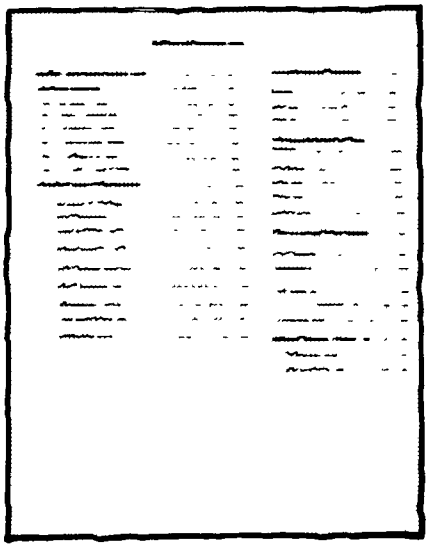
Symbols

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

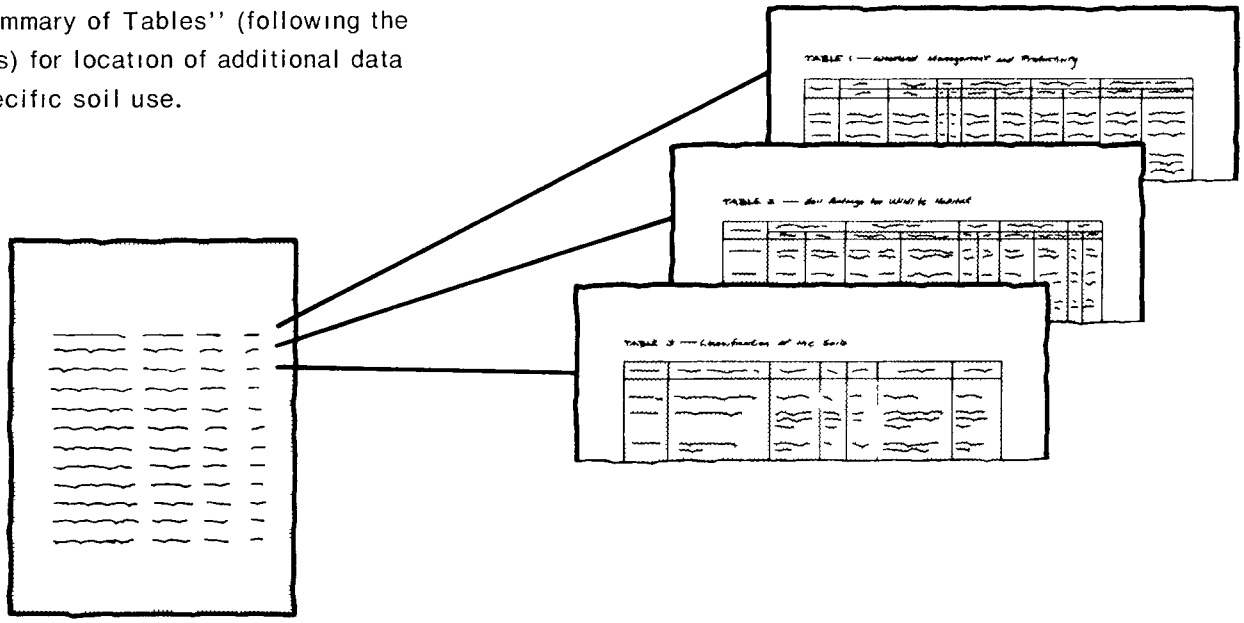
THIS SOIL SURVEY

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





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



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

Contents

	Page
Index to soil mapping units	v
Summary of tables	vii
Foreword	ix
General nature of the county	1
History of settlement	1
Physiography, drainage and relief	1
Climate	2
Natural resources	3
Water supply	3
Agriculture	3
Industry	4
How this survey was made	4
General soil map for broad land use planning	5
Soils forming in unconsolidated alluvium on stream terraces, flood plains and bottomlands	5
1. Alda-Loveland-Fluvaquents	5
2. Nunn-Satanta-Haverson	6
3. Mosher-Lebsack	6
Sand to fine sandy loam soils forming on unconsolidated materials on the uplands	6
4. Valent	6
5. Dailey-Julesburg	7
6. Haxtun-Julesburg	7
7. Manter-Ascalon-Vona	7
Sandy loam to clay loam soils forming on unconsolidated materials on the uplands	8
8. Platner-Rago-Rosebud	8
9. Weld-Platner-Ascalon	8
10. Norka-Ulysses-Colby	8
11. Wages-Satanta-Norka	9
Deep, moderately deep and shallow soils underlain by consolidated sediments on the uplands	9
12. Rosebud-Escabosa-Canyon	9
13. Ustic Torriorthents-Badland	9
14. Mitchell-Keota	10
15. Stoneham-Cushman-Shingle	10
Deep soils forming in unconsolidated gravelly materials on upland ridges and fans	10
16. Dix-Eckley-Chappell	10
Broad land use considerations	11
Soil maps for detailed planning	12
Soil descriptions	13
Use and management of the soils	96
Crops and pasture	97
Yields per acre	98
Capability classes and subclasses	99
Range	99
Woodland	100
Windbreaks and environmental plantings	101
Engineering	101
Building site development	102
Sanitary facilities	102
Construction materials	103
Water management	104
Recreation	105
Wildlife habitat	105
Soil properties	107
Engineering properties	107
Physical and chemical properties	108
Soil and water features	109
Classification of the soils	110
Soil series and morphology	110
Albinas series	110
Alda series	110
Altvan series	111
Arvada series	111
Ascalon series	112
Bankard series	112
Bayard series	112
Bridgeport series	113
Canyon series	113
Chappell series	113
Colby series	114
Cushman series	114
Dacono series	115
Dailey series	115
Dix series	115
Eckley series	115
Els series	116
Epping series	116
Escabosa series	117
Glenberg series	117
Haverson series	117
Haxtun series	118
Hayford series	118
Heldt series	118
Iliff series	119
Julesburg series	119
Keith series	120
Keota series	120
Kim series	120
Kuma series	121
Kutch series	121
Lebsack series	122
Loveland series	122
Manter series	122
Manzanola series	123
Midway series	123
Mitchell series	123
Mosher series	124
Norka series	124
Nunn series	125
Olney series	125
Peetz series	125
Platner series	126

Contents—continued

	Page
Rago series	126
Renohill series	127
Rosebud series	127
Satanta series	128
Shingle series	128
Stoneham series	128
Thedalund series	129
Ulysses series	129
Valent series	129
Vona series	130
Wages series	130
Weld series	131
Westplain series	131
Classification	131
Formation of the soils	132
Parent materials	132
Climate	133
Plant and animal life	134
Relief	134
Time	134
References	135
Glossary	135
Illustrations	141
Tables	153

Issued July 1977

Index to Soil Mapping Units

	Page
1—Albinas loam, 0 to 3 percent slopes	13
2—Alda sandy loam	13
3—Alda loam	14
4—Altvan-Eckley sandy loams, 3 to 5 percent slopes	15
5—Altvan-Eckley sandy loams, 5 to 9 percent slopes	16
6—Aquolls	17
7—Argiustolls, wet, 2 to 9 percent slopes	17
8—Argiustolls-Rock outcrop complex, 1 to 9 percent slopes	18
9—Arvada silt loam	18
10—Ascalon fine sandy loam, 0 to 3 percent slopes	18
11—Ascalon fine sandy loam, 3 to 5 percent slopes	19
12—Ascalon fine sandy loam, 5 to 9 percent slopes	20
13—Badland	21
14—Bankard sand	21
15—Bayard-Canyon complex, 1 to 9 percent slopes	21
16—Bridgeport loam	22
17—Canyon gravelly loam, 1 to 25 percent slopes	23
18—Chappell sandy loam	23
19—Colby loam, 6 to 20 percent slopes	24
20—Dacono loam	24
21—Dailey loamy sand, 0 to 3 percent slopes	25
22—Dailey loamy sand, 3 to 9 percent slopes	26
23—Dailey loamy sand, thick surface	26
24—Dix-Altvan complex, 9 to 25 percent slopes	27
25—Dix-Eckley complex, 5 to 25 percent slopes	28
26—Els loamy sand	29
27—Epping loam, 3 to 9 percent slopes	29
28—Fluvaquentic Haplaquolls	30
29—Fluvaquents	30
30—Glenberg fine sandy loam	31
31—Gravel pits	31
32—Haverson loam, 0 to 1 percent slopes	32
33—Haverson loam, 1 to 3 percent slopes	32
34—Haverson loam, frequently flooded	33
35—Haverson loam, saline	34
36—Haxtun loamy sand, 0 to 3 percent slopes	34
37—Haxtun loamy sand, 3 to 5 percent slopes	35
38—Haxtun sandy loam	36
39—Hayford silty clay loam	37
40—Hayford silty clay loam, saline	37
41—Heldt clay loam	38
42—Heldt clay loam, saline	38
43—Iliff loam	39
44—Julesburg loamy sand, 0 to 3 percent slopes	40
45—Julesburg loamy sand, 3 to 9 percent slopes	40
46—Julesburg fine sandy loam, 0 to 3 percent slopes	41
47—Julesburg fine sandy loam, 3 to 5 percent slopes	42
48—Julesburg fine sandy loam, 5 to 9 percent slopes	42
49—Julesburg-Eckley complex, 3 to 9 percent slopes	43
50—Keith loam	44
51—Kim loam, 3 to 9 percent slopes	44
52—Kuma loam	45
53—Kutch clay loam, 0 to 3 percent slopes	46
54—Kutch clay loam, 3 to 9 percent slopes	46
55—Lebsack silty clay loam	47
56—Lebsack clay loam, saline	47
57—Lebsack clay loam, wet	48
58—Loveland clay loam	49
59—Manter loamy sand, 0 to 3 percent slopes	49
60—Manter loamy sand, 3 to 9 percent slopes	50
61—Manter sandy loam, 0 to 3 percent slopes	51
62—Manter sandy loam, 3 to 5 percent slopes	51
63—Manter sandy loam, 5 to 9 percent slopes	52
64—Manter sandy loam, water table	53
65—Manter sandy loam, wet	53
66—Manzanola clay loam	54
67—Midway clay loam, 5 to 20 percent slopes	55
68—Mitchell loam, 0 to 3 percent slopes	55
69—Mitchell-Keota loams, 0 to 3 percent slopes	56
70—Mitchell-Keota loams, 3 to 9 percent slopes	56
71—Mitchell-Norka loams, 0 to 3 percent slopes	57
72—Mosher loam	58
73—Mosher clay	58
74—Norka loam, 0 to 1 percent slopes	59
75—Norka-Ulysses loams, 1 to 3 percent slopes	59
76—Nunn loam, 0 to 1 percent slopes	60
77—Nunn loam, 1 to 3 percent slopes	61
78—Nunn loam, 3 to 5 percent slopes	61
79—Nunn loam, 5 to 9 percent slopes	62
80—Nunn clay loam, 1 to 3 percent slopes	63
81—Nunn clay loam, 3 to 9 percent slopes	63
82—Nunn clay loam, water table	64
83—Nunn clay loam, wet	65
84—Olney sandy loam, 3 to 5 percent slopes	65
85—Olney sandy loam, 5 to 9 percent slopes	66
86—Peetz gravelly sandy loam, 5 to 25 percent slopes	67
87—Platner sandy loam, 0 to 3 percent slopes	67
88—Platner loam, 0 to 1 percent slopes	68
89—Platner loam, 1 to 3 percent slopes	69
90—Platner loam, 3 to 5 percent slopes	69
91—Platner-Rago-Dacono loams	70
92—Rago loam	71
93—Rago clay loam	72
94—Renohill-Shingle complex, 3 to 9 percent slopes	72
95—Rock outcrop-Argiustolls complex, 9 to 35 percent slopes	73
96—Rosebud-Escabosa loams, 3 to 5 percent slopes	73

Index to Soil Mapping Units—continued

	Page
97—Rosebud-Escabosa loams, 5 to 9 percent slopes..	74
98—Rosebud-Escabosa-Iliff loams, 0 to 3 percent slopes	75
99—Satanta loam, 0 to 1 percent slopes	76
100—Satanta loam, 1 to 3 percent slopes	77
101—Satanta loam, 3 to 5 percent slopes	78
102—Satanta loam, water table	78
103—Satanta loam, wet	79
104—Shingle loam, 1 to 9 percent slopes	80
105—Stoneham sandy loam, 3 to 9 percent slopes	80
106—Stoneham loam, 3 to 5 percent slopes	80
107—Stoneham loam, 5 to 9 percent slopes	81
108—Stoneham-Cushman complex, 3 to 9 percent slopes	82
109—Thedalund-Kim-Shingle complex, 9 to 20 percent slopes	82
110—Ulysses-Norka loams, 3 to 5 percent slopes	83
111—Ulysses-Norka-Colby loams, 5 to 9 percent slopes	84
112—Ustic Torriorthents	84
113—Valent sand, 0 to 1 percent slopes	85
114—Valent sand, 15 to 40 percent slopes	86
115—Valent loamy sand, 3 to 15 percent slopes	86
116—Vona loamy sand, 3 to 9 percent slopes	86
117—Vona fine sandy loam, 3 to 9 percent slopes	87
118—Wages loam, 0 to 3 percent slopes	88
119—Wages loam, 3 to 5 percent slopes	88
120—Wages loam, 5 to 9 percent slopes	89
121—Wages-Altvan complex, 5 to 9 percent slopes	90
122—Wages-Manter complex, 3 to 9 percent slopes	91
123—Wages-Rosebud loams, 3 to 5 percent slopes	92
124—Wages-Rosebud loams, 5 to 9 percent slopes	93
125—Weld loam, 0 to 1 percent slopes	93
126—Weld loam, 1 to 3 percent slopes	94
127—Westplain silty clay loam	95
128—Westplain-Alda complex	95

Summary of Tables

Page

Acreage and Proportionate Extent of the Soils (Table 4) 156
Acres. Percent.

Building Site Development (Table 7) 176
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Roads and streets.

Classification of the Soils (Table 16) 252
Soil name. Family or higher taxonomic class.

Construction Materials (Table 9) 194
Roadfill. Sand. Gravel. Topsoil.

Engineering Properties and Classifications (Table 13) 226
Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve number—4, 10, 40, 200. Liquid limit. Plasticity index.

Freeze Dates in Spring and Fall (Table 2) 155
Probability. Minimum temperature.

Growing Season Length (Table 3) 155
Probability. Daily minimum temperature during growing season.

Physical and Chemical Properties of Soils (Table 14) 239
Depth. Permeability. Available water capacity. Soil reaction. Salinity. Shrink-swell potential. Risk of corrosion—Uncoated steel, Concrete. Erosion factors—K, T. Wind erodibility group.

Rangeland Productivity and Characteristic Plant Communities (Table 6) 162
Range site. Total production—Kind of year, Dry weight. Common plant name. Composition.

Recreation (Table 11) 210
Camp areas. Picnic areas. Playgrounds. Paths and trails.

Sanitary Facilities (Table 8) 185
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Soil and Water Features (Table 15) 247
Hydrologic group. Flooding—Frequency, Duration, Months. High water table—Depth, Kind, Months. Bedrock—Depth, Hardness. Potential frost action.

Page

Temperature and Precipitation Data (Table 1) 154
Month. Temperature—Average daily maximum, Average daily minimum, Average daily, Average number of growing degree days. Precipitation—Average, Average number of days with 0.10 inch or more, Average snowfall.

Water Management (Table 10) 202
Features affecting—Pond reservoir areas, Embankments, dikes, and levees, Drainage, Irrigation, Terraces and diversions, Grassed waterways.

Wildlife Habitat Potentials (Table 12) 219
Potential for habitat elements—Grain and seed crops, Grasses and legumes, Wild herbaceous plants, Shrubs, Wetland plants, Shallow water areas. Potential as habitat for—Openland wildlife, Wetland wildlife, Rangeland wildlife.

Yields Per Acre of Crops and Pasture (Table 5) 158
Alfalfa hay. Sugar beets. Corn. Corn silage. Wheat. Grain sorghum.

Foreword

The Soil Survey of Logan County contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

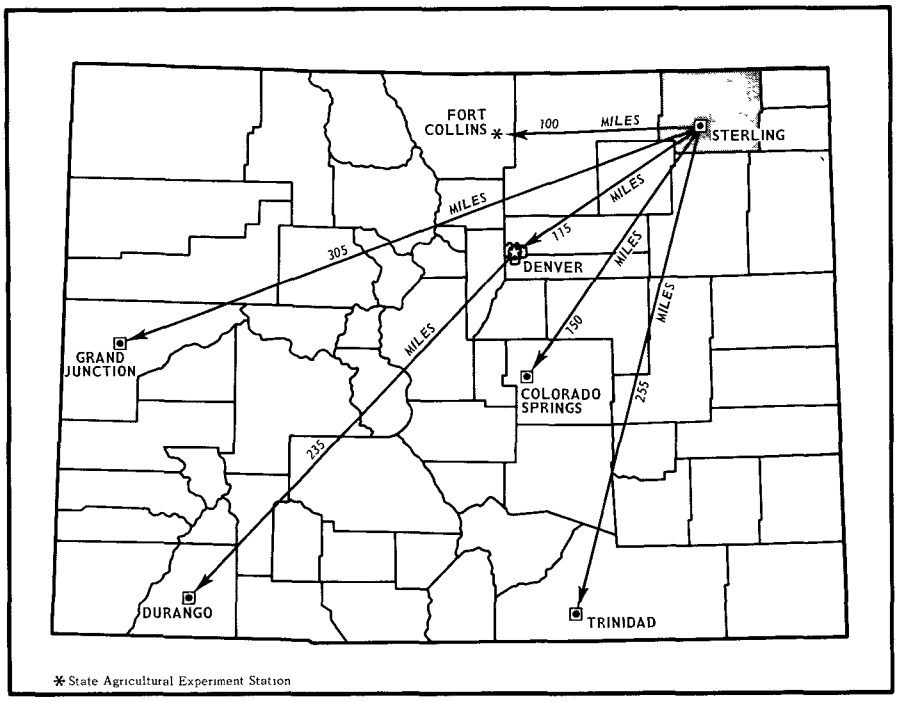
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Many people assume that soils are all more or less alike. They are unaware that great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

We believe that this soil survey can help bring us a better environment and a better life. Its widespread use can greatly assist us in the conservation, development, and productive use of our soil, water, and other resources.

State Conservationist
Soil Conservation Service



Location of Logan County in Colorado.

SOIL SURVEY OF LOGAN COUNTY, COLORADO

By Alan E. Amen, David L. Anderson, Terry J. Hughes, and Thomas J. Weber,
Soil Conservation Service

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

LOGAN COUNTY is located in the high plains of northeastern Colorado. (See facing page.) It is rectangular in outline, 48 miles long and 30 miles wide, with an area of 1,849 square miles, or 1,183,360 acres. It is bordered on the north by the State of Nebraska. Elevations range from 3,600 feet to approximately 4,100 feet. The South Platte River crosses the county in a northeasterly direction. Major tributaries are Pawnee Creek, Lewis Creek, and Cedar Creek entering the river from the north.

The population of the county is approximately 21,500. Sterling is the county seat and principal city with a population of about 13,500.

The county is a diversified agricultural area with irrigated and nonirrigated cropland and rangeland. Livestock raising, cattlefeeding, meatpacking, and sugar beet processing are all important to the economy.

General Nature of the County

This section gives general information concerning the county. It discusses history of settlement, physiography, drainage and relief, climate, natural resources, water supply, agriculture and industry.

History of Settlement

On February 28, 1887, Logan County was created from the northeast corner of Old Weld County. It was named in honor of General John A. Logan. Phillips and Sedgwick Counties were later created from part of the original Logan County in 1889. Although the first years of agricultural pioneering in northeastern Colorado were difficult ones, progress was quickly made with the advent of irrigation.

In 1872 Holom Godfrey built the earliest known irrigation canal in Logan County. Several other ditches were constructed from 1875 to 1886. In 1899, sugar beets were introduced in Logan County and became the first large-scale irrigated crop. In 1905 a factory built by the Great Western Sugar Company was established in Sterling, and this industry soon became the mainstay of the area's agricultural economy.

The sugar industry also served as a powerful catalyst in drawing large numbers of laborers from other states as well as foreign countries. Emigrants from Italy, Japan, and Mexico, along with a relatively large number of German colonists from the Lower Volga region in Russia, found ample work in the beet fields and later played a prominent role in beet production.

Other irrigated crops that eventually proved successful were corn, alfalfa, beans, barley, and oats. Although irrigation was an important asset to the economic health of Logan County, it also added to the area's agricultural diversification. Such dryland crops as wheat, milo, millet, corn, and grasses became increasingly significant. In fact, dryland wheat comprises the county's largest planted acreage today. Grazing lands and high hay production also helped bolster a burgeoning livestock industry. Although Logan County experienced an oil boom in the late 1940's and early 1950's, it continues to rely on agriculturally related industries.

Sterling, the principal city and county seat, was incorporated in 1884; Fleming, Merino, and Peetz in 1917; Crook in 1918; and Iliff in 1926. Other communities are Atwood, Dailey, Padroni, Proctor, and Willard.

Physiography, Drainage and Relief

Logan County is located near the center of the Great Plains area. Several distinct physiographic areas occur within the county. An understanding of these is important in understanding the soils and agriculture of each area. In general, the greater part of the county is a dissected plain which, in more recent geologic history, has been mantled with thin silty loess deposits, thick eolian sandy deposits, and locally reworked old alluvial materials.

Elevations within the county vary from approximately 3,600 feet above sea level, along the South Platte Terrace, to 4,100 feet on the "Peetz Table" at the extreme north side of the area. The elevation at Sterling, located on the South Platte River Terrace, is 3,939 feet.

The South Platte River flows diagonally through the county in a southwest to northeast direction. It drains the area to the north and west through many intermittent tributaries; the most important are Pawnee Creek, Lewis Creek and Cedar Creek. Areas south and east of the South Platte River drain mainly to the east into the upper Frenchman tributary of the North Republican River. In the northwest and northeast parts of the county, natural drainageways are well defined, particularly by the creeks that are entrenched into the underlying shale formations and gravelly alluvium. The sandhill area paralleling the South Platte River on the south side has poorly defined drainageways.

The valley of the South Platte River varies in width from 1 mile to 4 miles. Adjacent to the river are the nearly level bottomlands and low terraces with fluctuating water tables at depths of 20 to 60 inches. The well drained higher terraces, mainly on the north side of the river, are some of the best irrigated soils in the area.

The larger tributaries, Pawnee, Lewis and Cedar Creeks, have narrow valleys of loamy alluvial deposits and enter the river from the north. Pawnee creek joins the river near the town of Atwood, Cedar Creek between Sterling and Iliff, and Lewis Creek between Iliff and Proctor.

The area along the north side of the valley floor from Sterling to the eastern county line is a nearly level to strongly sloping, high lying old terrace deposit of stratified alluvium mantled with loamy eolian materials. This area is divided by many small drainageways that flow toward the river in a southeasterly direction.

In the northern part of the county, the "Peetz Table," as it is known locally, represents a separate physiographic area in the form of a high, gently rolling plateau which slopes eastward. In the southeastern part of the county, the large "Kelley-Leroy Table" is a similar area with respect to geology and topography. These plateaus are underlain by calcareous sandstone and stratified sandy and gravelly old alluvium. Both areas are mantled by a thin loess deposit that has been reworked by water.

Bordering the Peetz Table on the southwest are the steep to nearly vertical "Chimney and Lewis Canyons," consisting of siltstone exposures capped by calcareous sandstone of the Ogallala Formation. Southeast of the "Peetz Table" is a strongly sloping and steep area of reddish colored gravelly alluvium occurring as ridges and resembling remnants of old high terraces. This is dissected by many intermittent drainageways flowing to the southeast.

In the northwest part of the county, mainly south of the Chimney and Lewis Canyon area, is a nearly level to moderately sloping area with deposits of materials derived from siltstone and interbedded sandstone and shale. Outcrops of shale and siltstone are common in this area, especially on ridges bordering intermittent drainageways.

North and west of Sterling is a nearly level to moderately sloping area that is mantled by a thin veneer of loess and eolian calcareous sandy materials.

Paralleling the south side of the South Platte River is an extensive, thick eolian sand deposit with dunelike topography. This deposit grades into the tableland area in the southeast part of the county.

Climate

The climate of Logan County is semiarid continental. Because the county is separated from major sources of moisture by large distances and mountain ranges, its climate is characterized by low humidity, wide variations in precipitation and temperature, and abundant sunshine.

Logan County is usually warm in summer with frequent hot days. The highest temperature occurs during July and August. In winter, periods of very cold weather are caused by Arctic air moving in from the north or northeast. Cold periods alternate with milder periods that occur often when westerly winds are warmed as they move downslope. Most precipitation falls as rain during the warmer part of the year and is normally heaviest in late spring and early summer. Winter snowfalls are frequent, but snow cover usually disappears during mild periods.

The mean annual precipitation in Logan County ranges from 13 inches in the western part to nearly 19 inches in the eastern part. Most of the precipitation occurs during the growing season, commonly as thunderstorms. Not all of this precipitation is effective for plant growth because of high runoff.

Table 1 gives data on temperature and precipitation for Logan County, as recorded at Sterling for the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 27.5 degrees F, and the average daily minimum is 13.7 degrees. The lowest temperature on record, -29 degrees, occurred at Sterling on February 1, 1951. In summer the average temperature is 71 degrees, and the average daily maximum is 86.3 degrees.

Growing degree days, shown in table 3, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature. The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 12.27 inches, or 81 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the April-September rainfall is less than 10 inches. The heaviest 1-day rainfall during the period of record was 4.88 inches on August 15, 1968. Thunderstorms occur on about 45 days each year, and most occur in June and July.

Average seasonal snowfall is 29.9 inches. The greatest snow depth at any one time during the period of record was 20 inches. On the average, 12 days have at least 1

inch of snow on the ground, but the number of days varies greatly from year to year.

The average relative humidity in midafternoon in spring is less than 45 percent; during the rest of the year it is about 55 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The prevailing direction of the wind is from the northwest. Average windspeed is 10 miles per hour. The highest, 13 miles per hour, is in April.

Some years, blizzards with high winds and drifting snow occur in the county, and snow remains on the ground for a few weeks. High winds cause soil blowing in dry periods on both dry and irrigated farms, causing dust storms. Tornadoes occur occasionally in the county. Summer hailstorms are common and can cause severe local damage to crops in the county.

Drought is always a risk in nonirrigated cropland areas. Most nonirrigated crops are grown in a sequence with summer fallow. This sequence tends to reduce the hazard of crop failure. The growing season is long enough for all crops commonly grown in the county to mature, whether nonirrigated or irrigated. Occasionally, early frost will damage corn that has been planted late. Favorable yields are generally produced by those farmers who conserve moisture, use good irrigation practices, and use other good crop and soil management practices.

Natural Resources

Soil, surface and underground water, oil, natural gas, sand and gravel, and native vegetation are the major natural resources of Logan County. Soil, the most widely used of the county's resources, can be expected to yield benefits without depletion if managed and used properly. The purpose of this survey is to aid in maintaining and improving the value of the soil resource.

The South Platte River is the principal source of surface water. The number of irrigation wells have increased greatly in the past 10 years. With careful management and efficient use of water, the water resources of the county can be conserved.

Oil and natural gas production expanded in the late 1940's to about 1955, but has been reduced during the past years.

An abundance of sand and gravel is available for building roads and other structures. The sources of these materials are the sandy and gravelly alluvial lands and the exposed sandy and gravelly old alluvium underlying plateaus of the area.

The native vegetation has been plowed out to make way for nonirrigated and irrigated cropland in about half of the county. The remainder is being grazed by livestock. The grass resource can be maintained by careful grazing management. Maintaining the native vegetation can also be helpful in maintaining the soil resource by minimizing soil loss through erosion.

Water Supply

The South Platte River is the principal source of surface water in Logan County. Other streams contributing are Lewis Creek, Pawnee Creek and Cedar Creek. The water source of the South Platte River is snowmelt and runoff waters from the foothills and mountains and ground water discharge. The creek water sources are snowmelt and runoff water from the adjacent dissected terraces and ground water discharge. Streamflows are not constant. During the late spring and summer months streamflows are low.

The North Sterling (fig. 1), Prewitt and Jumbo Reservoirs were formed by damming basinlike valleys. These three lakes provide about 7,680 acres of open water. Water for these reservoirs is drawn from the South Platte River during peak flow periods of the winter months. Water from North Sterling and Prewitt Reservoirs is used for irrigation in Logan County. Jumbo Reservoir water is used for irrigation in Sedgwick County.

The ground water recharge in Logan County is chiefly from precipitation, but there are additions from the irrigation water delivery system in the Platte River Valley. The amount and frequency of the recharge vary considerably from place to place and year to year, depending on precipitation and the amount and distribution of the water diverted for irrigation.

Springs commonly occur along the contact of the relatively impermeable Brule Formation and the overlying more permeable gravel of the Ogallala Formation. Water derived from springs is used primarily for livestock.

Irrigation water in Logan County comes from three main sources: (1) surface water diverted from the South Platte River, (2) ground water pumped from wells, and (3) water stored in the North Sterling and Prewitt Reservoirs. Many farms with irrigation wells also obtain water from surface ditches. During years when surface water is limited, water from wells is used advantageously. A delay of a day or two in irrigating crops that are in crucial need of moisture may be the difference between success and failure.

Most of the wells in the county were drilled into the sand and gravel formation of Pleistocene geologic age. This formation underlies the bottomlands and low terraces along the South Platte River. A few wells were drilled into fissures of the Brule Siltstone Formation. Other wells in this upland area were located in the gravel members of the Ogallala Formation.

Irrigation wells along the South Platte Terrace system range from 30 to 100 feet in depth. Wells located on the uplands outside the valley range from 200 to 300 feet deep.

Agriculture

The first settlers in Logan County were mainly cattle and sheep ranchers. Dryland farming began on a small scale when land was opened to homesteading.

The drought and depression of the 1890's caused a large number of the homesteaders to leave. Those who stayed discovered that they could raise forage crops to supplement the range, providing a basis for small farms and ranches.

The raising and selling of livestock continued to be the main enterprise until irrigation was introduced and expanded. In the late 1870's the first irrigation canals were constructed, diverting water from the South Platte River to the bottomland and terrace soils nearby. Sugar beets was the first irrigated crop grown in the county. Sugar beets and cattle were, for many years, the mainstay of the economy. Later, corn, alfalfa and wheat became important crops.

Agriculture today is diversified, consisting of irrigated cropland, dryland cropland, and livestock raising and feeding, resulting in a stable economy for the county. About 48 percent of the acreage of Logan County is used for cropland and 51 percent is used for rangeland. Of this acreage, about 137,620 acres is used for irrigated cropland and pasture with 9,400 acres under sprinkler irrigation. About 433,500 acres is used for nonirrigated cropland. About 598,160 acres is in rangeland and used for grazing.

The main crops in nonirrigated areas are corn for grain or silage, alfalfa, and sugar beets. Other crops grown are grain sorghum, beans, wheat and barley. Most of the corn and alfalfa is used locally in cattlefeeding. Large acreages of corn in recent years have been cut for silage and used for feeding farm livestock or sold to commercial feedlots.

The acreage of irrigated crops is limited in the area by availability of irrigation water. Sprinkler irrigation, mainly the pivotal type system, is used in areas of sandy soils where underground water is available.

Wheat is the main crop grown in irrigated croplands in an alternate crop-fallow system. Millet, grain sorghums, and corn are also grown, mainly for supplemental winter feed for livestock. Wheat is expected to continue as one of the main crops in the county. The critical problem on nonirrigated cropland in the county, especially in the western part, is the supply of moisture.

Livestock enterprises are an important part of the county's agriculture. Approximately half of the county is native rangeland providing late spring and summer grazing for cattle. The steer calves are fed in local commecial feedlots, and the cows are pastured and then fed in farmstead feedlots during the winter. Commercial cattlefeeding has expanded during recent years. Most local feed grown is used by the commercial feedlots and farmers.

The trend in Logan County, as in most northeast Colorado counties, has been toward fewer and larger farms in both irrigated and nonirrigated areas because of the increase of mechanization. More farms are diversified to include livestock raising and feeding in addition to irrigated and nonirrigated farming.

Interest in conservation of soil and water began in the 1940's. Meetings were held and soil conservation practices demonstrated on farms. The first conservation district, organized in 1944, was the Peetz Soil Conservation District. Later, two additional districts were formed in the county, the Padroni Soil Conservation District and the South Platte Soil Conservation District. In 1975, the Peetz and Padroni Soil Conservation Districts were combined to form the Centennial Soil Conservation District.

Sterling is the agricultural center of northeastern Colorado. Logan County is one of the most important agricultural areas on the eastern plains.

Industry

Much of the industry of Logan County is related to agriculture. The Great Western sugar processing plant, in Sterling, processes mainly locally grown sugar beets. Cattle from four large commercial feedlots, small ranches, and farm feedlots of the county are processed in the meatpacking plant in Sterling. The county also has two alfalfa dehydrating plants. Several oil companies are involved in the extraction and transport of oil and natural gas. There are no oil refineries in the county. Fertilizer companies, trucking firms, farm equipment agencies, and feed mills fill out the bulk of the county's industrial base.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

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

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

The areas shown on a soil map are called soil mapping units. Some mapping units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Mapping units are discussed in the section "Soil Maps for Detailed Planning."

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

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

General Soil Map for Broad Land Use Planning

The general soil map at the back of this publication shows, in color, the soil units for broad land use planning described in this survey. Each soil unit is a unique natural landscape that has a distinct pattern of soils and of relief and drainage features. A unit typically consists of one or more soils of major extent and some soils of minor extent. It is named for the major soils. The kinds of soil in one unit can occur in other soil units, but in a different pattern.

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

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

The soil units in the survey area vary widely in their potential for major land uses. Adverse soil properties that pose limitations to the use are indicated. The ratings of soil potential are based on the assumption that practices in common use in the county are used to overcome soil limitations. These ratings reflect the ease of overcoming such soil limitations and the probability of soil problems persisting after such practices are used. The location of existing transportation systems or other kinds of facilities is not considered.

Major land uses considered are for cultivated cropland, both irrigated and nonirrigated, and grazing. Some minor land uses considered are windbreak plantings, urban uses and wildlife. Cultivated farm crops include those grown extensively by farmers in the survey area. Grazing refers to use of rangeland for livestock. Windbreak plantings include tree and shrub species best adapted in the survey area. Urban uses include residential, commercial, and industrial developments. Wildlife includes rangeland, openland, and wetland wildlife habitat.

Soils Forming in Unconsolidated Alluvium on Stream Terraces, Flood plains and Bottomlands

1. Alda-Loveland-Fluvaquents

Deep, nearly level, somewhat poorly drained and poorly drained soils forming mostly in loamy alluvium underlain by sand and gravel; on bottomlands and low terraces

These nearly level soils are on bottomlands and low terraces of the South Platte River, commonly adjacent to the river channel. These soils are affected by a fluctuating water table, and are subject to frequent or occasional flooding during spring and early summer.

The unit covers about 4 percent of the county, a total of approximately 47,360 acres. About 50 percent of the unit is Alda soils, 20 percent Loveland soils, 20 percent Fluvaquents, and the remaining 10 percent is soils of minor extent.

Alda and Loveland soils are on low terraces and are deep and somewhat poorly drained. Both soils are loamy and are underlain by sand and gravel at depths of 20 to 40 inches. Fluvaquents are on bottomlands and are poorly drained soils underlain by sand and gravel at depths of less than 20 inches. They are stratified and variable in texture and are most commonly vegetated with cottonwood trees and willows.

The minor soils are the somewhat poorly drained Hayford and Els soils and the poorly drained Fluvaquentic Haplaquolls. The Hayford and Els soils are on low terraces. The Fluvaquentic Haplaquolls are on bottomlands bordering the Fluvaquents.

This unit is used for irrigated cropland, grazing and wildlife habitat. Alfalfa, sugar beets, and corn are the main crops grown on areas of the Alda and Loveland soils. Wetness and flooding are the main limitations for use as cropland and for most other purposes. Areas of Fluvaquents are used for grazing because they are too wet for cropland. On irrigated soils the maintenance of fertility and the proper use of irrigation water are the principal concerns of management.

This unit, when adequately managed, produces good yields of crops. Yields on grazed areas are also good. The

potential for urban uses is poor because of wetness and flooding. The potential for development of wetland and openland wildlife habitat is fair. This is an important area for wildlife because of its association with the South Platte River.

2. Nunn-Satanta-Haverson

Deep, nearly level, well drained and moderately well drained soils forming in loamy alluvium on terraces and flood plains

These nearly level soils are on terraces of the South Platte River and flood plains of Pawnee, Lewis and other intermittent tributary streams. This unit is the most important irrigated cropland area in the county.

This unit occupies about 4 percent of the county, a total of approximately 45,440 acres. About 40 percent of the unit is Nunn soils, 30 percent Satanta soils, 20 percent Haverson soils, and the remaining 10 percent is soils of minor extent.

Nunn clay loam, water table, is a deep, moderately well drained soil with a clay loam surface layer and subsoil. Satanta loam and Haverson loam are deep, well drained loamy soils.

The minor soils are the well drained Manter sandy loam and the well drained Lebsack silty clay loam.

Most of this unit is used for irrigated cropland. Small areas are used for grazing. Alfalfa, sugar beets, corn, and small grains are the principal crops grown. Yields are generally higher on this unit than on other irrigated areas in the county. Much of the unit has been leveled so that irrigation water is more uniformly applied. Main management concerns are proper use of irrigation water and maintenance of fertility.

This unit has a fair to good potential for urban uses. Nunn clay loam, water table, has shrink-swell limitations and slow permeability. The water table is below 40 inches. The potential for the development of openland wildlife is good.

3. Mosher-Lebsack

Deep, nearly level, somewhat poorly drained, saline and alkali affected soils forming in clayey alluvium on bottomlands and terraces

These nearly level soils are on bottomlands and terraces on the north side of the South Platte River from Proctor eastward to the Sedgwick County line.

This unit occupies about 1 percent of the county, a total of about 11,840 acres. About 60 percent of the unit is Mosher soils, 30 percent Lebsack saline soils, and the remaining 10 percent is soils of minor extent.

Mosher soils are deep, somewhat poorly drained soils with strongly alkaline clay loam subsoils. The Lebsack saline soils are deep, somewhat poorly drained soils with heavy clay loam subsoils and are moderately to strongly saline. All have clay loam surface layers.

The minor soils are the Nunn clay loam saline and the Mosher clay soils on similar positions. The Nunn clay loam soil in nearly all of this area is used for grazing. A few small areas are cultivated, mainly to square up field boundaries. Crop yields are low. The vegetation on this unit consists mainly of alkali sacaton and inland saltgrass.

This unit is used mainly for grazing. Some small scattered areas are used for irrigated cropland with alfalfa and small grains as the main crops. Crop yields and choice of crops are severely limited by the saline-alkali condition. This is an important livestock grazing area providing grazing throughout the year.

The strongly saline-alkali condition is the main limitation to the use of these soils. Correcting this condition is difficult because the soils are slowly permeable and lack drainage outlets. The potential for cropland is poor. The potential for homesites and urban development is poor because of the saline and alkali condition. This is an important area for wildlife because of its association with the South Platte River and cropland.

Sand to Fine Sandy Loam Soils Forming on Unconsolidated Materials on the Uplands

4. Valent

Deep, undulating to hilly, excessively drained soils forming in noncalcareous eolian sandy materials on uplands

These soils are located on the undulating to hilly sandhill areas paralleling the South Platte River on the south. The succession of ridges and hills commonly extend in a northwesterly direction. Drainage patterns are poorly defined.

This unit occupies about 11 percent of the county, a total of approximately 134,400 acres. About 90 percent is Valent soils, and the remaining 10 percent is soils of minor extent.

Valent soils are deep, excessively drained soils on upland hills. These soils formed in eolian, noncalcareous sandy material and have thin loamy sand surface layers.

The minor soils are the deep, somewhat excessively drained Dailey soils. They occupy the more gently sloping and nearly level, narrow interdunal valleys which occur throughout the sandhills.

This unit is used almost entirely for grazing (fig. 2). It is one of the most important livestock grazing areas in the county. A few old cultivated fields have been seeded to grass and are used for grazing. Soil blowing is a hazard in this area. If the grass cover is reduced, soils are subject to severe soil blowing. Management of grazing is important in maintaining a cover of native plants.

The potential for nonirrigated and irrigated croplands is poor, mainly because of the steep slopes, low available water capacity, the severe soil blowing hazard, and low inherent fertility. The unit is well suited to grazing. The potential for urban uses is good. Slope and the soil blowing hazard are the primary limitations. The potential for development of rangeland wildlife habitat is fair.

5. Dailey-Julesburg

Deep, nearly level to moderately sloping, somewhat excessively drained and well drained soils forming in noncalcareous eolian sandy materials on uplands

These soils are located on the nearly level to moderately sloping sandy lands that lie between the South Platte River bottomlands and the sandhills on the south side of the river. They extend from below Iliff northeastward to the Sedgwick County line.

This unit occupies about 2 percent of the county, a total of approximately 23,360 acres. About 50 percent is Dailey soils, 35 percent is Julesburg soils, and 15 percent is soils of minor extent.

Dailey soils are deep, excessively drained soils on ridges. Julesburg soils are deep, well drained soils on ridges and flats. All formed in eolian, noncalcareous sandy material. The surface layer is loamy sand.

The minor soils in this area are the deep, well drained Haxtun soils, occupying nearly level and gently sloping interdunal valleys, and the deep, excessively drained Valent soils occurring on hills.

This unit is used mainly for grazing and cropland under sprinkler irrigation. Corn, sugar beets and alfalfa are the main crops. Some potatoes and beans are also grown.

The potential for nonirrigated cropland is poor, mainly because of the droughty soils, low inherent fertility and the severe soil blowing hazard. The unit is well suited to grazing and irrigated cropland. The potential for urban uses is good. The soil blowing hazard is the primary limitation. The potential for development of rangeland and openland habitat is fair to good.

6. Haxtun-Julesburg

Deep, nearly level to moderately sloping, well drained soils forming in noncalcareous eolian sandy loam materials on uplands

Areas of these soils are located on the nearly level to moderately sloping sandy uplands that lie between the sandhills and the hardland area in the southeastern part of the county.

This unit occupies about 6 percent of the county, a total of approximately 73,920 acres. About 50 percent is Haxtun soils, 35 percent is Julesburg soils, and the remaining 15 percent is soils of minor extent.

Both Haxtun and Julesburg soils are deep and well drained. Haxtun soils are located on interdunal flats and formed in eolian sandy material deposited over a buried hardland soil. Julesburg soils are located on ridges and formed in eolian, noncalcareous sandy material. These soils have loamy sand and sandy loam surface layers.

The minor soils in this unit are the Valent, Dailey, Bayard and Canyon soils. The Valent, Dailey and Bayard soils are deep and excessively drained to well drained. They occupy moderately sloping ridges. The Canyon soils are shallow, well drained soils overlying calcareous sandstone and are on ridge crests.

This unit is used mainly for nonirrigated cropland and grazing. Some small areas are used for sprinkler irrigated cropland. Wheat and millet are the main nonirrigated crops. Corn, sugar beets and alfalfa are the main irrigated crops. Soil blowing is the primary concern of cropland management. Practices that conserve soil moisture and control soil blowing are essential in cropland areas. These soils are located in a 13 to 15 inch rainfall zone.

The potential for sprinkler irrigated cropland is good where groundwater is available. The potential for urban uses is good. The potential for rangeland wildlife development is fair. In irrigated areas the potential for openland wildlife habitat is fair to good.

7. Manter-Ascalon-Vona

Deep, nearly level to moderately sloping, well drained soils forming in calcareous, eolian and alluvial sandy and sandy loam materials on uplands

These nearly level to moderately sloping soils occur generally west of Sterling, Atwood and Merino in the southwestern part of the county. The area consists of elongated convex ridges that lie in a northwesterly direction.

This unit occupies about 4.5 percent of the county, a total of about 51,520 acres. About 40 percent of the unit is Manter soils, 30 percent Ascalon soils, 15 percent Vona soils, and the remaining 15 percent soils of minor extent.

Manter soils are deep, well drained soils formed on upland flats and ridges. Ascalon soils are deep, well drained soils formed in upland valleys and on ridges and side slopes. Both formed in calcareous loamy eolian and alluvial materials. Vona soils formed on upland ridges and hills in calcareous eolian sandy materials. These soils have loamy sand and sandy loam surface layers.

The minor soils are the well drained Haxtun sandy loam occurring on nearly level flats and the excessively drained Valent loamy sand occurring on moderately sloping hills.

This unit is used mainly for nonirrigated cropland and grazing. Some small areas are used for sprinkler irrigated cropland. Wheat and millet are the main nonirrigated crops. Corn, sugar beets, and alfalfa are the main irrigated crops. Soil blowing is the primary concern of cropland management. Practices that conserve soil moisture and control soil blowing are essential in cropland areas.

This unit has a good potential for sprinkler irrigation development where underground water is available. Nonirrigated cropland that has been severely eroded is best seeded to grass and used for grazing. Grazing management practices increase the potential for production on rangeland. The potential for urban uses on these soils is good. Soil blowing is the primary limitation. In irrigated sections, the potential for openland wildlife habitat is good. In nonirrigated sections the potential for both rangeland and openland wildlife habitat is fair.

Sandy Loam to Clay Loam Soils Forming on Unconsolidated Materials on the Uplands

8. Platner-Rago-Rosebud

Deep and moderately deep, nearly level to moderately sloping, well drained soils forming in loamy alluvial and eolian materials on uplands

These nearly level to gently sloping soils are on upland tablelands located in the southeastern and north central part of Logan County. Slopes along intermittent drainageways are steeper than the dominant 0 to 3 percent slopes occurring in the area.

This unit occupies about 23.5 percent of the county, a total of approximately 278,090 acres. About 40 percent of the unit is Platner soils, 30 percent Rago soils, 20 percent Rosebud soils, and the remaining 10 percent soils of minor extent.

Platner soils are deep and well drained. They occupy flats and convex ridges and formed in mixed calcareous alluvial and eolian deposits. Rago soils are deep, well drained soils occupying low lying flats and depressions on uplands. They formed in calcareous loamy alluvial and eolian deposits of two ages. Rosebud soils are moderately deep, well drained soils occupying convex ridges and sideslopes. They formed in calcareous loamy alluvial and eolian materials over calcareous sandstone at depths of 20 to 40 inches.

This is the most extensive unit in the county. It is also the most important, most productive nonirrigated cropland area. The unit is used mainly for nonirrigated cropland with wheat, millet and grain sorghum as the principal crops. A few isolated areas are used for irrigated cropland where underground water is available. Some small scattered areas are used for grazing. Soil blowing and water erosion are hazards in the area. Practices that conserve moisture, control runoff, and protect the soil from blowing should be implemented. Stubble mulch tillage and incorporating crop residues are effective in conserving moisture and controlling soil blowing. On sloping areas, terraces are effective in controlling runoff and water erosion.

Where irrigation water is available, the potential for irrigated cropland is good. The potential for urban uses is fair. The high shrink-swell and slow permeability characteristic of the Platner and Rago subsoils are limitations. Depth to bedrock should also be considered in the Rosebud soils. In irrigated lands the potential for openland wildlife habitat is good. In nonirrigated lands the potential for openland and rangeland wildlife habitat is fair.

9. Weld-Platner-Ascalon

Deep, nearly level to moderately sloping, well drained soils forming in loamy alluvial and eolian materials on uplands

These nearly level to moderately sloping soils are distributed throughout the western and southwestern part of the county. The unit occurs on upland tablelands and ridges and in valleys.

This unit occupies about 9.5 percent of the county, a total of approximately 113,760 acres. About 30 percent of the unit is Weld soils, 30 percent Platner soils, 20 percent Ascalon soils, and the remaining 20 percent soils of minor extent.

The major soils are deep and well drained. Weld soils occur on upland tablelands. They formed in calcareous, loamy eolian deposits. Platner soils occur on upland tablelands and hills. They formed in calcareous alluvial and eolian deposits. Ascalon soils occur on upland ridges and flats and in valleys. They formed in calcareous loamy eolian and alluvial deposits. Weld and Platner soils have loam surface layers. Ascalon soils have sandy loam surface layers.

Minor soils are the Manter, Cushman and Rago soils. Manter soils occupy moderately sloping ridges. Cushman soils are moderately deep, occurring on ridges underlain by shale at 20 to 40 inches. The deep Rago soils are in depressions and along drainageways. All are well drained.

This unit is used mainly for nonirrigated cropland and grazing. Some small areas are used for irrigated cropland. Wheat and millet are grown in nonirrigated areas. Alfalfa, corn and sugar beets are the main irrigated crops. Soil blowing and water erosion are the main management concerns.

The scarcity of water limits the potential for irrigated cropland. The unit has a good potential for urban uses, although the Weld soils may be limited by high shrink-swell and slowly permeable subsoils. The potential for the development of openland and rangeland wildlife habitat in nonirrigated and irrigated sections is poor to good.

10. Norka-Ulysses-Colby

Deep, gently sloping to strongly sloping, well drained soils forming in calcareous loamy eolian materials on uplands

These gently sloping to strongly sloping soils are located in the southern part of the county. The high rounded elongated ridges extending in a northwest direction are divided by narrow elongated drainageways.

This unit occupies about 2 percent of the county, a total of approximately 23,360 acres. About 40 percent of the unit is Norka soils, 30 percent Ulysses soils, 20 percent Colby soils, and the remaining 10 percent soils of minor extent.

The major Norka, Ulysses and Colby soils are deep, well drained soils with loam surface layers. They formed in calcareous loamy eolian deposits. Norka and Ulysses soils are on mid slopes and foot slopes of ridges. Colby soils occur on ridge crests. They are usually eroded.

The minor soils are the Kuma and Albinas soils in the nearly level drainageways and Keith soils on the nearly level to gently sloping upland flats. These soils are deep, well drained loamy soils.

This unit is used for nonirrigated cropland and grazing. The principal nonirrigated crops are wheat and millet. The major problems in the area are soil blowing and water erosion. Where the calcareous silty parent material is exposed, soil blowing is more severe.

The potential for irrigated cropland is limited by slope and lack of underground water. With intensive management, these soils will yield favorably under nonirrigated cropping. The potential for urban uses and roads is good. The major limitation is soil blowing. The potential is fair for openland wildlife habitat and poor for rangeland wildlife habitat.

11. Wages-Satanta-Norka

Deep, nearly level to strongly sloping, well drained soils forming in calcareous, loamy alluvial and eolian materials on upland flats, in valleys, and on ridges

These soils are located in the uplands that lie north of the South Platte River terrace. The unit is characterized by high-lying upland flats that are dissected by drainageways oriented in a southeastern direction.

This unit occupies about 6.5 percent of the county, a total of approximately 79,360 acres. About 35 percent of the unit is Wages soils, 20 percent Satanta soils, 15 percent Norka soils, and the remaining 20 percent soils of minor extent.

The major soils of this unit are deep, well drained loamy soils formed in calcareous loamy eolian and alluvial materials. Wages soils are on nearly level flats and gently to moderately sloping hills. Satanta soils are in nearly level upland valleys and on flood plains. Norka soils are on nearly level upland flats.

The minor soils are the Altvan, Chappell, Manter, Dix, and Bridgeport soils. These soils are deep and well drained. Altvan soils are on hills and ridges and are underlain by sand and gravel at 20 to 40 inches. The Chappell and Bridgeport soils are on flood plains and alluvial fans. Manter soils are on nearly level flood plains and gently sloping ridges. Dix soils are on ridge crests and knobs and are underlain by sand and gravel at less than 20 inches.

This unit is used for irrigated and nonirrigated cropland and grazing. The more level areas that lie below the North Sterling Canal are used for irrigated cropland. Areas which cannot be reached by irrigation water are used primarily for nonirrigated cropland. Wheat is the main crop in nonirrigated areas. Corn, alfalfa, sugar beets and small grains are the main crops in the irrigated areas. Strongly sloping areas and low lying seeped areas are used for grazing. The main limitations and problems of this area are soil erosion on sloping lands, uniform application and efficient use of irrigation water, seepage from irrigation canals and laterals, and drainage.

This unit is an important irrigated cropland area, but lacks an adequate supply of underground water. It is a diversified agricultural area and is important for cropland as well as cattle raising and feeding. The potential for urban uses is good in most places with the exception of seeped areas. The potential for openland and rangeland wildlife is good in irrigated areas and poor to good in nonirrigated.

Deep, Moderately Deep and Shallow Soils Underlain by Consolidated Sediments on the Uplands

12. Rosebud-Escabosa-Canyon

Moderately deep and shallow, gently sloping to moderately steep, well drained loamy soils underlain by calcareous sandstone; on uplands

These gently sloping to moderately steep soils are in the northwest corner of the county. They are underlain by calcareous sandstone of the Ogallala Formation and are divided by narrow elongated drainageways.

This unit occupies about 2 percent of the county, a total of approximately 20,800 acres. About 50 percent of the unit is Rosebud soils, 25 percent Escabosa soils, 15 percent Canyon soils, and the remaining 10 percent soils of minor extent.

Rosebud soils are moderately deep, well drained loamy soils in footslope and midslope positions on ridges and hills. Escabosa soils are moderately deep, well drained loamy soils on crests and ridgetops. Canyon soils are shallow, well drained loamy soils on upland ridges and knobs. All formed in calcareous loamy alluvial and eolian materials underlain by calcareous sandstone.

The minor soils are the Albinas, Wages and Mitchell soils. All are deep, well drained loamy soils. Albinas soils are along narrow elongated drainageways. Wages and Mitchell soils are on gentle and moderate slopes.

This unit is used for grazing and nonirrigated cropland. The main crops are wheat and millet. Cropland areas are commonly irregular in shape and divided by very steep canyons. The soils are subject to a high soil blowing hazard. Conserving moisture, controlling runoff and protecting the soil from soil blowing and water erosion are the major concerns of management.

The potential for cropland development is limited by shallow soils and steep slopes. The potential for urban uses is fair. It is limited by depth to bedrock in some places. The potential for openland wildlife and rangeland wildlife habitat is fair.

13. Ustic Torriorthents-Badland

Shallow, steep, well drained loamy soils, underlain by siltstone and calcareous sandstone, and Badland; on uplands

This unit occurs as narrow bands of steep rocky land and siltstone outcrops divided by deep gullies and ravines (fig. 3) mostly in the northwestern part of the county.

This unit occupies about 2 percent of the county, a total of approximately 24,320 acres. About 50 percent of the unit is Ustic Torriorthents, 40 percent is Badland, and the remaining 10 percent is soils of minor extent.

The Ustic Torriorthents are steep, shallow, well drained soils forming in calcareous loamy alluvium derived from siltstone and calcareous sandstone. Badland consists of steep and very steep barren land dissected by many intermittent drainageways that have entrenched into the soft shale and siltstone.

The minor soils in this unit are small isolated areas of Keota and Mitchell soils, Argiustolls, and Rock outcrop.

This unit is used entirely for grazing and wildlife habitat. The potential for other uses is poor. The unit is barren or nearly barren and is too steep or inaccessible for livestock. In ravines and steep canyonlike areas, Rocky Mountain juniper is common. Wildlife, such as deer, antelope and bobcat, are common in this isolated rugged area.

Most of the unit is too steep or too rocky for cultivation. The soils are droughty and susceptible to soil blowing and water erosion. Water for livestock is also difficult to locate in this area. Some areas have potential for recreational activities, such as hiking and nature study.

14. Mitchell-Keota

Deep and moderately deep, nearly level to moderately sloping, well drained soils formed in loamy materials derived from siltstone; on uplands

These soils are located on the nearly level to moderately sloping upland flats, fans, ridges and hills in the northwestern part of the county.

This unit occupies about 7.5 percent of the county, a total of approximately 86,080 acres. About 60 percent of the unit is Mitchell soils, 25 percent Keota soils, and the remaining 15 percent soils of minor extent.

Mitchell soils are deep, well drained loamy soils on flats and fans. Keota soils are moderately deep, well drained loamy soils on ridges, underlain by bedrock at depths of 20 to 40 inches. All formed in materials derived from siltstone and are usually calcareous throughout.

The minor soils are the well drained Epping, Arvada and Norka soils. The Epping soils are shallow, are underlain by bedrock at 10 to 20 inches, and are on knobs and ridges. The Arvada soils are deep, alkali affected soils occurring in depressions. The Norka soils are deep, nearly level soils on flats and fans.

This unit is used almost entirely for grazing. Some scattered small areas of the deeper soils on smoother slopes are used for nonirrigated cropland. Wheat and millet are the principal crops.

The potential for nonirrigated cropland is fair because of the limited precipitation and high erosion hazard. The potential for irrigated cropland is poor mainly because of the lack of underground water. This unit is best suited to grazing. The potential for urban uses is good for Mitchell soils and fair for Keota soils. Depth to rock is the primary limitation. The potential for development of rangeland and openland wildlife habitat is fair.

15. Stoneham-Cushman-Shingle

Deep to shallow, gently sloping to strongly sloping, well drained soils formed in calcareous loamy materials underlain by shale; on uplands

These gently sloping to strongly sloping soils are located in the western part of the county. This unit is made up of ridges and hills and is divided by intermittent drainageways.

This unit occupies about 9.0 percent of the county, a total of approximately 104,870 acres. About 50 percent is Stoneham soils, 25 percent Cushman soils, 15 percent Shingle soils, and the remaining 10 percent soils of minor extent.

The major soils in this unit are the loamy, well drained Stoneham, Cushman and Shingle soils. Stoneham soils are deep soils forming in calcareous loamy alluvial and eolian materials on ridges and hills. Cushman soils are moderately deep soils underlain by shale at depths of 20 to 40 inches. They are on ridge crests. Shingle soils are shallow soils underlain by shale at depths of less than 20 inches. They are on strongly sloping ridge crests and knobs.

The minor soils are the deep, well drained Wages and Olney soils, and the moderately deep Renohill soils on ridges and hills. Also included are the deep, well drained Haverson soils on narrow flood plains of intermittent drainageways.

Most of this unit is used for grazing. Some scattered areas are used for nonirrigated cropland, with wheat and sorghum as the main crops. Soils of this unit are subject to soil blowing and water erosion. Concerns of management are conserving moisture and protecting soil from soil blowing and water erosion.

The potential for irrigation is limited by the lack of underground water. This unit has a fair potential for urban uses. It is limited mainly by depth to bedrock. The potential for development of openland and rangeland wildlife is fair.

Deep Soils Forming in Unconsolidated Gravelly Materials on Upland Ridges and Fans

16. Dix-Eckley-Chappell

Deep, gently sloping to moderately steep, well drained and somewhat excessively drained soils forming in gravelly alluvium; on upland ridges and alluvial fans

These soils are on the gently sloping to moderately steep gravelly ridges and fans located mostly in the northeastern part of the county. The unit is dissected by many intermittent drainageways.

This unit occupies about 5.5 percent of the county, a total of approximately 64,880 acres. About 40 percent of the unit is Dix soils, 30 percent Eckley soils, 20 percent Chappell soils, and the remaining 10 percent soils of minor extent.

Dix soils are deep, somewhat excessively drained soils on ridges and knobs. Eckley soils are deep, well drained soils in mid slope positions. All are underlain by sand and gravel at less than 20 inches. Chappell soils are deep, well drained soils on alluvial fans and foot slopes. They are underlain by sand and gravel at depths of 20 to 40 inches.

The minor soils in this unit are the deep, well drained Wages and Altvan soils. They occur as small areas on the smoother side slopes where deposits of loamy materials mantle the gravelly Ogallala Formation.

This unit is used mainly for grazing and wildlife. A few small areas of Chappell soils are used for nonirrigated cropland.

The potential for nonirrigated and irrigated cropland is poor mainly because of the slopes and high water erosion hazard. The unit is well suited to grazing. The potential for urban uses is good to fair. Slope is the primary limitation. The potential for development of rangeland wildlife habitat is fair.

Broad Land Use Considerations

Logan County is a diversified agricultural area used mainly for irrigated cropland, nonirrigated cropland and rangeland. The major change in land use is toward irrigation. Each year a considerable amount of land is developed for irrigation. During the past few years approximately 12,000 acres has been developed for pump irrigation, mainly sprinkler type. Small acreages are being developed for urban uses, mainly adjacent to and west of Sterling. Areas of severely eroded nonirrigated cropland, especially in areas of low precipitation, have been seeded to grass and are used for grazing. The soil map for general planning is helpful in planning the general outline of major land uses in the survey area.

The potential for additional development of irrigated cropland is predicted on the availability of underground water or surface water. The proposed Narrows Dam or similar structures on the South Platte River will provide water to meet this potential.

The Dailey-Julesburg unit has been developed into an important sprinkler irrigated area. The remaining range areas of this unit have a good potential for sprinkler irrigation. The potential for sprinkler irrigation in the adjoining Valent unit is limited by the scarcity of underground water, high soil blowing hazard and slope.

The Nunn-Satanta-Haverson unit is an extensive irrigated cropland area with nearly all areas used for crops. The potential for additional irrigated cropland in the Alda-Loveland-Fluvaquents unit is limited by wetness, flooding, and soils shallow over sand and gravel.

The Wages-Satanta-Norka unit is an important irrigated area, but the potential for additional irrigated cropland is limited by the scarcity of underground water. This unit will also require canal sealing, lined irrigation ditches and drainage systems to minimize the seepage problem.

Some small scattered areas are used for irrigated cropland in the Platner-Rago-Rosebud and Weld-Platner-Ascalon units. The potential for additional irrigated cropland is limited by the scarcity of underground water. Some small scattered tracts are used for sprinkler irrigation in the Haxtun-Julesburg unit. Additional acreages can be developed where underground water is located. The remaining upland units have a poor potential for irrigation development, mainly in that they lack available water.

Most areas suitable for nonirrigated cropland are being used for this purpose. The most extensive acreages are in the Haxtun-Julesburg, Platner-Rago-Rosebud, Weld-Platner-Ascalon, Norka-Ulysses-Colby, and Wages-Satanta-Norka units. The potential for additional nonirrigated cropland in the county is limited to scattered small tracts of deep, nearly level and gently sloping soils in those units. These small tracts are usually near farmsteads and are used for grazing.

On some nonirrigated cropland in the Manter-Ascalon-Vona, Norka-Ulysses-Colby, Rosebud-Escabosa-Canyon and Stoneham-Cushman-Shingle units strongly sloping soils that are moderately to severely eroded are best seeded to grass and used for grazing. Most units on the uplands have some deep, nearly level to gently sloping arable tracts, but too small and scattered to be used as nonirrigated cropland.

Soil units that are well suited to rangeland use are the Mosher-Lebsack, Valent, Dailey-Julesburg, Mitchell-Keota, Rosebud-Escabosa-Canyon, Dix-Eckley-Chappell, and Stoneham-Cushman-Shingle. These are very important in cattle raising and feeding in the county, providing large amounts of forage for grazing.

Scattered range areas are common in other units in the county, usually on the steeper and shallower soils. Eroded nonirrigated cropland is best seeded to grass and used for grazing.

Nearly all of the soils are well suited to grazing. The potential for continued productive grazing on rangeland can be maintained and improved by using range management practices.

Areas unfavorable for urban development are not extensive in the survey area. Large parts of the Alda-Loveland-Fluvaquents unit, however, are subject to flooding and water table conditions and are severely limited. The Ustic Torriorthents-Badland unit also is severely limited for homesites and road locations because of steep slopes and shallow soils. Other units, such as the Rosebud-Escabosa-Canyon, Mitchell-Keota, and Stoneham-Cushman-Shingle, contain soils that are limited by depth to bedrock. The Valent and Dix-Eckley-Chappell units have soils that are limited by excessive seepage.

Currently most urban development is in the vicinity south, west and north of the city of Sterling. Most soils in this area are favorable, requiring only a few compensating measures. The moderately well drained Nunn clay loam and some seeped soils lying below irrigation canals are wet and require special compensating measures.

The potential for wildlife habitat varies in the survey area. The Alda-Loveland-Fluvaquents, Nunn-Satanta-Haverson, and Mosher-Lebsack units and the seeped parts of Wages-Satanta-Norka unit have a good potential for wetland wildlife habitat. In general, irrigated cropland in all units has a good potential for openland wildlife habitat. Most nonirrigated cropland in the Haxtun-Julesburg, Platner-Rago-Rosebud, Wages-Satanta-Norka and Rosebud-Escabosa-Canyon units has a fair to good potential for openland wildlife.

Where moisture is more limiting as in the Manter-Ascalon-Vona, Weld-Platner-Ascalon, and Stoneham-Cushman-Shingle units, wildlife habitat potential is fair to poor. Rangeland wildlife habitat potential is fair in the Valent, Ustic Torriorthents-Badland, Mitchell-Keota, Stoneham-Cushman-Shingle, and Dix-Eckley-Chappell units. All provide large expansive grazing areas. The Ustic Torriorthents-Badland and Dix-Eckley-Chappell units provide natural cover for wildlife.

Wildlife habitat development should not be overlooked in any area. It is an important use of land, especially in small isolated areas that can be used profitably for wildlife habitat.

Most of the units of the county have a fair or good potential for windbreak plantings. Exceptions are the Ustic Torriorthents-Badland, Mitchell-Keota, and Stoneham-Cushman-Shingle units that have soils limited by depth to bedrock. The Valent and Dix-Eckley-Chappell units have a poor potential for plantings because the soils have a limited available water capacity. Soil units located in the western part of the county are more limited by precipitation. Plantings require supplemental water and intensive management. Windbreak plantings are generally successful in units located in the eastern and northern parts that receive more precipitation.

Soil Maps for Detailed Planning

The kinds of soil (mapping units) shown on the detailed soil maps at the back of this publication are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each soil is given in the section "Use and Management of the Soils."

Preceding the name of each mapping unit is the symbol that identifies the unit on the detailed soil map. Each mapping unit description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated and the management concerns and practices needed are discussed.

A soil mapping unit represents an area on the landscape and consists mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map at the back of this publication are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. All the soils in the United States having the same series name have essentially the same properties that affect their use and their response to management practices.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect the use of the soils. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Julesburg loamy sand, 0 to 3 percent slopes, is one of several phases within the Julesburg series.

Some mapping units are made up of two or more dominant kinds of soil. Only one such kind of mapping unit is shown on the soil map of this survey area, a soil complex.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Renohill-Shingle complex, 3 to 9 percent slopes, is an example.

Most mapping units include small, scattered areas of soils other than those that appear in the name of the mapping unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the mapping unit. The soils that are included in mapping are recognized in the description of each mapping unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Badland is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each mapping unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses are given for each kind of soil in other tables in this survey. (See "Summary of Tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil Descriptions

1—Albinas loam, 0 to 3 percent slopes. This is a deep, well drained soil of upland flood plains, alluvial fans and drainageways. It formed in calcareous, loamy alluvium deposited by intermittent streams. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Satanta loam and Rago loam. Also included are small areas of Albinas loam located in drainageway bottoms that are subject to damaging floods.

Typically the surface layer is grayish brown loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is grayish brown loam and light clay loam about 23 inches thick. The lower part is gray, calcareous loam about 3 inches thick. The substratum is light gray and light brownish gray calcareous loam and very fine sandy loam about 20 inches thick over yellowish brown gravelly coarse sand that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is subject to occasional shallow, broad overland flooding during spring and summer months.

This soil is used mainly for nonirrigated cropland. Wheat and grain sorghum are the main crops. Some areas are used for irrigated cropland where water is available. Alfalfa, corn and sugar beets are the principal crops grown in irrigated areas. The remaining acreage is used for grazing.

In nonirrigated cropland areas the primary objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling will break up tillage pans and improve water infiltration. Tillage should be kept to a minimum.

Management concerns in irrigated areas are irrigation water management and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is needed in some areas to obtain a more uniform application of water. Good irrigation water management including the proper length of run is needed for efficient use of water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increases water infiltration and improves soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use coupled with planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation and other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival. Species best suited are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, the inclusion of undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by water developments and fencing to permit unrestricted movement.

The primary limiting soil feature for homesites and other urban developments is a flooding hazard. Offsetting engineering designs and measures such as embankments and elevated building pads are needed to protect homesites and roads. Special sewage systems must be anticipated since septic tank absorption fields and sewage lagoons will not function properly during flooding. Capability subclass IIc nonirrigated, IIe irrigated.

2—Alda sandy loam. This is a deep, somewhat poorly drained soil on low terraces. It formed in calcareous, stratified, loamy alluvium overlying mottled sand and gravel deposited by the South Platte River. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level.

Included in this unit are small areas of Loveland loam. In leveled areas, exposures of the underlying sand and gravel are common.

Typically the surface layer is dark grayish brown sandy loam about 14 inches thick. The underlying layer is stratified light brownish gray and light gray, calcareous loam and fine sandy loam. It is mottled in the lower part and is about 11 inches thick over mottled coarse sand and gravel that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 20 to 40 inches during the winter and spring months.

This soil is used mainly as irrigated cropland. Small areas are used for grazing. Alfalfa, corn, sugar beets and small grains are the principal crops grown.

Efficient use of irrigation water and fertility maintenance are the main concerns of management in irrigated areas. Irrigation methods suitable are furrows or borders, depending on the crop. Land leveling and good irrigation water management are needed for uniform application and efficient use of water. Short irrigation runs and more frequent irrigations are needed on this soil because of the depth to the underlying sand and gravel and the sandy loam surface layer. Incorporating crop residues reduces soil blowing and improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility.

Rangeland vegetation consists mainly of sand bluestem, little bluestem, sand reedgrass, switchgrass, indiangrass, prairie cordgrass, western wheatgrass and sedge. Key forage grasses need to be maintained by proper grazing use and planned grazing systems that include deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock water developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The high water table and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control, and selection of water tolerant plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use for cropland and its position in relation to the bottomlands of the South Platte River. Its primary value for wildlife species lies in the food it produces, that wildlife utilize while using the riverbottom areas for cover. Wildlife utilizing this soil include mule and white-tailed deer, bobwhite, ducks, geese, and miscellaneous nongame species. Wildlife habitat can be provided and improved on this soil by tree and shrub plantings, planting grasses and legumes for undisturbed nesting cover, and providing wildlife travel lanes from riverbottom areas to cropland or feeding areas. Shallow water wetland areas can be developed with irrigation water.

Where areas are used for homesites and other urban development, the primary limiting soil feature is a water table at 20 to 40 inches. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table. If sewage lagoons are used they must have special designs to compensate for seepage. In homesite and urban development construction, compensating measures are needed to offset the high water table. Road designs are needed that will take into account the frost action of the soil. Capability subclass IIIw nonirrigated, IIIw irrigated.

3—**Alda loam.** This is a deep, somewhat poorly drained soil on low terraces and bottomlands. It formed in calcareous, stratified, loamy alluvium overlying mottled sand and gravel deposited by the South Platte River. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Loveland loam, Alda sandy loam and Westplain silty clay loam. The Westplain soil is in swale and low lying areas. In leveled areas exposures of the underlying sand and gravel are common.

Typically the surface layer is dark grayish brown loam about 10 inches thick. The underlying layer is stratified light brownish gray and light gray, calcareous loam and fine sandy loam. It is mottled in the lower part and is about 14 inches thick over mottled coarse sand and gravel that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 20 and 40 inches during the winter and spring months. This soil is subject to occasional flooding during late spring and early summer months.

This soil is used mainly as irrigated cropland. Small areas are used for grazing. Alfalfa, corn, sugar beets and small grains are the principal crops grown.

Efficient use of irrigation water and fertility maintenance are the main concerns of management in irrigated areas. Irrigation methods suitable are furrows or borders, depending on the crops. Land leveling and irrigation water management are needed for uniform application and efficient use of water. Short irrigation runs and frequent irrigations are needed on this soil because of the depth to underlying sand and gravel. Incorporating crop residues reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility.

Rangeland vegetation consists mainly of sand bluestem, little bluestem, sand reedgrass, switchgrass, indiangrass, prairie cordgrass, western wheatgrass and sedge. Key forage grasses need to be maintained by proper grazing use and planned grazing use that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock water developments are effective in obtaining uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The high water table and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control, and selection of water tolerant plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are Amer-

ican plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use for cropland and its position in relation to the bottomlands of the South Platte River. Its primary value for wildlife species is in the food it produces, that wildlife utilize while using the riverbottom areas for cover. Wildlife utilizing this soil include mule and white-tailed deer, bobwhite, ducks, geese, and miscellaneous nongame species. Wildlife habitat can be provided and improved by tree and shrub plantings, planting grasses and legumes for undisturbed nesting cover, and providing wildlife travel lanes from riverbottom areas to feeding areas. Shallow water wetland areas can be developed to attract waterfowl with irrigation.

Where the soil is used for homesites and other urban developments, the primary limiting soil features are a water table at depths of 20 to 40 inches and a flooding hazard. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table. In homesite and other urban development construction, compensating measures and designs are needed to overcome the water table and flooding hazard. Road designs are needed that will take into account the frost action of the soil. Capability subclass IIIw nonirrigated, IIIw irrigated.

4—**Altvan-Eckley sandy loams, 3 to 5 percent slopes.** These gently sloping soils are on upland ridges and side slopes in the northern part of the county. The average annual precipitation ranges from 15 to 19 inches. Altvan sandy loam, 3 to 5 percent slopes, makes up 50 percent of the unit and Eckley sandy loam, 3 to 5 percent slopes, about 30 percent. The Altvan soil is on foot slopes and at midslope. Eckley soils are on ridge crests and knobs.

About 20 percent of this unit is Chappell sandy loam and Wages loam, both having 3 to 5 percent slopes, and Dix gravelly sandy loam, 5 to 9 percent slopes. The Chappell and Wages soils are on footslopes and in concave positions. The Dix soil is on ridge crests and knobs.

The Altvan soil is a deep, well drained gravelly upland soil. It formed in calcareous, loamy alluvial and eolian deposits underlain by sand and gravel.

Typically the surface layer is a dark grayish brown sandy loam about 5 inches thick. The subsoil is a dark grayish brown heavy sandy loam and sandy clay loam about 18 inches thick. The substratum is light brownish gray, calcareous sandy clay loam about 18 inches thick over light brown coarse sand and gravel (fig. 4) that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

The Eckley soil is a deep, well drained soil. It formed in stratified, reddish, gravelly alluvial materials of the Ogallala Formation.

Typically the surface layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is dark brown and brown, gravelly sandy clay loam about 17 inches thick. The substratum is light brown gravelly coarse loamy sand and coarse sand to 60 inches or more.

Permeability is moderate. The effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used for nonirrigated cropland, irrigated cropland and rangeland. Corn, alfalfa, sugar beets, and wheat are the principal crops in irrigated areas. Wheat is the main crop in nonirrigated cropland areas.

In nonirrigated cropland areas intensive management is needed to control soil erosion, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture, and protecting the soil from erosion. Terracing and contour tillage are essential to reduce runoff and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improving water penetration. Tillage should be kept to a minimum. Combinations of these practices are essential on these soils to maintain productivity and protect them from erosion.

In irrigated areas, special management is needed to protect these soils from erosion, to get uniform application and distribution of irrigation water and to maintain fertility. Contour ditch and contour furrow are irrigation methods best suited. Land smoothing is needed to obtain uniform distribution of water and control soil loss. Care must be taken to determine the maximum depth of cut on these soils because of their depth over sand and gravel. Some sacrifice acreage may be expected. Frequent irrigations with small amounts of water are required to reduce soil loss and obtain efficient use of irrigation water. Crop residue use and applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed to maintain fertility.

Rangeland vegetation of the Altvan soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Rangeland vegetation of the Eckley soil consists mainly of blue grama, sideoats grama, little bluestem, buffalograss and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation. Range seeding will speed revegetation of areas depleted by heavy grazing, cultivation, or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition on the Altvan soils.

Windbreaks and environmental plantings are difficult to establish on these soils. Depth to sand and gravel is the principal concern in establishing tree and shrub plantings. Special care consisting of summer fallow a year in advance of planting and continued cultivation for weed control is needed to insure establishment of plantings.

Supplemental irrigation is essential to establish and insure survival of plantings. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover around field edges. For pheasants the inclusion of undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock water developments and fencing of the type to permit unrestricted antelope movement.

These soils are well suited to the construction of homesites and other urban developments. Minor limitations can be easily modified. Effective seals are required to overcome excessive seepage if these soils are used for sewage lagoons or landfills. Capability subclass IVe nonirrigated IVe irrigated.

5—Altvan-Eckley sandy loams, 5 to 9 percent slopes. These moderately sloping soils are on upland ridges and side slopes in the northern part of the county. The average annual precipitation ranges from 15 to 19 inches. Altvan sandy loam, 5 to 9 percent slopes, makes up 50 percent of the unit and the Eckley sandy loam, 5 to 9 percent slopes, about 30 percent. The Altvan soil is on foot slopes and at midslope. Eckley soils are on ridge crests and knobs.

About 20 percent of this unit is Chappell sandy loam and Wages loam, both having 5 to 9 percent slopes, and Dix gravelly sandy loam, 9 to 12 percent slopes. The Chappell and Wages soils are on foot slope and concave positions. The Dix soil is on the steeper crests and knobs.

The Altvan soil is a deep, well drained gravelly upland soil. It formed in calcareous alluvium and windlain deposits over sand and gravel.

Typically the surface layer is a dark grayish brown sandy loam about 5 inches thick. The subsoil is a dark grayish brown heavy sandy loam and sandy clay loam about 18 inches thick. The substratum is light brownish gray, calcareous sandy clay loam about 18 inches thick over light brown coarse sand and gravel that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is high.

The Eckley soil is a deep, well drained soil. It formed in stratified, reddish colored, gravelly alluvial materials of the Ogallala Formation.

Typically the surface layer is dark grayish brown gravelly loam about 3 inches thick. The subsoil is dark brown and brown gravelly sandy clay loam about 17 inches thick. The substratum is light brown gravelly loamy coarse sand and coarse sand to 60 inches or more.

Permeability is moderate. The effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is high.

These soils are used for grazing and irrigated cropland. Some small areas are used for nonirrigated cropland but are commonly severely eroded and best seeded to grass. Corn, alfalfa, sugar beets, and wheat are the main crops grown on irrigated cropland.

In irrigated areas, intensive management is needed to prevent soil loss and maintain productivity. Contour furrow and contour ditch are the best methods of irrigation. Land leveling or smoothing is needed in most areas to obtain better distribution of water. Before attempting to level or smooth these soils, care must be taken to determine the maximum depth of cuts because of the depth to sand and gravel. Irrigation water management is important in obtaining efficient use of water. To control soil loss, alfalfa, small grains and other close sown crops can be irrigated by contour ditches. Row crops are best planted in the contour. Incorporating crop residues improves soil tilth, increases water infiltration, and helps control soil loss. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility. Frequent irrigations with small amounts of water are required to reduce soil loss and obtain more efficient use of irrigation water.

Rangeland vegetation of the Altvan soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Rangeland vegetation of the Eckley soil consists mainly of sideoats grama, little bluestem, buffalograss and sedge. Proper grazing use and planned grazing systems are the important practices needed to maintain quantity and quality of desirable vegetation. Range seeding will speed revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater developments, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition on the Altvan soil.

Windbreaks and environmental plantings are difficult to establish on these soils. Depth to sand and gravel and the slope are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow a year in advance of planting, planting on the contour, and continued cultivation for weed control is needed to insure establishment of plantings. Supplemental irrigation is essential to establish and to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on these soils. Proper livestock grazing management is necessary if livestock and wildlife share the range. Livestock watering facilities are also important and are utilized by various wildlife species.

Cropland areas and the location of this mapping unit to croplands makes it valuable as escape cover areas for openland wildlife, especially pheasants.

These soils are well suited for use as homesites and other urban developments with only minor soil limitations that can be easily modified. Excessive seepage below the subsoil is the primary limiting soil feature. Sealing is needed in sewage lagoons or landfills. Capability subclass VIe nonirrigated, IVe irrigated.

6—Aquolls. Aquolls consists of deep, somewhat poorly drained to poorly drained dark colored salt affected soils formed in alluvium. They occupy the nearly level upland valleys and the fans and foot slopes where they are affected by seepage from irrigation canals. Drainage ditches are common.

Included are small areas of the saline Lebsack and the wet Satanta soils. Also included are small areas of moderate to severely alkali affected soils, identified by spot symbols on the soil map.

This soil is extremely variable within short distances. Visible salt occurs within 20 inches of the surface and mottling is common in the lower part of the subsoil. Stratified lenses of coarse materials are common. These soils are subject to common flooding during spring and summer months.

This soil is used mainly for grazing. Small localized areas are used for irrigated cropland. Crop yields are low because of the saline condition.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass and sedge. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock watering developments are effective in obtaining more uniform distribution of grazing.

Where used for irrigated cropland, the saline condition is sufficient to influence the choice of crops. This soil is suited to furrow or border irrigation. Intensive management is required to reduce the salt content and wetness of the soils and maintain soil productivity. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Land leveling is needed in some areas to obtain uniform water distribution. Tile drain systems and open drainage ditches are essential to minimize the wetness and provide an outlet for salts. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Windbreaks and environmental plantings are difficult to establish on this soil. The saline condition and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Special care consisting of continued cultivation for vegetation control and selection of adapted plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

These are important soils for wildlife because of their association with irrigated cropland. They offer protection and nesting cover for such wildlife as pheasants, waterfowl, and deer. Wildlife values can be enhanced on this soil by tree and shrub plantings and by providing undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl can be attracted by development of shallow water areas.

Where areas are considered for homesites and other urban developments, special onsite investigation is needed because of variable soil textures. Capability subclass IVw nonirrigated, IVw irrigated.

7—Argiustolls, wet, 2 to 9 percent slopes. Argiustolls, wet, are deep, somewhat poorly drained and poorly drained soils. They formed in loamy, calcareous, eolian and alluvial deposits. They are affected by a moderate to severe saline and wet condition caused by seepage from irrigation systems. They occupy the gently sloping and moderately sloping side slopes on the uplands below irrigation canals. They are located primarily in the northeastern part of the county.

Included in this unit are small areas of Satanta loam, Wages loam, and Ascalon sandy loam.

These soils vary considerably, but predominantly have loam surface layers and loam to clay loam subsoils. Visible salt occurs within 20 inches of the surface and mottling is common in the lower part of the subsoil.

This unit is used mainly for grazing. Some small areas are used for irrigated cropland. Crop yields are low because of the saline condition.

Vegetation on this soil is highly variable and, for the most part, unlike that of other range sites in the area or planted pastures. The major soil properties that influence plant growth on this soil are seepage water from irrigation ditches and salinity. Grazing of the forage produced on this soil must be managed in a way that will maintain the plant cover and prevent erosion. Normally at least 50 percent of the annual growth of perennial grasses should be left standing at the end of the grazing season.

Where the soil is used for irrigated cropland, the saline condition is sufficient to influence the choice of crops. This soil is suited for contour furrow and contour ditch irrigation. Intensive management is required to reduce the salt content and wetness of the soil and maintain soil productivity. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Land leveling is needed in some areas to obtain more uniform water distribution. Tile drain systems and open drainage ditches are essential to minimize the wetness and to provide an outlet for salts. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Windbreaks and environmental plantings are difficult to establish on this soil. The saline condition and abundant competing vegetation are the principal concerns in

establishing tree and shrub plantings. Special care consisting of continued cultivation for vegetation control and selection of adapted plants is needed to ensure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

These are important soils for wildlife because of their association with irrigated cropland and irrigation canals. They offer protection and nesting cover for such wildlife as pheasants, waterfowl, and deer. Wildlife values can be enhanced by tree and shrub plantings and undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Where areas are considered for homesites and other urban developments, wetness and the saline condition are the primary limiting soil features. Onsite soil investigations are required to determine compensating measures at proposed sites because of the variable soil textures. Capability subclass VIw nonirrigated, IVw irrigated.

8—**Argiustolls-Rock outcrop complex, 1 to 9 percent slopes.** Argiustolls-Rock outcrop complex consists of gently sloping to moderately sloping soils and Rock outcrop on upland buttelike flats, sideslopes and ridges. It is in the western part of the county. Argiustolls, 1 to 9 percent slopes, makes up 30 percent of the unit, and Rock outcrop makes up about 30 percent. Rock outcrop, consisting mainly of sandstone, is scattered throughout the complex without pattern.

Included in this unit are small areas of Ascalon sandy loam and Wages loam.

This unit is used almost entirely for grazing. Small localized areas with less rock outcrop are used for nonirrigated cropland and have irregular field boundaries. These areas are best seeded to grass and used for grazing.

Rangeland vegetation of the Argiustolls consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation, or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Wildlife such as antelope, deer, cottontail, and coyote are best adapted on this unit. Proper livestock grazing management is necessary if livestock and wildlife share the range. Livestock watering facilities are also important and are utilized by various wildlife species. This soil is valuable as a producer of escape cover areas for openland and rangeland wildlife, especially pheasants.

Urban uses and windbreak plantings require special onsite investigations. Capability subclass VIs nonirrigated.

9—**Arvada silt loam.** This is a deep, well drained soil on upland alluvial fans, swales and depressions in the northwest part of the county. It formed in calcareous, loamy eolian and alluvial materials derived from Brule Siltstone. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Mitchell loam and Manzanola clay loam. Both have 0 to 3 percent slopes and are on higher lying positions.

Typically the surface layer is light brownish gray silt loam about 4 inches thick. The subsoil is grayish brown and light brownish gray, calcareous heavy silt clay loam about 7 inches thick over light gray, calcareous silt loam about 4 inches thick. The substratum is light gray, calcareous silt loam containing salt crystals and extending to a depth of 60 inches.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is affected by an alkali condition.

Nearly all of the acreage of this soil is used for grazing. Crops are not suited because of the alkali condition.

The rangeland vegetation of this soil consists mainly of inland saltgrass, alkali sacaton, western wheatgrass and fourwing saltbush. This soil is difficult to revegetate, and it is especially important that livestock grazing management be carefully applied. Occasional rest from grazing during the growing season favors the main forage species. Chiseling or pitting aids water infiltration and improves plant cover where it has been depleted and is in poor or fair range condition. Control of greasewood or rabbitbrush is sometimes needed where these shrubs have increased to a point that reduces forage production.

Wildlife is limited on this soil. Rangeland wildlife such as antelope and scaled quail can be encouraged by proper livestock grazing management, installation of livestock watering facilities, and range seeding where necessary.

Windbreak and environmental plantings are generally not suited on this soil. Onsite investigation is needed to determine if plantings are feasible.

Slow permeability, high shrink-swell potential, and the inherent low strength are the primary limiting soil features concerning the use of this soil for homesites and other urban developments. Intensive and costly compensating measures are needed to minimize these limiting soil features. Capability subclass VIs nonirrigated.

10—**Ascalon fine sandy loam, 0 to 3 percent slopes.** This is a deep, well drained soil of upland ridges, flats and valleys. It formed in calcareous, loamy eolian and alluvial deposits and is extensive in the western part of the county. Average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Satanta loam and Haxtun fine sandy loam. The Haxtun soils are in swale areas.

Typically the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is brown sandy clay loam about 16 inches thick and is calcareous in the lower part. The substratum is very pale brown, calcareous sandy loam about 21 inches thick over very pale brown, calcareous loamy sand that extends to depths of 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Wheat and grain sorghum are the principal crops grown in nonirrigated areas. In irrigated areas alfalfa, sugar beets, and corn are the principal crops. The remaining acreage is used for grazing.

Primary objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are essential practices to protect soil from erosion, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration in the subsoil. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are efficient use of irrigation water, soil fertility, and soil blowing. This soil is suited to furrow, border or sprinkler irrigation. Leveling is necessary to obtain uniform water distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff, and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by good livestock grazing management, livestock water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for the construction of homesites and other urban developments with only minor limitations that can be easily modified. Where considered for a sewage lagoon system, special sealing methods are required to overcome excessive seepage. Capability subclass IIIe nonirrigated, IIe irrigated.

11—Ascalon fine sandy loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and side slopes, mainly in the western part of the county. It formed in calcareous, loamy eolian and alluvial deposits. The average annual precipitation ranges from 13 to 19 inches. Slopes are gentle to moderately sloping.

Included in this unit are small areas of Satanta loam and Manter sandy loam.

Typically the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is brown sandy clay loam about 16 inches thick and is calcareous in the lower part. The substratum is very pale brown, calcareous sandy loam about 21 inches thick over very pale brown, calcareous loamy sand that extends to depths of 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Some areas are used for grazing. Wheat is the principal crop grown in nonirrigated areas. Corn, alfalfa, sugar beets and small grains are the principal crops grown in irrigated areas.

Primary objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are essential practices to protect soil from blowing, improve soil tilth and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration in the subsoil. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are efficient use of irrigation water, soil fertility and control of soil erosion. This soil is suited to contour furrow, contour ditch or sprinkler methods of irrigation. Land leveling is needed to obtain uniform water distribution and efficient use of water. Incorporating crop residues is

needed to reduce soil blowing during periods when soil is not protected by growing crops and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by good livestock grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Where considered for a sewage lagoon, special sealing methods are required to overcome excessive seepage. Capability subclass IIIe nonirrigated, IIIe irrigated.

12—Ascalon fine sandy loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland ridges and side slopes in the western part of the county. It formed in calcareous, loamy eolian and alluvial deposits. The average annual precipitation ranges from 13 to 19 inches. Slopes are moderately sloping to gently rolling.

Included in this unit are small areas of Manter sandy loam and Satanta loam.

Typically the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is brown sandy clay loam about 16 inches thick and is calcareous in the lower part. The substratum is very pale brown, calcareous sandy loam about 21 inches thick over very pale brown, calcareous loamy sand that extends to a depth of 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow. The erosion hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. The remaining acreage is used for grazing. Wheat is the principal crop grown in nonirrigated cropland areas. In irrigated cropland areas alfalfa, corn, sugar beets and small grains are the main crops grown.

Primary objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from erosion. Stubble mulch tillage and incorporating crop residues are essential practices to protect soil from erosion, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration in the subsoil. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage should be kept to a minimum. Intensive use of these practices is essential to protect this soil and maintain productivity.

In irrigated areas the main concerns of management are efficient use of irrigation water, controlling soil erosion, and maintaining and improving soil fertility. This soil is suited to contour furrow, contour ditch or sprinkler methods of irrigation. Land leveling is needed in most areas to obtain more uniform application of water. Incorporating crop residues is needed to reduce soil blowing during periods when soils are not protected by growing crops and improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility. More frequent irrigations with smaller amounts of water are needed to prevent soil loss because of slope.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of slope. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, contour planting, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry.

Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by good livestock grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for the contruction of homesites and other urban developments, with only minor limitations that can be easily modified. Where the soil is considered for a sewage lagoon system, special sealing methods are required to overcome the excessive seepage. Capability subclass IVe nonirrigated, IVe irrigated.

13—**Badland.** This unit consists of steep and very steep barren land dissected by many intermittent drainage channels that have entrenched into the soft shale and siltstone of the Brule Formation and the Algal Limestone of the Ogallala Formation. About 75 percent or more of the unit is unvegetated. It is located mainly in the northwestern part of the county. Runoff is very high, and geologic erosion is active.

Included are small isolated areas of Keota, Mitchell, Canyon and Epping soils. These soils support some vegetation with very limited value for grazing by livestock and wildlife.

This unit provides protection and cover for livestock and wildlife.

Rocky Mountain juniper and eastern redcedar are trees common in the narrow ravines and valleys. Yellow currant, common chokecherry, squawbush, wild rose and wild plum are common native shrubs.

Onsite investigations are needed for more detailed interpretations to determine use and planning at proposed sites. Capability subclass VIIIe nonirrigated.

14—**Bankard sand.** This is a deep, somewhat excessively drained soil on flood plains and low terraces. It formed in stratified sandy recent alluvium deposited by intermittent streams. Average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Glenberg sandy loam, 0 to 3 percent slopes.

Typically the surface layer is brown sand about 3 inches thick. The underlying layer is yellowish brown and very pale brown gravelly sand stratified with thin lenses of sandy loam and loam to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate. This soil is subject to a frequent flooding hazard during spring and summer months.

This soil is best suited for and used almost entirely for grazing.

The rangeland vegetation of this soil consists mainly of sand bluestem, blue grama, sand reedgrass, sand dropseed, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. When proper grazing use is combined with deferred grazing and planned grazing systems, the vegetation is further benefited. Fencing is necessary for grazing management on this soil to separate it from other grazed units. Brush management is applicable when sand sagebrush becomes excessively dense.

Windbreaks and environmental plantings are generally not suited to this soil. Onsite investigation is needed to determine if plantings are feasible.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on this soil. Proper livestock grazing management is necessary if livestock and wildlife share the rangeland. Watering facility developments are also important and are utilized by various wildlife species. The position of this soil in relation to croplands makes it valuable as escape cover areas for openland wildlife, especially pheasants.

Where this soil is considered for homesites and other urban developments, the primary limiting soil feature is frequent flooding. Intensive and costly compensating measures such as embankments and elevated building pads are needed to minimize this soil condition. Capability subclass VIw nonirrigated, IVw irrigated.

15—**Bayard-Canyon complex, 1 to 9 percent slopes.** These gently to moderately sloping soils are on upland ridges in the eastern part of the county. The average annual precipitation ranges from 17 to 19 inches. Bayard loamy sand, 1 to 9 percent slopes, makes up about 65 percent of the unit, and Canyon gravelly loam, 1 to 9 percent slopes, makes up about 30 percent. The Bayard soil is at midslope and on foot slopes. The Canyon soil is on ridge crests and nearly level flats.

Included in this unit are small areas of Haxtun loamy sand, 3 to 5 percent slopes, on foot slope positions.

The Bayard soil is a deep, well drained soil. It formed in calcareous, sandy alluvial and eolian materials.

Typically the surface layer is grayish brown loamy sand about 12 inches thick. The underlying layer is light brownish gray and light gray, calcareous sandy loam about 21 inches thick over a light brown, calcareous sandy loam that extends to 60 inches.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the water erosion hazard is slow, and the soil blowing hazard is moderate.

The Canyon soil is a shallow, well drained soil. It formed in a thin mantle of calcareous, loamy alluvial and eolian materials underlain by calcareous sandstone.

Typically the surface layer is a dark grayish brown, calcareous gravelly loam about 3 inches thick and 15 percent calcareous sandstone fragments. The underlying layer is a

dark grayish brown, calcareous gravelly loam that is about 2 inches thick and 15 percent calcareous sandstone fragments. It overlies light gray, calcareous loam that is about 6 inches thick and about 25 percent calcareous sandstone fragments. At a depth of about 11 inches is calcareous sandstone.

Permeability is moderate. Effective rooting depth is 6 to 20 inches. Available water capacity is low. Surface runoff is moderate to rapid, and the erosion hazard is high.

These soils are used almost entirely for grazing. Some small localized areas are used for nonirrigated cropland. These areas include odd field corners. Croplands are best reseeded to grass.

The rangeland vegetation of the Bayard soil consists of sand reedgrass, little bluestem, needleandthread, switchgrass, blue grama, sand dropseed, and sand bluestem as the main forage species. Sand sagebrush is in a scattered stand in the vegetation.

The rangeland vegetation of the Canyon soil consists mainly of blue grama, little bluestem, sideoats grama, sedge, needleandthread, red threeawn and sand reedgrass. Proper grazing use and planned grazing systems are needed to maintain or improve the quantity and quality of desirable vegetation. Periodic deferment of grazing during the growing season is also beneficial. The Bayard soil can be seeded to rangeland grasses if it becomes denuded by grazing or farming. Range seeding by mechanical means is not applicable on the Canyon soil.

Windbreaks and environmental plantings are difficult to establish on these soils. Limited available water capacity and rooting depth and soil blowing are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow a year in advance of planting, cultivating only in the tree row, and leaving a strip of vegetation cover between rows is needed to insure establishment and survival of plantings. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac, lilac and Siberian peashrub.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on these soils. Proper livestock grazing management is necessary if livestock and wildlife share the range. Livestock watering facilities are also important and are utilized by various wildlife species. The position of this soil in relationship to croplands makes it valuable as escape cover areas for openland wildlife, especially pheasants.

Where areas are considered for homesites and other urban developments, the Bayard soil is well suited, with only minor limitations that can be easily modified. The Canyon soil is limited by depth to bedrock. Very intensive and costly compensating measures are needed to minimize this soil feature. Capability subclass VIe nonirrigated.

16—Bridgeport loam. This is a deep, well drained soil on terraces and flood plains. It formed in calcareous, stratified loamy alluvium deposited by intermittent streams. The average annual precipitation ranges from 17 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Satanta loam and Haverson loam.

Typically the surface layer is a dark grayish brown loam about 10 inches thick. The subsoil layer is grayish brown and gray loam and silt loam about 11 inches thick. The substratum is light gray, calcareous silt loam about 9 inches thick over light gray, calcareous very fine sandy loam that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the wind and water erosion hazard is slight.

This soil is used mainly for irrigated cropland. The remaining acreage is used for grazing. Corn, alfalfa and sugar beets are the main crops grown in irrigated areas.

Management concerns in irrigated areas are efficient use of irrigation water and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is needed in some areas to obtain uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues and maintaining organic matter content increases water infiltration and improves soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation or rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, road-

sides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock water developments and types of fencing to permit unrestricted antelope movement.

The inherent low strength is the primary limiting soil feature for homesites or other urban developments. Minor engineering measures are needed to offset this limiting soil feature. Capability subclass IIc nonirrigated, I irrigated.

17—Canyon gravelly loam, 1 to 25 percent slopes. This is a shallow, well drained soil on upland ridges, knobs and tablelands. It formed in a thin mantle of calcareous, loamy alluvial and eolian material underlain by calcareous sandstone. The average annual precipitation ranges from 15 to 17 inches. Slopes are nearly level to moderately steep.

Included in this unit are small areas of Escabosa loam and Rosebud loam, both having 5 to 9 percent slopes.

Typically the surface layer is a dark grayish brown, calcareous gravelly loam about 3 inches thick and 15 percent calcareous sandstone fragments. The underlying layer is dark grayish brown, calcareous gravelly loam that is about 2 inches thick and 15 percent calcareous sandstone fragments over light gray, calcareous gravelly loam that is about 6 inches thick and 25 percent fragments of calcareous sandstone. At a depth of about 11 inches is calcareous sandstone (fig. 5).

Permeability is moderate. Effective rooting depth is 6 to 20 inches. Available water capacity is low. Surface runoff is medium to rapid, and the erosion hazard is high.

This soil is used almost entirely for grazing. It is not suited for cropland because of the shallow rooting depth. Small areas within large areas of cropland soils are used for nonirrigated cropland.

The rangeland vegetation of this soil consists mainly of blue grama, little bluestem, sideoats grama, sedge, needleandthread, red threeawn and sand reedgrass. Proper grazing use to improve or maintain range condition is needed on this soil to prevent loss of forage plants. Grazing systems that include periodic deferment are highly beneficial. Range seeding and mechanical treatment are generally not applicable.

Windbreak and environmental plantings are generally not suited to this soil. Onsite investigation is needed to determine if plantings are feasible.

Rangeland wildlife such as antelope, cottontail rabbit, coyote and scaled quail are best adapted on this soil. Forage production is typically low, and proper livestock grazing management is necessary if wildlife and livestock share the range. Livestock watering developments are also important and are utilized by various wildlife species.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are the depth to bedrock and slope where it exceeds 8 percent. Intensive and costly compensating measures are needed to minimize these limiting soil features. Capability subclass VIIs nonirrigated.

18—Chappell sandy loam. This is a deep, well drained soil on flood plains and alluvial fans. It formed in calcareous, stratified sandy alluvium deposited by intermittent streams. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Manter sandy loam and Bankard sand, both having 0 to 3 percent slopes.

Typically the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown coarse sandy loam about 24 inches thick. The substratum is brown loamy coarse sand about 11 inches thick over pale brown, calcareous gravelly loamy coarse sand that extends to 60 inches.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low or moderate. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate. Some areas are subject to occasional, very brief flooding during spring and summer months.

This soil is used mainly for grazing. Some areas are used for irrigated and nonirrigated cropland. Corn, alfalfa, sugar beets and wheat are the main crops on irrigated areas. Wheat is the main crop on nonirrigated cropland.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth, and conserve moisture. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are efficient use of irrigation water, soil fertility, and soil blowing. This soil is suited to furrow, border or sprinkler irrigation methods. Leveling and irrigation water management are necessary to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility. Frequent light irrigations are needed on this soil because of the low or moderate available water capacity.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings can be established on this soil. Soil blowing is the principal reason for establishing trees and shrubs. This hazard can

be overcome by special care consisting of cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock water developments.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are occasional flooding and seepage. Sealing methods are required to overcome excessive seepage condition when the soil is used for sewage lagoons or landfills. Offsetting engineering designs and measures, such as embankments and elevated building pads, are needed to protect homesites and roads. Special sewage systems must be anticipated because septic tank absorption fields will not function properly when the soil is flooded. Capability subclass IIIw nonirrigated, IIIw irrigated.

19—Colby loam, 6 to 20 percent slopes. This is a deep, well drained soil on upland ridge crests and hills. It formed in calcareous, loamy eolian material. It is extensive in the rolling loess area of the south central part of the county. The average annual precipitation ranges from 17 to 19 inches. Slopes are moderately sloping to moderately steep.

Included are small areas of Ulysses loam and Norka loam, both having slopes of 5 to 9 percent.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is pale brown and very pale brown, calcareous loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is rapid, and the erosion hazard is high.

This soil is used almost entirely for grazing. A few small areas within large areas of cropland soils are used for nonirrigated cropland. These small areas are commonly severely eroded and are best seeded to grass. This soil is best suited to rangeland.

Rangeland vegetation of this soil consists mainly of plants from both medium and short grass communities, including sideoats grama, squirreltail, sedge, little bluestem, western wheatgrass, needleandthread, and blue grama. This soil erodes easily when the vegetation is overgrazed. Grazing management practices needed to maintain and improve production and range condition are deferred grazing, planned grazing systems, and proper grazing use. Where slopes are less than 9 percent, contour furrowing and pitting improve water penetration and speed up recovery of areas in fair and poor range condition. Fencing and livestock water development are effective in obtaining more uniform distribution of grazing. Excessive trailing by livestock has caused gully erosion on this soil.

Windbreaks and environmental plantings are difficult to establish on this soil because of slope. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Rangeland wildlife such as antelope, cottontail rabbits and coyotes are best adapted on this soil. Forage production is typically low and proper livestock grazing management is necessary if wildlife and livestock share the range. Livestock watering developments are also important because they are utilized by various wildlife species.

Slope and the inherent low strength are the primary limiting soil features for homesites and other urban developments. Special planning and designs can be used to overcome the low strength and slope. Capability subclass VIe nonirrigated.

20—Dacono loam. This is a deep, well drained soil on upland tablelands. It formed in calcareous, loamy alluvium that overlies coarse sand and gravel. Average annual precipitation ranges from 17 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Platner loam and Altvan sandy loam, both having slopes of 0 to 3 percent.

Typically the surface layer is grayish brown loam about 5 inches thick. The subsoil is grayish brown and dark grayish brown heavy clay loam about 9 inches thick over light gray silt loam about 6 inches thick. The substratum is white, calcareous silt loam about 9 inches thick over light yellowish brown coarse sand and gravel that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland. Some areas are used for irrigated cropland and grazing. Wheat is the principal crop grown in nonirrigated areas. Corn, alfalfa hay, and small grains are the main crops grown in irrigated areas.

Management concerns in irrigated areas are efficient use of irrigation water, maintenance of fertility, and control of soil erosion. This soil is well suited to furrow and border irrigation methods. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of

water and control of soil loss. Short irrigation runs and frequent light irrigations are needed because of the slow permeability. Incorporating crop residues increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from erosion. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from erosion, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture in areas with slopes over 1 percent.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock grazing management, livestock water developments, and types of fencing to permit unrestricted antelope movement.

Where the soil is used for homesites and other urban developments, the primary limiting soil features are slow permeability, high shrink-swell, and seepage. Septic tank filter fields must be placed in the underlying coarse sand and gravel if they are to function properly. Lagoons may not function properly because of seepage. Compensating design measures such as footing placement within the coarse sand and gravel or backfilling with better soil material are needed to overcome the shrink-swell condition for building sites and roads. Capability subclass IIIs nonirrigated, IIIe irrigated.

21—Dailey loamy sand, 0 to 3 percent slopes. This is a deep, somewhat excessively drained soil in upland valleys. It formed in noncalcareous, eolian sandy material and is extensive in the sandhill area that parallels the South Platte River on the south side. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included in this mapping unit are small areas of Julesburg loamy sand in depression areas.

Typically the surface layer is grayish brown loamy sand about 16 inches thick. The underlying layer is pale brown loamy sand that extends to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for sprinkler irrigated cropland. Corn, sugar beets, and alfalfa are the main crops grown. Some small areas are used for grazing. This soil is not suited for nonirrigated cropland because of its low available water capacity. Areas being cultivated now are best seeded to grass.

In irrigated cropland areas the main concerns of management are soil blowing, maintenance of organic matter and fertility. This soil is best suited to the sprinkler irrigation method because of rapid permeability. Most of the pivotal sprinklers are located in areas of this soil. Special care consisting of cover crops grown after harvesting row crops and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yield of all crops.

Rangeland vegetation of this soil consists mainly of sand bluestem, switchgrass, sand reedgrass, little bluestem, needleandthread, sideoats grama, sand dropseed, and blue grama. These grasses furnish most of the forage. Sand sagebrush is scattered in the vegetation. Grazing management must be aimed at the maintenance or improvement of range condition through proper grazing use. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Range seeding is essential if severely depleted areas develop. Fencing and livestock watering places aid in obtaining more uniform distribution of grazing. Care must be taken not to locate livestock water developments in places where serious wind erosion can result.

Windbreaks and environmental plantings are difficult to establish on this soil. Soil blowing and low available water capacity are the principal concerns in establishing trees and shrubs. Trees should be planted in shallow furrows, and a vegetative cover maintained between the rows. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock grazing management, livestock water developments, and types of fencing to permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Where sewage lagoon systems are considered, special sealing methods are required to overcome excessive seepage. This soil should be protected at all times by utilization of mulches or vegetative cover. Capability subclass VIe nonirrigated, IVe irrigated.

22—Dailey loamy sand, 3 to 9 percent slopes. This is a deep, somewhat excessively drained soil on uplands, convex ridges and hills. It formed in eolian, noncalcareous sands and is dominantly in the sandhill area that parallels the South Platte River on the south. The average annual precipitation ranges from 15 to 19 inches. Slopes are moderately sloping to gently rolling.

Included in this unit are small areas of Julesburg loamy sand, 3 to 9 percent slopes, and Valent soils having slopes of 9 to 12 percent.

Typically the surface layer is grayish brown loamy sand about 16 inches thick. The underlying layer is pale brown loamy sand (fig. 6) that extends to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for sprinkler irrigated cropland. Corn, sugar beets, and alfalfa are the principal crops grown. The remaining acreage is used for grazing. This soil is not suited for nonirrigated cropland because of low available water capacity. Areas cultivated are usually severely eroded and are best seeded to grass.

In irrigated cropland areas the main concerns of management are soil blowing, maintenance of organic matter and fertility. This soil is best suited to the sprinkler irrigation method because of the rapid permeability. Most of the pivotal sprinklers are located in areas of this soil. Special care consisting of growing cover crops after harvesting row crops and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

Rangeland vegetation of this soil consists mainly of sand bluestem, switchgrass, sand reedgrass, little bluestem, needleandthread, sideoats grama, sand dropseed, sedge, and blue grama. These grasses furnish most of the forage. Sand sagebrush is scattered in the vegetation. Grazing management must be aimed at the maintenance or improvement of range condition through proper grazing use. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective in management systems for livestock use. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Seeding is essential if severely depleted areas develop. Fencing and livestock watering places aid in obtaining more uniform distribution of grazing. Care must be taken not to locate livestock water developments in places where serious wind erosion can result.

Windbreaks and environmental plantings are difficult to establish on this soil. Soil blowing and low available water capacity are the principal concerns in establishing trees and shrubs. Trees should be planted in shallow furrows, and vegetative cover maintained between the rows. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit, and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by livestock grazing management, water developments, and types of fencing that permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Where sewage lagoon systems are considered, special sealing methods are required to overcome excessive seepage. This soil should be protected at all times by utilization of mulches and vegetative cover. Capability subclass VIe nonirrigated, IVe irrigated.

23—Dailey loamy sand, thick surface. This is a deep, well drained soil in upland valleys. It formed in noncalcareous, eolian sands and is dominant in the sandhill area that parallels the South Platte River on the south side. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Haxtun loamy sand and Julesburg loamy sand, both having slopes of 0 to 3 percent.

Typically the surface layer is grayish brown loamy sand about 24 inches thick. The underlying layer is dark brown loamy sand about 13 inches thick over dark grayish brown and brown stratified sandy loam and loamy sand that extends to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low or moderate. Surface runoff is slow, the water erosion hazard is slight, and soil blowing is moderate.

This soil is used for irrigated cropland and grazing. Some small areas are used for nonirrigated cropland. In irrigated cropland areas corn, alfalfa and sugar beets are the principal crops grown. Winter wheat is grown in nonirrigated cropland areas.

In irrigated cropland areas the main concerns of management are soil blowing, maintenance of organic matter, and fertility. This soil is best suited to the sprinkler method of irrigation because of the rapid permeability. Most of the pivotal sprinkler systems are located on this soil. Special care consisting of growing cover crops after harvest of row crops and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Close grown crops are more effective in protecting soil from blowing. Intensive crop residue management is needed when growing row crops. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect the soil from blowing, improve soil tilth, and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting the soil from blowing.

Rangeland vegetation of this soil consists mainly of sand bluestem, switchgrass, sand reedgrass, little bluestem, needleandthread, sideoats grama, sand dropseed, sedge, and blue grama. These grasses furnish most of the forage. Sand sagebrush is scattered in the vegetation. Grazing management must be aimed at the maintenance or improvement of range condition through proper grazing use. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective in management systems for livestock use. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Seeding is essential if severely depleted areas develop. Fencing and livestock watering places aid in obtaining more uniform distribution of grazing. Care must be taken not to locate livestock water developments in places where serious wind erosion can result.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by special care, consisting of cultivating only in the tree row and leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by livestock grazing management, water developments and types of fencing to permit unrestricted antelope movement.

Where the soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Where sewage lagoon systems are considered, special sealing methods are required to overcome excessive seepage. This soil should be protected at all times by utilization of mulches and vegetative cover. Capability subclass IVe nonirrigated, IIIe irrigated.

24—Dix-Altvan complex, 9 to 25 percent slopes. These strongly sloping to moderately steep soils are on gravelly uplands in the northern part of the county. The average annual precipitation ranges from 17 to 19 inches.

Dix gravelly sandy loam, 15 to 25 percent slopes, makes up about 50 percent of the mapping unit, and Altvan sandy loam, 9 to 25 percent slopes, about 30 percent. The Dix soils are on the steeper crests and ridges. The Altvan soil is at midslope.

About 20 percent of this unit is Chappell sandy loam, 3 to 5 percent slopes, Eckley sandy loam, 15 to 25 percent slopes, and Wages loam, 5 to 9 percent slopes. The Chappell soils are on narrow elongated drainageways and fans, Eckley soils are on ridge crests, and the Wages soils are on foot slope positions.

The Dix soil is a deep, somewhat excessively drained soil. It formed in very gravelly alluvial deposits of the Ogallala Formation.

Typically the surface layer is a dark grayish brown gravelly sandy loam about 4 inches thick. The subsoil is a dark grayish brown gravelly coarse sandy loam about 14 inches thick. The substratum is a reddish yellow coarse sand and gravel to a depth of 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is high.

The Altvan soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian deposits underlain by sand and gravel.

Typically the surface layer is a dark grayish brown sandy loam about 5 inches thick. The subsoil is a dark grayish brown heavy sandy loam and sandy clay loam about 18 inches thick. The substratum is light brownish gray, calcareous sandy clay loam about 18 inches thick over light brown coarse sand and gravel that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used almost entirely for grazing. They are not suited to cropland because of the low available water capacity of the Dix soil, the slope, and the erosion hazard. Small isolated areas are used for nonirrigated cropland, but are best seeded back to grass.

Rangeland vegetation of the Dix soil consists mainly of blue grama, side-oats grama, little bluestem, and sedge. Rangeland vegetation of the Altvan soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important management practices to maintain quantity and quality of desirable vegetation. Combinations of stockwater development, fencing and deferred grazing during the grazing season help improve and maintain range condition. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition of the Altvan soil.

Windbreaks and environmental plantings are difficult to establish on these soils. Limited available water capacity, depth to sand and gravel, and slope are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow a year in advance of plantings, planting on the contour, continued cultivation for weed control, and supplemental water is needed to insure establishment and survival of plantings. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on these soils. The relief, natural springs and native vegetation provide food and cover. Areas of these soils provide sites that can be readily developed and managed for wildlife. Proper livestock grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species. The position of these soils in relationship to cropland makes it valuable as escape cover areas for openland wildlife, especially pheasants.

Slope is the primary limiting soil feature where these soils are used for homesites or other urban developments. Intensive engineering designs and measures are needed to minimize the slope limitations. Where the soils are considered for a sewage lagoon system, special sealing methods are required to overcome excessive seepage. Capability subclass VIe nonirrigated.

25—Dix-Eckley complex, 5 to 25 percent slopes. These moderately sloping to moderately steep soils are on gravelly uplands in the northern part of the county. The average annual precipitation ranges from 17 to 19 inches. Dix gravelly sandy loam, 9 to 25 percent slopes, makes up about 50 percent of the mapping unit and Eckley sandy loam, 5 to 18 percent slopes, about 30 percent. The Dix soils are on steeper crests and ridges. The Eckley soils are at midslope.

About 20 percent of this unit is Chappell sandy loam, 3 to 9 percent slopes, and Altvan sandy loam, 5 to 9 percent slopes. The Chappell soil is on the narrow elongated drainageways, fans and foot slopes. The Altvan soil is on mid slope and foot slope positions.

The Dix soil is a deep, somewhat excessively drained, gravelly soil. It formed in very gravelly alluvial deposits of the Ogallala Formation.

Typically the surface layer is dark grayish brown gravelly sandy loam about 4 inches thick. The subsoil is dark grayish brown gravelly coarse sandy loam about 14 inches thick. The substratum is a reddish yellow gravelly coarse sand and gravel (fig. 7) to a depth of 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is rapid, and the water erosion hazard is high.

The Eckley soil is a deep, well drained soil. It formed in stratified gravelly alluvial materials of the Ogallala Formation.

Typically the surface layer is dark grayish brown gravelly loam about 3 inches thick. The subsoil is dark brown gravelly sandy clay loam about 17 inches thick. The substratum is light brown, gravelly coarse sand to 60 inches or more.

Permeability is moderate. The effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the water erosion hazard is high.

These soils are used almost entirely for grazing. They are not suited to cropland because of the low available water capacity of the Dix soil, the slope, and the erosion hazard. Small isolated areas are used for nonirrigated cropland, including mainly odd field boundaries and corners. These areas are usually severely eroded and are best seeded back to grass.

Rangeland vegetation of both soils consists mainly of blue grama, side-oats grama, little bluestem, buffalograss, and sedge. Proper grazing use and planned grazing systems are needed on these soils to maintain the key forage species in good vigor. Periodic summer deferment is beneficial in reaching the objectives of range improvement and maintenance of high range conditions. Fencing and careful location of watering sites help improve distribution of grazing use.

Windbreaks and environmental plantings are difficult to establish on these soils. Limited available water capaci-

ty, depth to sand and gravel, and slope are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow a year in advance of planting, plantings on the contour, continued cultivation for weed control, and supplemental water is needed to insure establishment and survival of plantings. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on these soils. Proper livestock grazing management is necessary if livestock and wildlife share the range. Livestock watering facilities are also important and are utilized by various wildlife species. The position of these soils in relationship to croplands makes them valuable as escape cover areas for openland wildlife, especially pheasants. The relief, natural springs and native vegetation provide food and cover. Areas of these soils provide sites that can be readily developed and managed for wildlife.

Slope is the primary limiting soil feature where these soils are used for homesites or other urban developments. Intensive engineering designs and measures are needed to minimize the slope limitation. Where the soils are considered for a sewage lagoon system, special sealing methods are required to overcome excessive seepage. Capability subclass VIe nonirrigated.

26—Els loamy sand. This is a deep, somewhat poorly drained soil on low terraces and bottoms along the South Platte River. It formed in calcareous, stratified sandy alluvium underlain by mottled sand and gravel. Average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Alda loam and Fluvaquentic Haplaquolls.

Typically the surface layer is grayish brown loamy sand about 6 inches thick. The underlying layer is light brownish gray loamy fine sand about 11 inches thick over light gray, calcareous, mottled loamy fine sand that is stratified with thin lenses of silt loam and extends to 58 inches. Below a depth of 58 inches is a mixture of brownish, mottled coarse sand and gravel.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate. A fluctuating water table occurs below 20 inches during the winter and spring months. This soil is subject to occasional flooding during late spring and summer months.

This soil is used for irrigated cropland and grazing. Alfalfa, corn, and sugar beets are the main crops grown.

In irrigated cropland areas the main concerns of management are efficient use and distribution of water, fertility maintenance and protecting the soil from blowing. Sprinkler irrigation is best suited, but the size and position in the landscape of these areas makes the border or furrow irrigation method the one normally used. Irrigation frequency should be often and length of runs short for the most efficient application of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity. Leaving crop residues on the surface protects the soil from blowing during periods when there are no growing crops.

The rangeland vegetation of this soil consists mainly of tall prairie grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, sand reedgrass, sedge, and indiangrass. These produce an abundance of forage that can be cut for grass and hay. Management of the grazing is mandatory on these soils in order to maintain the productive grasses. Proper grazing and planned grazing systems that include deferment periodically during the growing season are effective in maintaining or improving the rangeland vegetation. Chemical or mechanical brush management is beneficial where dense stands of sand sagebrush encroach on this soil. Lands taken out of cropland or depleted by overgrazing can be seeded to adapted rangeland grasses. Fencing is essential in separating these soils from other soils in order to apply needed treatment and grazing systems.

Windbreaks and environmental plantings are generally well suited to this soil. The somewhat poorly drained condition and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control, and selection of adapted plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use for cropland and its association with the South Platte River. Under irrigation, it is an important food producer for waterfowl, pheasants and deer. All utilize crop residues which occur as aftermath following harvest. Wildlife values can be enhanced by developments of tree and shrub plantings and undisturbed nesting cover of grasses and legumes. In the presence of a water supply, waterfowl could be attracted to the area by development of shallow water areas.

Where areas are used for homesites or other urban developments, the primary limiting soil features are a water table at a depth of 20 to 40 inches and occasional flooding. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table. Homesites and other urban development construction will require compensating measures and designs to overcome the water table condition and flood hazard. Special road designs are also needed that will take into account the frost action potential of the soil. Capability subclass IVw nonirrigated, IVw irrigated.

27—Epping loam, 3 to 9 percent slopes. This is a shallow, well drained soil on uplands in the northwestern part

of the county. It formed in calcareous, loamy materials weathered from Brule Siltstone. The average annual precipitation ranges from 13 to 17 inches. Slopes are gently sloping to moderately sloping.

Included in this unit are small areas of Keota loam, 3 to 5 percent slopes.

Typically the surface layer is light brownish gray loam about 3 inches thick. The underlying layer is very pale brown and light gray, calcareous loam that is about 8 inches thick and contains weathered fragments of siltstone. Below this is a very pale brown, calcareous Brule Siltstone at a depth of 11 inches.

Permeability is moderate. Effective rooting depth is 10 to 20 inches. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is high.

This soil is used almost entirely for grazing. It is not suited for cultivation because of its shallow depth. Small areas once used as nonirrigated cropland are now seeded back to grass.

Rangeland vegetation on this soil consists mainly of blue grama, western wheatgrass, winterfat, threadleaf sedge, and sideoats grama. Proper grazing use and planned grazing systems must be designed to limit stocking and degree of use to maintain a protective plant cover on this soil. Periodic deferment of grazing during the summer months benefits the vegetation by permitting forage plants to complete growth and mature seed. Mechanical rangeland treatment practices are not recommended. Stock water is usually difficult to find in areas of this soil.

Windbreak and environmental plantings are generally not suited to this soil because of the shallow depth. Onsite investigation is needed to determine if plantings are feasible.

Rangeland wildlife such as antelope and scaled quail could best be encouraged by proper livestock grazing management and installation of watering facilities.

Depth to bedrock is the primary limiting soil feature for homesites or other urban developments. Special sewage systems must be designed. Septic tank absorption fields will not function properly because of the depth to rock. Compensating building and road designs must be utilized in order to offset the shallow bedrock condition. Capability subclass VIe nonirrigated.

28—Fluvaquentic Haplaquolls. Fluvaquentic Haplaquolls consist of deep, dark-colored, poorly drained soils formed in recent alluvial deposits underlain by sand and gravel at depths less than 20 inches. These nearly level soils are on bottomlands along the South Platte River and have a braided pattern of old meandering channels. They are extremely variable in texture within short distances, ranging from sandy loam to clay.

Included are small areas of Westplain silty clay loam and Alda loam.

These soils have a fluctuating water table during most of the year and are subject to frequent flooding during spring and summer months. A moderate saline condition is also common.

These soils are used mainly for grazing (fig. 8). A few small areas bordering areas of more productive soils are used for irrigated cropland. These soils are best suited for grazing.

Irrigated cropland areas require intensive management. Special care is required on this soil in applying irrigation water. Sprinkler irrigation is best suited, but border or furrow methods can be used. Land leveling is difficult because these soils may be shallow over sand and gravel. Short irrigation runs and frequent light irrigations are needed. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses should be maintained by proper grazing use and grazing management systems that include deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock water developments are effective in obtaining more uniform distribution of grazing.

Windbreak and environmental plantings are generally difficult to establish on these soils because of frequent flooding and the high water table. Onsite investigation is needed to determine feasibility of plantings and adapted plants.

Wetland wildlife, especially waterfowl, utilize these soils. The high water table allows production of wetland plants that provide nesting and protective cover, as well as some food for waterfowl. Because these soils provide cover for wildlife and are near irrigated cropland where the wildlife species obtain much of their food, they are valuable for openland, wetland and rangeland wildlife. Openland wildlife, especially pheasants, use these areas for cover and nesting. They also provide excellent cover for rangeland wildlife, especially deer. Management for wildlife should include prevention of overgrazing by livestock and protection from unplanned fire. Where livestock are present, these valuable wildlife areas should be fenced to prevent unwanted encroachment and overuse.

Frequent flooding and a fluctuating water table at 10 to 40 inches limit these soils for use as homesites or other urban developments. Intensive and costly engineering design and measures are needed in order to overcome these limiting soil features. Capability subclass VIw nonirrigated, IVw irrigated.

29—Fluvaquents. Fluvaquents are deep, somewhat poorly drained and poorly drained soils formed in recent alluvial deposits bordering the South Platte River Channel. They are nearly level. The area is dissected by old river channels and by smaller intermittent streams.

This unit is extremely variable from place to place. The surface layer ranges from loamy sand to clay overlying sand and gravel at depths of 4 to 20 inches.

These soils have a fluctuating water table ranging from 10 to 60 inches during winter and summer months. They

are subject to frequent flooding during spring and summer months.

These soils are used entirely for limited livestock grazing and wildlife.

Native vegetation consists mainly of scattered stands of grasses such as blue grama, sand reedgrass, and prairie cordgrass, and annual weeds, willows and cottonwood trees.

Wetland wildlife, especially waterfowl, utilize these soils. The availability of moisture on these soils allows production of wetland plants that provide nesting and protective cover, as well as some food for waterfowl. Because these soils provide cover for wildlife and are near irrigated cropland where wildlife obtain much of their food, they are valuable to both wetland and rangeland wildlife. They provide excellent cover for deer. Openland wildlife, especially pheasants, also use these areas for cover and nesting. Management for wildlife would include prevention of overgrazing by livestock, protection from unplanned fire, and prevention of drainage. Where livestock are present, these valuable wildlife areas should be fenced to prevent overuse by livestock and unwanted encroachment.

Frequent flooding and the fluctuating water table severely limit these soils for use as homesites, roads and other urban developments.

30—Glenberg fine sandy loam. This is a deep, well drained soil on low terraces and flood plains. It formed in calcareous, stratified, sandy alluvium deposited by intermittent streams in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Haverson loam, 0 to 3 percent slopes.

Typically the surface layer is dark grayish brown and pale brown fine sandy loam about 13 inches thick and is calcareous in the lower part. The underlying layer is very pale brown, calcareous fine sandy loam stratified with thin lenses of loam and silt loam to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow. The erosion hazard is slight, and the soil blowing hazard is moderate. This soil is subject to occasional flooding occurring during spring and summer months.

This soil is used mainly for grazing and irrigated cropland. Corn, alfalfa, sugar beets and small grains are the principal crops grown in irrigated areas. Some small isolated areas are used for nonirrigated cropland, with forage sorghum, wheat and millet as the main crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, blue grama, western wheatgrass, sedge, sand dropseed, needleandthread and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use and planned grazing systems are essential. When proper grazing is used along with deferred grazing, the vegetation is further benefited. Fencing is necessary to obtain more uniform distribution of grazing. Brush management is needed when sand sagebrush becomes excessively dense and interferes with forage production.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and soil blowing. This soil is suited to furrow, border or sprinkler irrigation. Leveling and good irrigation water management are necessary to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Primary objectives of management in nonirrigated cropland areas are protecting soil from blowing and conserving moisture. Stubble mulch tillage and incorporating crop residues are essential practices to protect the soil from blowing, improve soil tilth, and conserve moisture. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Production of close grown crops is most effective in protecting soil from blowing. Tillage should be kept to a minimum. Intensive use of conservation practices is essential to protect and maintain soil productivity.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by special care consisting of cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by livestock grazing management, water developments, and types of fencing to permit unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil feature is occasional flooding. Intensive and costly compensating measures such as embankments and elevated building pads are needed to minimize this condition. Capability subclass IVw nonirrigated, IIw irrigated.

31—Gravel pits. This unit consists of open excavations and borrow areas from which soil and underlying material, most commonly gravel, have been removed. The remaining exposed materials usually support limited vegetation.

These excavations are usually located in areas of soils underlain by gravel at depths of 10 to 40 inches. Included are borrow areas next to roads and major canals that were used as a source of fill materials.

Onsite investigations are required on this unit to determine use and management.

Where pits are abandoned, reshaping the side slopes and backfilling with topsoil will aid in revegetation and control of erosion.

32—Haverson loam, 0 to 1 percent slopes. This is a deep, well drained soil on terraces and flood plains. It formed in calcareous, stratified, loamy alluvium derived from sedimentary rocks and deposited by intermittent streams in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Glenberg sandy loam having 0 to 3 percent slopes.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is light brownish gray and light yellowish brown, calcareous loam stratified with thin lenses of fine sandy loam and sandy loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Organic matter content in the surface layer is low. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate. This soil is subject to rare flooding during the spring and summer months.

This soil is used mainly for irrigated and nonirrigated cropland. In irrigated areas alfalfa, corn, sugar beets and beans are the chief crops. Winter wheat is the main crop in nonirrigated areas. Small isolated areas are used for grazing.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow or border irrigation systems. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues and maintaining organic matter content increases water infiltration and improves soil tilth.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting the soil from erosion. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from soil blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. They are somewhat hard to establish because of limited precipitation. Special care consisting of summer fallow a year prior to planting, supplemental water during plantings and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by good water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil feature is rare flooding. Special engineering measures such as embankments and elevated building pads are needed to minimize this condition. Capability subclass IVe nonirrigated, I irrigated.

33—Haverson loam, 1 to 3 percent slopes. This is a deep, well drained soil on terraces, fans and flood plains. It formed in calcareous, stratified, loamy alluvium deposited by intermittent streams in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Glenberg sandy loam and Bridgeport loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is light brownish gray and light yellowish brown calcareous loam stratified with thin lenses of fine sandy loam and sandy loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate. This soil is subject to rare flooding during spring and summer months.

This soil is used for nonirrigated and irrigated cropland and livestock grazing. Wheat is the principal crop grown in nonirrigated areas. Corn, sugar beets, alfalfa and small grains are the main crops in irrigated areas.

Management concerns in irrigated areas are proper use of irrigation water, maintenance of fertility and control of soil blowing. This soil is well suited to furrow and border irrigation systems. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil loss. Incorporating crop residues increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. They are somewhat hard to establish because of limited precipitation. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by good livestock water developments and types of fencing permitting unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil feature is rare flooding. Compensating engineering measures such as embankments and elevated building pads are needed to minimize this condition. Capability subclass IVe nonirrigated, IIe irrigated.

34—**Haverson loam, frequently flooded.** This is a deep, well drained soil on narrow flood plains of intermittent drainageways mainly in the northwestern part of the county. It formed in calcareous, stratified, loamy alluvium derived from sedimentary rocks. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Heldt clay loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is light brownish gray and light yellowish brown, calcareous loam stratified with thin lenses of fine silty loam to silt loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate. This soil is subject to frequent flooding during spring and summer months.

This soil is used almost entirely for grazing and native hayland. Some small isolated areas are used for nonirrigated cropland, with wheat and forage sorghum as the main crops.

The rangeland vegetation consists mainly of big bluestem, switchgrass, buffalograss, green needlegrass, sedge, western wheatgrass, and blue grama. This soil is often subjected to heavy livestock use because of the lush vegetation, the proximity to watering places, and the protection from cold winds that it provides. For periodic deferment during the grazing season, fences are needed. Otherwise, the range is overgrazed. Seeding is needed if the vegetation is depleted or destroyed by plowing.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from soil blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from soil blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by good livestock grazing management, water developments and type of fencing to permit unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil feature is frequent flooding. Intensive and costly compensating measures such as embankments and elevated building pads are needed to minimize this condition. Capability subclass IVw nonirrigated.

35—Haverson loam, saline. This is a deep, somewhat poorly drained soil affected by a slightly saline condition. It is on flood plains and terraces and formed in calcareous, stratified, loamy alluvium deposited by intermittent streams. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Haverson loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is light brownish gray and light yellowish brown, calcareous loam stratified with thin lenses of fine sandy loam and sandy loam to 60 inches or more. It contains visible salts in thin seams and streaks.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is subject to occasional flooding during spring and summer months.

This soil is used mainly for irrigated cropland and grazing. Alfalfa, corn and sugar beets are the principal crops grown in irrigated cropland areas. Crop yields are low because of the saline condition.

Management concerns in irrigated areas are irrigation water use, maintenance of fertility, and reduction of the saline condition. This soil is well suited to border and furrow irrigation systems. Irrigation water management and land leveling are needed for uniform distribution, efficient use of water and salt reduction. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residue helps maintain organic matter content and soil tilth and minimizes possible soil blowing and erosion.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland grasses or adapted introduced grasses such as tall wheatgrass. Fencing is effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally suited to this soil. The saline and somewhat poorly drained conditions and the abundant natural vegetation are principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control and selection of adapted plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its position in relation to irrigation canals and irrigated cropland. Under irrigation, it is important for food production. Wildlife, such as waterfowl, pheasants, and deer, utilize crop residues following harvest. Wildlife values can be enhanced on this soil by habitat development such as tree and shrub plantings and undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl could be attracted to the area by development of shallow water areas.

Where this soil is considered for homesites and other urban developments, the primary limiting soil features are occasional flooding and the saline condition. Intensive compensating measures such as embankments and elevated building pads are needed to minimize the flooding hazard. Special consideration of building materials is needed in order to compensate for possible corrosion from the saline condition. Capability subclass VIw nonirrigated, IIIw irrigated.

36—Haxtun loamy sand, 0 to 3 percent slopes. This is a deep, well drained soil of upland valleys and flats. It formed in sandy eolian materials over an older buried soil that formed in mixed calcareous loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gentle.

Included in this unit are small areas of Julesburg loamy sand and Ascalon sandy loam.

Typically the surface layer is grayish brown loamy sand about 8 inches thick. The upper part of the subsoil is grayish brown sandy loam about 13 inches thick. The lower part of the subsoil consists of dark grayish brown and grayish brown clay loam and loam about 14 inches thick. The substratum is a white, calcareous loam about 12 inches thick over unconformable light brown, calcareous, stratified coarse sand and gravel that extends to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated cropland. Small areas are used for sprinkler irrigation. The remaining acreage is used for grazing. Wheat, corn and grain sorghum are the main crops grown in nonirrigated cropland areas. Alfalfa and corn are the principal crops grown in irrigated areas.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues into the surface layer are needed to protect soil from blowing, improve soil tilth and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind (fig. 9) is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing. Crop residue management is needed when growing row crops.

In irrigated cropland areas the main concerns of management are soil blowing and maintenance of organic matter and fertility. This soil is best suited to sprinkler irrigation because of the rapid intake rate. Special management consisting of seeding a cover crop after row crops have been harvested and incorporating crop residues into the surface layer is needed to protect the soil from blowing. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are needed for high yields of all crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited on this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments with only minor limitations that can be easily modified. This soil should be protected from blowing by use of plant residue mulches or vegetation. Capability subclass IIIe nonirrigated, IIIe irrigated.

37—Haxtun loamy sand, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in sandy eolian deposits over an older buried loamy soil that formed in mixed calcareous, alluvial and eolian materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are gently sloping.

Included in this unit are small areas of Julesburg loamy sand and Ascalon sandy loam.

Typically the surface layer is grayish brown loamy sand about 8 inches thick. The upper part of the subsoil is grayish brown sandy loam about 13 inches thick. The lower part of the subsoil consists of dark grayish brown clay loam about 8 inches thick over grayish brown loam about 6 inches thick. The substratum is a white, calcareous loam about 12 inches thick over light brown, calcareous, stratified coarse sand and gravel that extends to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated cropland. Small areas are used for irrigated cropland. The remaining acreage is used for livestock grazing. Wheat, corn and sorghum are the principal crops grown in nonirrigated areas. In irrigated areas, corn and alfalfa are the main crops grown.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing. Crop residue management is needed when growing row crops.

In irrigated cropland areas the main concerns of management are soil blowing and maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of the rapid intake rate. Special care consisting of growing cover crops after row crop harvest and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Application of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Application of commercial fertilizers containing nitrogen and phosphorus is required for crop yields.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants proper grazing use is essential. Periodic deferment of grazing

during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by livestock grazing management, livestock water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments with only minor limitations that can be easily modified. This soil should be protected from blowing by the use of plant residue mulches as vegetative cover. Capability subclass IVe nonirrigated, IVe irrigated.

38—**Haxtun sandy loam.** This is a deep, well drained soil of upland valleys and flats. It formed in eolian sandy loam deposits overlying an older buried loamy soil that formed in mixed calcareous loamy alluvial and eolian deposits. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Ascalon sandy loam, Rago loam and Haxtun loamy sand, all having 0 to 3 percent slopes.

Typically the surface layer is grayish brown sandy loam about 8 inches thick. The upper part of the subsoil is grayish brown sandy loam about 13 inches thick. The lower part of the subsoil consists of dark grayish brown clay loam about 8 inches thick over grayish brown loam about 6 inches thick. The substratum is a white, calcareous loam about 12 inches thick over light yellowish brown, calcareous stratified coarse sand and gravel that extends to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated cropland. Remaining areas are used for irrigated cropland and for livestock grazing. Wheat, corn and sorghum are the principal crops grown in nonirrigated cropland areas. Alfalfa, corn and sugar beets are the main crops in irrigated areas.

Main objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are essential practices to protect soil from blowing, improve soil tilth and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and soil blowing. This soil is suited to furrow, border and sprinkler irrigation systems. Leveling and irrigation water management are necessary to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by livestock grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can

be easily modified. The soil should be protected from blowing by use of plant residue mulches as a vegetative cover. Capability subclass IIe nonirrigated, IIe irrigated.

39—Hayford silty clay loam. This is a deep, somewhat poorly drained soil on terraces. It formed in calcareous, loamy alluvium underlain by sand and gravel deposited by the South Platte River. It occurs mainly in an area between Sterling and Crook. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in mapping are small areas of Loveland clay loam and Alda loam. Much of this soil has been leveled, and exposures of the underlying parent material are common.

Typically the surface layer is dark gray silty clay loam about 7 inches thick. The subsoil is dark gray and gray, heavy silty clay loam about 15 inches thick. The substratum is light gray, calcareous, mottled clay loam about 10 inches thick over mottled sand and gravel that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table (fig. 10) occurs between 20 to 40 inches during winter and spring months.

This soil is used almost entirely for irrigated cropland though some small areas are used for grazing. Alfalfa, corn and sugar beets are the principal crops.

Proper use of irrigation water and fertility maintenance are the main concerns of management in irrigated areas. Irrigation methods suitable are furrows or borders, depending on the crop. Land leveling and irrigation water management are needed for uniform application and efficient use of water. Leveling designs must limit the depth of cuts to prevent exposure of the underlying sand and gravel. Incorporating crop residues improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility. Frequent light irrigations are needed because of the moderate available water capacity and slow permeability.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge and rush. Key forage grasses can be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. The soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing is effective in obtaining more uniform distribution of grazing.

Windbreak and environmental plantings are generally well suited to this soil. The high water table and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control, and selection of adapted plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use as cropland and its proximity to the South Platte River. Under irrigation, it is important for food production. Wildlife, such as waterfowl, pheasants and deer, utilize crop residues following harvest. Wildlife values can be enhanced by wildlife habitat development such as tree and shrub plantings and undisturbed nesting cover consisting of grasses and legumes. In the presence of an adequate water supply, waterfowl can be attracted to the area by development of shallow water areas.

Where areas are used for homesites and other urban developments, the primary limiting soil features are the water table at 20 to 40 inches, slow permeability, and high shrink-swell potential. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table and slow permeability. Compensating building designs are needed for dwellings and roads in order to minimize the shrink-swell and water table conditions. Capability subclass IIIw nonirrigated, IIIw irrigated.

40—Hayford silty clay loam, saline. This is a deep, somewhat poorly drained soil on terraces. It is underlain by sand and gravel. It formed in calcareous, saline and alkali loamy alluvium deposited by the South Platte River. It occurs mainly in the area between Proctor and the Nebraska State line. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in mapping are small areas of Alda loam and Lebsack clay loam, saline.

Typically the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is dark gray heavy silty clay loam about 15 inches thick with streaks of visible salt accumulations. The substratum is a stratified, mottled, light gray clay loam about 10 inches thick over mottled sand and gravel that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 20 to 40 inches during the winter and spring months. This soil is affected by a moderate saline-alkali condition.

This soil is used mainly for livestock grazing. Small areas are used for irrigated cropland, with alfalfa, small grains, and sugar beets as the principal crops. The saline-alkali condition limits crop yields.

Where the soil is used for irrigated cropland, the saline-alkali condition is sufficient to influence the choice of crop. Intensive management is required to reduce and minimize the saline-alkali condition and maintain soil productivity. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Drainage is needed to lower the water table and provide an outlet for excess salts and alkali. Land leveling is

needed in some areas to obtain uniform water distribution. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses can be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. The soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock water developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The high water table and saline-alkali condition are the principal concerns in establishing tree and shrub plantings. Special care consisting of summer fallow, continued cultivation for weed control, and selection of adapted saline-alkali tolerant plants is needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This soil has importance for wildlife because of its proximity to the South Platte River. Under irrigation, it is important for food production for wildlife such as waterfowl, pheasants and deer, all of which utilize crop residues following harvest. Wildlife values can be enhanced on this soil by developments such as tree and shrub plantings and by undisturbed nesting cover, which consists of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Where areas are used for homesites and other urban developments, the primary limiting soil features are a water table at 20 to 40 inches, slow permeability, and high shrink-swell potential. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table and slow permeability. Special consideration should be made in choosing building materials because of possible corrosion problems. Compensating building designs are needed for dwellings and roads in order to minimize the shrink-swell and water table condition. Capability subclass IVs nonirrigated, IIIw irrigated.

41—Heldt clay loam. This is a deep, well drained soil on upland flood plains of intermittent drainageways in the northwestern part of the county. It formed in calcareous, stratified clayey alluvium derived from shale and interbedded sandstone. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Manzanola clay loam.

Typically the surface layer is a grayish brown clay loam about 6 inches thick. The subsoil is grayish brown and light brownish gray, calcareous silty clay that extends to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for grazing. Some small areas are used for nonirrigated cropland, with wheat as the main crop.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton and sedge. Managing rangeland to maintain a balance between livestock and forage production is essential on this soil. Contour furrowing or pitting aids in recovery of depleted vegetation by trapping surface runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be improved by chemical control of these species.

In nonirrigated cropland areas management practices such as stubble mulch tillage and incorporating crop residues are needed to minimize soil blowing, improve soil tilth and conserve moisture. Chiseling and subsoiling will improve water and root penetration. Tillage pans form easily if this soil is tilled when wet. Terracing is also beneficial in reducing runoff and conserving moisture.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of limited moisture and soil moisture relationship. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Rangeland wildlife such as antelope, cottontails, coyotes and scaled quail are best adapted on this soil. Proper grazing management is necessary if wildlife and livestock share the rangeland. Watering developments are also important and are utilized by various wildlife species.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are slow permeability, low inherent strength and high shrink-swell potential. Compensating building and road designs must be utilized in order to offset the high shrink-swell potential and low strength. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of slow permeability. Capability subclass IVs nonirrigated.

42—Heldt clay loam, saline. This is a deep, well drained, saline affected soil. It is on upland flood plains and formed in calcareous, stratified clayey alluvium derived from shale and interbedded sandstone. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Heldt clay loam having 0 to 3 percent slopes and a few slickspots.

Typically the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is grayish brown and

light brownish gray, calcareous silty clay that is about 29 inches thick and contains visible salts occurring as streaks and seams. The substratum is light brownish gray, calcareous silty clay and clay loam to 60 inches. It also contains visible salts occurring as streaks and seams.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow. The erosion hazard is slight.

This soil is used almost entirely for grazing. It is not suited for cropland.

The rangeland vegetation of this soil consists mainly of inland saltgrass, alkali sacaton, western wheatgrass and fourwing saltbush. This soil is difficult to revegetate because of the saline condition. It is especially important that livestock grazing management be carefully applied. Periodic planned rest from grazing during the growing season is needed to maintain the key forage species. Chiseling or pitting reduces surface runoff, aids water infiltration, and improves plant cover where it has been depleted and is in poor or fair condition. Management of greasewood or rabbitbrush is needed where these shrubs have increased and now interfere with forage production and grazing distribution.

Windbreak and environmental plantings are generally not suited to this soil.

Rangeland wildlife such as antelope and mule deer can best be encouraged by proper grazing management and installation of watering facilities.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are slow permeability, inherent low strength, and high shrink-swell potential. Intensive and costly compensating measures are needed to minimize this condition. Capability subclass VIs nonirrigated.

43—Iliff loam. This is a moderately deep, well drained soil on upland tablelands. It formed in eolian silty material deposited over sandstone. It is dominant in the southeastern part of the county. The average annual precipitation ranges from 17 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Rago loam, 0 to 1 percent slopes, and Weld loam, 1 to 3 percent slopes.

Typically the surface layer is grayish brown loam about 11 inches thick. The subsoil (fig. 11) is dark grayish brown heavy silty clay loam about 14 inches thick. The substratum is light gray, calcareous silt loam about 12 inches thick over white, calcareous sandstone at 34 inches.

Permeability is slow. Effective rooting depth ranges from 20 to 40 inches. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight.

Most of the acreage is cultivated, mainly to nonirrigated crops such as wheat and grain sorghum grown in a crop-fallow system. In irrigated areas corn, alfalfa and sorghums are the main crops grown. Some small areas are used for grazing.

In nonirrigated cropland areas the primary objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to minimize soil erosion, improve water infiltration and soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing surface runoff and conserving moisture.

Proper use of irrigation water, slow permeability, and fertility maintenance are the main concerns of management in irrigated areas. Irrigation methods suitable are furrows or borders, depending on the crops. Land leveling and good irrigation water management are needed for uniform application and efficient use of water. Short irrigation runs and frequent light irrigations are needed on this soil because of the slow permeability and depth to bedrock. Incorporating crop residues reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizer consisting of nitrogen and phosphorus are important to maintain fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Special care consisting of summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control is needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are depth to rock, slow permeability and high shrink-swell potential. Compensating dwelling and road designs are needed to minimize the high shrink-swell potential. Depth

to bedrock limits shallow excavations, sewage lagoons and dwellings with basements. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the depth to bedrock and slow permeability. Capability subclass IIIs nonirrigated, IIIe irrigated.

44—Julesburg loamy sand, 0 to 3 percent slopes. This is a deep, well drained soil in upland valleys. It formed in noncalcareous, sandy eolian and alluvial deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Haxtun loamy sand.

Typically the surface layer is grayish brown loamy sand about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown loamy fine sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for irrigated and nonirrigated cropland. Wheat is the principal crop grown in nonirrigated areas. Corn, alfalfa, and small grains are the main crops grown in irrigated areas. Remaining areas are used for grazing.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting the soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting the soil from blowing. Close grown crops are effective in protecting the soil from blowing. Crop residue management is needed when growing row crops.

In irrigated cropland areas the main concerns of management are soil blowing and maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of the rapid intake rate. Most of the pivotal sprinkler systems are located in areas of this soil. Special care consisting of growing cover crops after row crop harvest and incorporating crop residues during periods when no growing crop is present is needed to protect the soil from blowing. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Sealing methods are required to overcome excessive seepage if this soil is used for sewage lagoons. This soil should be protected from blowing at all times by utilization of mulches or vegetative cover. Capability subclass IVe nonirrigated, IIIe irrigated.

45—Julesburg loamy sand, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in noncalcareous, sandy eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are gently to moderately sloping.

Included in this unit are small areas of Haxtun loamy sand. The areas of Haxtun soils are on foot slopes.

Typically the surface layer is grayish brown loamy sand about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown loamy fine sand to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for irrigated cropland (fig. 12) and grazing. It is not suited for nonirrigated cropland because of its low available water capacity and limited precipitation. Corn and alfalfa are the principal crops grown in irrigated areas. Areas in nonirrigated cropland are best seeded to grass.

In irrigated cropland areas the main concerns of management are soil blowing and maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of its rapid intake rate.

Most of the pivotal sprinkler systems are located in areas of this soil. Special care consisting of growing cover crops after row crop harvest and incorporating crop residues during periods when no growing crop is present is needed to protect the soil from blowing. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand dropseed, sand reedgrass, little bluestem, blue grama, switchgrass, and needleandthread as the main forage species. Sand sagebrush is interspersed with the grasses. Proper grazing use is needed to maintain or improve a productive growth of forage. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range conditions. This soil can be seeded to rangeland grasses if it becomes depleted by grazing or farming. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Sealing methods are required to overcome the excessive seepage if the soil is used for sewage lagoons. This soil should be protected from blowing by utilization of straw and other plant residue mulches or vegetative cover. Capability subclass VIe nonirrigated, IVe irrigated.

46—Julesburg fine sandy loam, 0 to 3 percent slopes. This is a deep, well drained soil in upland valleys. It formed in noncalcareous, sandy eolian and alluvial deposits. The average annual precipitation ranges from 15 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Haxtun loamy sand and Julesburg loamy sand.

Typically the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown, noncalcareous loamy fine sand to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used for irrigated cropland, nonirrigated cropland and grazing. In irrigated areas, corn, alfalfa and sugar beets are the main crops grown. Wheat is the main crop grown in nonirrigated cropland areas.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and soil blowing. This soil is suited to furrow, border or sprinkler irrigation methods. Leveling and irrigation water management are necessary to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Primary objectives of management in nonirrigated cropland areas are protecting the soil from blowing and conserving moisture. Stubble mulch tillage and incorporating crop residues are essential practices to protect the soil from blowing and improve soil tilth. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting the soil from blowing. Close grown crops are also effective in protecting the soil from blowing.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing

nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can be easily modified. Where this soil is considered for a sewage lagoon system, special sealing methods are required to overcome the excessive seepage. Capability subclass IIIe nonirrigated, IIe irrigated.

47—Julesburg fine sandy loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland convex ridges and hills. It formed in noncalcareous, sandy eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are gently sloping.

Included in this unit are small areas of Manter sandy loam.

Typically the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown, noncalcareous loamy fine sand to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used for nonirrigated cropland and irrigated cropland. The remaining acreage is used for grazing. Wheat and sorghum are the main crops grown in nonirrigated areas. Alfalfa, corn, sugar beets and small grains are the principal crops in irrigated areas.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and control of soil blowing. This soil is suited to contour furrow, contour ditch and sprinkler methods of irrigation. Land leveling between irrigation ditches and irrigation water management are needed to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Primary objectives of management in nonirrigated cropland areas are protecting soil from blowing and conserving moisture. Stubble mulch tillage and incorporating crop residues are essential practices to protect the soil from blowing and improve soil tilth. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting the soil from blowing. Close grown crops are also effective in protecting the soil from blowing.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

The rangeland vegetation of this soil consists of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can be easily modified. Where the soil is considered for a sewage lagoon system, special sealing methods are required to overcome the excessive seepage. Capability subclass IIIe nonirrigated, IIIe irrigated.

48—Julesburg fine sandy loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland ridges lying commonly in a northwesterly direction. It formed in noncalcareous, sandy eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are moderately sloping.

Included in this unit are small areas of Julesburg loamy sand and Manter sandy loam.

Typically the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown, noncalcareous loamy fine sand to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used for irrigated and nonirrigated cropland and grazing. Wheat and sorghum are the main crops grown in nonirrigated cropland areas. In irrigated cropland areas alfalfa, corn and small grains are the principal crops grown.

In irrigated areas the main concerns of management are proper use of irrigation water, controlling soil blowing and maintaining and improving soil fertility. Special care is needed in application of irrigation water because of the steepness of slope. This soil is best suited to sprinkler irrigation. If furrow or corrugation irrigation methods are used, short runs and frequent applications of water are necessary. The furrows and corrugations should be placed across the slope to reduce soil losses. Land leveling is also needed in most areas to smooth slopes in order to obtain more uniform application of water. Incorporating crop residues is needed to reduce soil blowing during periods when soils are not protected by growing crops and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing.

The rangeland vegetation of this soil consists of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing and steepness of slope are the principal concerns to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments.

Where used for homesites and other urban developments, this soil has only minor limitations that can be easily modified. Seepage and slope are the primary limiting soil features. Where the soil is considered for a sewage lagoon system, special design and construction are needed to overcome the excessive seepage loss and the slope. Capability subclass IVe nonirrigated, IVe irrigated.

49—Julesburg-Eckley complex, 3 to 9 percent slopes. These gently to moderately sloping soils are on upland ridges and hills in the south central part of the county. Average annual precipitation ranges from 17 to 19 inches. Julesburg sandy loam, 3 to 6 percent slopes, makes up about 60 percent of the map unit, and Eckley gravelly loam, 3 to 9 percent slopes, makes up about 40 percent. The Julesburg soil is at midslope and on foot slopes. The Eckley soil is on ridge crests and knobs.

Included in this unit are small areas of Dix gravelly sandy loam, 9 to 18 percent slopes, and Dailey loamy sand, 3 to 9 percent slopes. The Dix soil is on knobs and the Dailey soil is on concave and foot slope positions.

The Julesburg soil is a deep, well drained soil. It formed in noncalcareous, sandy eolian deposits.

Typically the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsoil is dark grayish brown, grayish brown, and brown sandy loam about 26 inches thick. The substratum is brown and pale brown, noncalcareous loamy fine sand to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

The Eckley soil is a deep, well drained soil. It formed in stratified, reddish colored, gravelly alluvial materials of the Ogallala Formation.

Typically the surface layer is dark grayish brown gravelly loam about 3 inches thick. The subsoil layer is dark brown and brown gravelly sandy clay loam about 17 inches thick. The substratum layer is light brown gravelly coarse loamy sand and coarse sand to 60 inches or more.

Permeability is moderate. The effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is rapid, and the erosion hazard is high.

These soils are used almost entirely for grazing. Small isolated areas are used for nonirrigated cropland but are commonly severely eroded and are best seeded back to grass. These soils are best suited for grazing.

Rangeland vegetation of the Julesburg soil consists of blue grama, sand dropseed, sand reedgrass, little bluestem, switchgrass, sand bluestem, and needleandthread as the main forage species. Sand sagebrush is in a scattered stand in the vegetation. Rangeland vegetation of the Eckley soil consists mainly of sideoats grama, little bluestem, blue grama, buffalograss, and sedge. Grazing management on these soils is needed to maintain or improve productive range condition. Periodic deferment of grazing during the growing season is beneficial in improving and maintaining range condition. These soils can

be seeded to rangeland grasses if they become denuded by grazing or by cultivation. Rangeland mechanical treatment is not generally applicable on these soils because of the high erosion hazard of the Eckley soil. Fencing and careful location of livestock watering places improve distribution of grazing use.

Windbreaks and environmental plantings are difficult to establish on these soils. Soil blowing and steepness of slope are the principal concerns to establishing trees and shrubs. These hazards can be overcome by cultivating only in the tree row, by contour planting and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Rangeland wildlife such as antelope, cottontail and coyote are best adapted on this soil. Livestock grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species. The position of this soil to croplands makes it valuable as a producer of escape cover areas for openland wildlife, especially pheasants.

These soils are well suited to use as homesites and other urban developments, with only minor limitations that can be easily modified. Sealing methods are required to overcome excessive seepage if these soils are used for sewage lagoons or sanitary landfills. Capability subclass VIe nonirrigated.

50—Keith loam. This is a deep, well drained soil on upland flats. It formed in calcareous loamy eolian materials and is extensive in the northern and south central parts of the county. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included are small areas of Kuma loam and Satanta loam, both having 0 to 3 percent slopes.

Typically the surface layer is grayish brown loam about 6 inches thick. The subsoil is grayish brown loam and clay loam about 12 inches thick over light brownish gray, calcareous loam about 7 inches thick. The substratum is very pale brown, calcareous loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used almost entirely for nonirrigated and irrigated cropland. Some isolated areas are used for grazing. Wheat and grain sorghum are the principal crops grown in nonirrigated areas. Alfalfa, corn and sugar beets are the main crops grown in irrigated cropland.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting the soil from blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are proper use of irrigation water, maintenance of fertility, and control of soil blowing. This soil is well suited to furrow and border irrigation. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil losses. Incorporating crop residues into the surface soil increases infiltration, reduces soil blowing and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management and water developments.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIe nonirrigated, IIe irrigated.

51—Kim loam, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy alluvial and eolian materials. The

average annual precipitation ranges from 13 to 17 inches. Slopes are gently to moderately sloping.

Included in this unit are small areas of Stoneham loam and Mitchell loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam and sandy loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for grazing. Small areas are used for irrigated cropland, with alfalfa as the main crop grown. This soil is best suited for grazing in nonirrigated areas. Small dryfarmed areas are usually eroded and are best reseeded to grass.

In irrigated areas managing irrigation water, controlling soil erosion and maintaining soil fertility are the main concerns of management. Under good management this soil can be cultivated safely. Because of the slopes and erosion hazard, this soil should be kept in close growing crops and not used for row crops. Some land leveling is generally needed to remove slope irregularities in order to obtain more uniform distribution of irrigation water. Contour furrow and contour ditch are the best suited methods of irrigation on this soil. Short irrigation runs and use of small heads of water are essential in controlling soil loss. Incorporating crop residue is important in controlling soil erosion, maintaining fertility and improving soil tilth. Application of manure and commercial fertilizer containing nitrogen and phosphates are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil because of slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water development, and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments. Low strength is the primary limiting soil feature. Dwelling and road designs need to be modified to offset the low inherent ability to support a load. Capability subclass VIe nonirrigated, IVe irrigated.

52—Kuma loam. This is a deep, well drained soil of upland flats, swales and depressions. It formed in calcareous, eolian materials of two ages. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included are small areas of Keith loam and Rago loam, both having 0 to 3 percent slopes.

Typically the surface layer is grayish brown loam about 5 inches thick. The upper 12 inches of the subsoil is grayish brown loam. The lower part is a buried soil consisting of dark gray and dark grayish brown loam about 11 inches thick over light brownish gray, calcareous loam about 4 inches thick. The substratum is light gray and very pale brown, calcareous loam and very fine sandy loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland, with wheat as the main crop grown. Some areas are used for irrigated cropland where water is available. Alfalfa, corn and sugar beets are the principal crops grown in irrigated areas. The remaining acreage is used for grazing.

In nonirrigated cropland areas the primary objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increase water infiltration and improve soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing nesting and escape cover areas. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

This soil has only minor limitations that can be easily modified where used for homesites and other urban developments. Capability subclass IIc nonirrigated, IIe irrigated.

53—Kutch clay loam, 0 to 3 percent slopes. This is a moderately deep, well drained soil on upland flats. It formed in calcareous clayey materials weathered from shale. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Nunn clay loam.

Typically the surface layer is grayish brown clay loam about 3 inches thick. The subsoil is dark grayish brown and light brownish gray clay about 17 inches thick. The substratum is light gray, calcareous clay loam about 17 inches thick. Soft shale is at a depth of about 37 inches. Permeability is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used for nonirrigated cropland and grazing. Wheat is the principal crop grown in nonirrigated cropland areas.

In nonirrigated cropland areas management practices such as stubble mulch tillage and incorporating crop residues are needed to protect the soil from blowing and improve water and root penetration. Tillage pans form easily if this soil is tilled when wet. Terracing is also beneficial in reducing runoff and conserving moisture.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of limited moisture and soil moisture relationship. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton and sedge. Managing rangeland to maintain a balance between livestock and forage production is essential on this soil. Contour furrowing or pitting aids in recovery of depleted vegetation on this soil by reducing runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be managed by chemical control of these species.

Rangeland wildlife such as antelope, cottontails, coyote and scaled quail are best adapted on this soil. Forage production is typically low and proper grazing management is necessary if wildlife and livestock share the range. Watering developments are also important and are utilized by various wildlife species. In cropland areas, openland wildlife can be encouraged if food and cover areas are provided.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are depth to rock, slow permeability, high shrink-swell and low strength. Intensive compensating measures are needed to minimize these limiting soil properties. Capability subclass IVs nonirrigated.

54—Kutch clay loam, 3 to 9 percent slopes. This is a moderately deep, well drained soil on upland ridges and valley side slopes. It formed in calcareous, clayey materials weathered from shale. The average annual precipitation ranges from 13 to 17 inches. Slopes are gently to moderately sloping.

Included in this unit are small areas of Nunn clay loam, 3 to 5 percent slopes, on foot slope positions.

Typically the surface layer is grayish brown clay loam about 3 inches thick. The subsoil is dark grayish brown and light brownish gray clay about 17 inches thick. The substratum layer is light gray clay loam about 17 inches thick. Soft shale is at a depth of about 37 inches.

Permeability is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used almost entirely for grazing. Some small areas are used for nonirrigated cropland, with wheat as the main crop. The soil is best suited for grazing.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green

needlegrass, alkali sacaton and sedge. Managing rangeland to maintain a balance between livestock and forage production is essential on this soil. Contour furrowing or pitting aids in recovery of depleted vegetation on this soil by decreasing runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be managed by chemical control of these species.

In nonirrigated cropland areas, management practices such as stubble mulch tillage and incorporating crop residues are needed to protect the surface soil from blowing, improve soil tilth and conserve moisture. Chiseling and subsoiling improve water and root penetration. Tillage pans form easily if this soil is tilled when wet. Terracing is also beneficial in reducing runoff, controlling erosion, and conserving moisture.

Windbreaks and environmental plantings are difficult to establish on this soil because of limited moisture and soil moisture relationship. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Rangeland wildlife such as antelope, cottontails, coyote and scaled quail are best adapted on this droughty soil. Forage production is typically low and proper grazing management is necessary if wildlife and livestock share the range. Watering developments are also important and will be utilized by various wildlife species. In nonirrigated cropland areas openland wildlife can be encouraged if food and cover areas are provided through various means of wildlife development.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are depth to bedrock, slow permeability, high shrink-swell and low strength. Intensive compensating measures are needed to minimize these limiting soil properties. Capability subclass IVe nonirrigated.

55—Lebsack silty clay loam. This is a deep, moderately well drained soil on terraces. It formed in calcareous, clayey alluvium deposited by the South Platte River and large tributary streams. Annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Nunn clay loam and Satanta loam, water table.

Typically the surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is grayish brown, calcareous heavy silty clay loam about 28 inches thick. The substratum is light gray, calcareous heavy silty clay loam to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

Nearly all of this soil is used for irrigated cropland. Corn, alfalfa, and sugar beets are the main crops grown. Some small areas are used for grazing.

Management concerns in irrigated areas are mainly proper use of irrigation water and maintenance of fertility. This soil is well suited to furrow or border irrigation. Land leveling is necessary in some areas to obtain uniform distribution of water. Length of runs should be designed to allow for infiltration of irrigation water because of the slow permeability. Incorporating crop residues in the surface soil increases infiltration and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass and sedge. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and water developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The moderately well drained condition and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control, and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use for cropland and its proximity to the South Platte River. Under irrigation it is important for food production for wildlife such as waterfowl, pheasants and deer utilizing crop residues following harvest. Wildlife values can be enhanced by wildlife habitat developments such as tree and shrub plantings and by undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl could be attracted to the area by development of shallow water areas.

Where areas are used for homesites and other urban developments, the primary limiting soil features are slow permeability and high shrink-swell potential. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of slow permeability. Compensating engineering designs and measures such as backfilling with materials of low shrink-swell potential and offsetting structural construction are needed for dwellings and roads to minimize the shrink-swell potential. Capability subclass IIIs nonirrigated, IIs irrigated.

56—Lebsack clay loam, saline. This is a deep, moderately well drained, salt affected soil. It is on terraces and formed in calcareous clayey alluvium deposited by the South Platte River. The annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included are small areas of Hayford silty clay loam, saline and Nunn clay loam, wet.

Typically the surface layer is grayish brown silty clay loam about 9 inches thick. The subsoil is grayish brown, calcareous, salt affected heavy silty clay loam about 25 inches thick. The substratum is light gray, calcareous heavy silty clay loam to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for grazing. Some small areas are used for irrigated cropland. Alfalfa and small grains are the principal crops grown. Crop yields are low and crop selection limited because of the salt condition.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and watering developments are effective in obtaining more uniform distribution of grazing.

Where the soil is used for irrigated cropland, the saline condition will influence the choice of crop. Intensive management is required to reduce and minimize the saline condition and maintain soil productivity. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Land leveling is needed in some areas to obtain more uniform water distribution. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Windbreaks and environmental plantings are difficult to establish on this soil. The saline condition and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control, and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its proximity to the South Platte River. Under irrigaton, it is important for food production for wildlife such as waterfowl, pheasants and deer, all of which utilize crop residues following harvest. Wildlife values can be enhanced by wildlife habitat developments such as tree and shrub plantings and by undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Where areas are used for homesites and other urban developments, the primary limiting soil features are slow permeability and high shrink-swell potential. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building designs and measures are needed for dwellings and roads in order to minimize the shrink-swell condition. Capability subclass VIs nonirrigated, IVs irrigated.

57—Lebsack clay loam, wet. This is a deep, somewhat poorly drained soil on terraces, upland flood plains and alluvial fans. It formed in calcareous, clayey alluvium. This soil is affected by wetness caused by seepage from irrigation supply systems. The average annual precipitation ranges from 15 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Nunn clay loam, wet, and Satanta loam, wet.

Typically the surface layer is grayish brown silty clay loam about 9 inches thick. The subsoil is grayish brown, calcareous heavy silty clay loam about 25 inches thick. The substratum is light gray, calcareous, heavy silty clay loam to 60 inches. Salts is common in the substratum and lower part of the subsoil.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is moderately affected by excess salt.

This soil is used for irrigated cropland and grazing. Choice of crops and crop yields are affected by the high water table and saline condition. Alfalfa and sugar beets are the principal crops grown.

Where this soil is used for irrigated cropland, intensive management is required to reduce and minimize the wetness and saline condition and maintain soil productivity. Subsoiling is effective in improving water infiltration, thus allowing salts to leach downward. A tile field drainage system together with open drainage ditches are essential to improve drainage and provide an outlet for leached salts. Land leveling is needed in some areas to obtain more uniform water distribution. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and watering developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The wetness and salt content and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control, and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its position in relation to irrigation canals and irrigated cropland. Under irrigation, it is important for food production for wildlife such as waterfowl, pheasants and deer, all of which utilize crop residues following harvest. Wildlife values can be enhanced on this soil by wildlife habitat developments such as tree and shrub plantings and by undisturbed nesting cover which consists of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are high shrink-swell potential, slow permeability and wetness. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building and road designs are needed to offset the shrink-swell and wetness. Capability subclass IIw nonirrigated, IIw irrigated.

58—Loveland clay loam. This is a deep, somewhat poorly drained soil on low terraces and bottomlands. It formed in calcareous, loamy alluvium underlain by mottled sand and gravel deposited by the South Platte River. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Hayford silty clay loam and Alda loam. In leveled areas, exposures of the underlying parent material are common.

Typically the surface layer is grayish brown clay loam about 13 inches thick. The underlying layer is mottled, grayish brown, calcareous light clay loam and sandy clay loam about 21 inches thick over mottled sand and gravel that extends to 60 inches or more.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 20 and 40 inches during the winter and spring months. This soil is subject to occasional flooding during late spring and early summer months.

This soil is used mainly for irrigated cropland. Some small areas are used for grazing. Alfalfa, corn, sugar beets and small grains are the principal crops.

Proper use of irrigation water and maintenance of fertility are the main concerns of management. Protective dikes may be required to minimize the flood hazard. Irrigation methods suitable are furrows or borders, depending on the crops. Land leveling and irrigation water management are needed for uniform application and efficient use of water. Incorporating crop residues with the surface soil increases infiltration and improves soil tilth. Application of manure and commercial fertilizers containing nitrogen and phosphorus are important to maintain soil fertility.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. The soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and water developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are well suited to this soil. The high water table and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its intensive use for cropland and its position in relation to the bottomlands of the South Platte River. Its primary value for wildlife species lies in the food it produces, which the wildlife utilize while using the river bottom areas for cover. Wildlife utilizing this soil include mule and white-tailed deer, bobwhite, ducks, geese, and miscellaneous nongame species. Wildlife habitat can be provided and improved on this soil by tree and shrub plantings, planting grasses and legumes for undisturbed nesting cover, and providing wildlife travel lanes from riverbottom areas to feeding areas. Shallow water wetland areas can be developed to attract waterfowl.

Where areas are used for homesites and other urban developments, the primary limiting soil features are a water table at depths of 20 to 40 inches, and occasional flooding. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the high water table. For homesites and urban development construction, compensating measures and designs are needed to overcome the water table and the flooding. Road designs are needed that will take into account the frost action of the soil. Capability subclass IIIw nonirrigated, IIIw irrigated.

59—Manter loamy sand, 0 to 3 percent slopes. This is a deep, well drained soil of upland flats and valleys. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 18 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Ascalon sandy loam, 0 to 3 percent slopes.

Typically the surface layer is grayish brown loamy sand about 6 inches thick. The subsoil is dark grayish brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used for grazing, nonirrigated and irrigated cropland. Wheat is the principal crop grown in nonirrigated areas. Corn, alfalfa and small grains are the main crops grown in irrigated areas.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting the soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth and conserve moisture. Tillage should be kept to a minimum. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing. Intensive crop residue management is needed when row crops are grown.

In irrigated cropland areas the main concerns of management are soil blowing, maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of the rapid intake rate. Special care consisting of growing cover crops after row crop harvest and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Sealing methods are required to overcome excessive seepage in sewage lagoon sites. This soil should be protected from soil blowing at all times by utilization of mulches or vegetative cover. Capability subclass IVe nonirrigated, IIIe irrigated.

60—Manter loamy sand, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are gently sloping to moderately sloping.

Included in this unit are small areas of Ascalon sandy loam and Julesburg loamy sand.

Typically the surface layer is grayish brown loamy sand about 6 inches thick. The subsoil is dark grayish brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is high.

This soil is used mainly for grazing and irrigated cropland. It is not suited for nonirrigated cropland because of the high soil blowing hazard. Areas in nonirrigated cropland are usually severely eroded and are best seeded back to grass. Corn and alfalfa are the principal crops grown in sprinkler irrigated areas.

In irrigated cropland areas the main concerns of management are soil blowing, maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of its rapid intake rate. Special care consisting of growing cover crops after row crop harvest and incorporating crop residues during periods when no growing crop is present to protect the soil is needed. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yields of all crops.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows.

Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbit, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are seepage and soil blowing. Sealing methods are required to overcome the excessive seepage in sewage lagoon sites. This soil should be protected from soil blowing at all times by utilization of mulches and vegetative cover. Capability subclass VIe nonirrigated, IVe irrigated.

61—Manter sandy loam, 0 to 3 percent slopes. This is a deep, well drained soil on upland flats, terraces and alluvial fans. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Ascalon sandy loam and Chappell sandy loam.

Typically the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil is dark grayish brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Some areas are used for grazing. Wheat is the principal crop grown in nonirrigated areas. In irrigated areas corn, alfalfa and sugar beets are the main crops.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are practices needed to protect soil from blowing, improve soil tilth and conserve moisture. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and soil blowing. This soil is suited to furrow, border or sprinkler irrigation methods. Leveling and irrigation water management are necessary to obtain uniform distribution and efficient use of water. Frequent light irrigations are beneficial on this soil because of its moderate available water capacity. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

The rangeland vegetation of this soil consists of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can be easily modified. Sealing methods are required to overcome the excessive seepage if the soil is used for sewage lagoon sites. Capability subclass IIIe nonirrigated, IIe irrigated.

62—Manter sandy loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland hills and ridges. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are moderately sloping.

Included in this unit are small areas of Ascalon sandy loam and Chappell sandy loam. The Chappell soil is on small alluvial fans.

Typically the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil is dark grayish

brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Some areas are used for grazing. Wheat is the principal crop in nonirrigated cropland. Alfalfa, corn, and sugar beets are the main crops on irrigated cropland.

Primary objectives of management in nonirrigated cropland areas are protecting soil from blowing and conserving moisture. Stubble mulch tillage and incorporating crop residues are essential practices to protect the soil from blowing and improve soil tilth. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and control of soil erosion. This soil is suited to contour furrow, contour ditch or sprinkler methods of irrigation. Land leveling and irrigation water management are needed to obtain uniform distribution and efficient use of water. Irrigation runs should be short when using the contour systems to minimize soil losses. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water development.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can be easily modified. Sealing methods are required to overcome the excessive seepage when the soil is used as a sewage lagoon site. Capability subclass IVe nonirrigated, IIIe irrigated.

63—Manter sandy loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland hills and ridges. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 18 inches. Slopes are moderately sloping.

Included in this unit are small areas of Ascalon sandy loam.

Typically the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil is dark grayish brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Some areas are used for grazing. Wheat is the principal crop on nonirrigated cropland. In irrigated cropland areas alfalfa, corn and sugar beets are the main crops grown.

In nonirrigated cropland areas the main concerns of management are conserving soil moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are needed to protect soil from blowing, improve soil tilth and conserve moisture. Planting crops in alternate strips at right angles to the prevailing wind is effective in protecting soil from blowing. Close grown crops are also effective in protecting soil from blowing. Tillage should be kept to a minimum.

In irrigated areas the main concerns of management are proper use of irrigation water, controlling soil erosion and maintaining and improving soil fertility. This soil is suited to contour furrow, contour ditch or sprinkler methods of irrigation. Land leveling is needed in most areas to smooth slopes to obtain more uniform application of water. Irrigation runs should be short when using contour systems to minimize soil losses. Incorporating crop residues is needed to reduce soil blowing during periods when soils are not protected by growing crops and improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments.

Where used for homesites and other urban developments, this soil has only minor limitations that can be easily modified. Sealing methods are required to overcome the excessive seepage when this soil is used for sewage lagoon sites. Capability subclass IVe nonirrigated, IVe irrigated.

64—Manter sandy loam, water table. This is a deep, moderately well drained soil on terraces. It formed in calcareous, loamy alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level.

Included in this unit are small areas of Julesburg fine sandy loam, 0 to 3 percent slopes.

Typically the surface layer is a grayish brown sandy loam about 6 inches thick. The subsoil (fig. 13) is dark grayish brown and brown sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches. Mottles are common in the substratum below 40 inches.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for irrigated cropland. Some small areas are used for grazing. Corn, alfalfa and sugar beets are the main crops grown.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and soil blowing. This soil is suited to furrow, border or sprinkler irrigation methods. Leveling and good irrigation water management are necessary to obtain uniform distribution and efficient use of water. Frequent light irrigations are most effective on this soil because of the moderate available water capacity. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

The rangeland vegetation of this soil consists mainly of sand bluestem, sand reedgrass, sand dropseed, little bluestem, blue grama, needleandthread, and switchgrass. Sand sagebrush is interspersed with the grasses. To maintain a productive growth of forage plants, proper grazing use is essential. Periodic deferment of grazing during the growing season is beneficial in maintaining and improving range condition. Fencing is necessary to obtain more uniform distribution of grazing animals. Brush management is needed when sand sagebrush becomes excessively dense and reduces forage production.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal concern in establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Openland wildlife such as pheasant, cottontail, mourning dove and miscellaneous songbirds are favored on this soil because of its high potential for growing habitat utilized by these kinds of wildlife. Under irrigation, growing a great variety of crops and cover types is possible. Some of the primary needs of openland wildlife populations include tree and shrub plantings and undisturbed nesting cover.

The primary limiting soil features for homesites, other urban developments, and roads are the water table and seepage. Special septic systems are needed to offset the high water table. Compensating engineering measures are required for dwellings with basements in order to overcome the water table condition. Special sealing methods are required to overcome excessive seepage when this soil is used as a sewage lagoon site. Capability subclass IIIe nonirrigated, IIw irrigated.

65—Manter sandy loam, wet. This is a deep, wet soil affected by a slight saline condition. It is on upland flats and ridges and is affected by excessive seepage from irrigation canals. It formed in calareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Manter sandy loam, 0 to 3 percent slopes.

Typically the surface layer is a grayish brown sandy loam about 6 inches thick. The subsoil is dark grayish brown and brown sandy loam about 18 inches thick with some visible salts occurring as streaks and seams in the lower part. The substratum is light gray and pale brown, calcareous sandy loam and loamy sand extending to 60 inches. This layer contains mottles and some visible salts occurring as streaks and seams.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the water erosion hazard is slight, and the wind erosion is moderate. The water table fluctuates between 2 and 4 feet from April to October.

This soil is used mainly for irrigated cropland. Some small areas are used for grazing. Alfalfa, corn, sugar beets and small grains are the principal crops.

In irrigated areas the main concerns of management are proper use of irrigation water, fertility, soil blowing, salinity, and wetness. Artificial drainage, either tile or deep open ditch, is needed to lower the water table and provide an outlet for excessive salts. This soil is suited to furrow, border or sprinkler irrigation methods. Frequent and light irrigations are essential. Leveling and good irrigation water management are necessary to obtain uniform distribution and efficient use of water. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Rangeland vegetation consists mainly of sand bluestem, sand reedgrass, little bluestem, indiangrass, prairie cordgrass, switchgrass, western wheatgrass and sedge. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and watering developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are suited to this soil. The saline condition, high water table and abundant natural vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its position in relation to irrigation canals and irrigated cropland. Under irrigation, it is important for food production for wildlife such as waterfowl, pheasants and deer, all of which utilize crop residues following harvest. Wildlife values can be enhanced on this soil by habitat developments such as tree and shrub plantings and undisturbed nesting cover, which consists of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

The primary limiting soil feature for homesites and other urban developments is wetness. Special septic systems are needed. Compensating engineering measures are required for dwellings with basements in order to overcome the wetness. Capability subclass IIIs nonirrigated, IIw irrigated.

66—Manzanola clay loam. This is a deep, well drained soil on terraces and flood plains. It formed in calcareous, loamy alluvium deposited by the larger intermittent streams in the northwestern part of the county. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level to gently sloping.

Included in mapping are small areas of Heldt clay loam having 0 to 3 percent slopes.

Typically the surface layer is a grayish brown clay loam about 3 inches thick. The subsoil is grayish brown and light brownish gray heavy clay loam about 8 inches thick and is calcareous in the lower part. The substratum layer is pale yellow, calcareous clay loam, containing visible salts in thin seams and streaks and extending to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used for nonirrigated and irrigated cropland and grazing. In irrigated areas alfalfa, corn, sugar beets and small grains are the principal crops. Wheat is the main crop in nonirrigated areas.

In nonirrigated cropland areas management practices such as stubble mulch tillage and incorporating crop residues are needed to protect the soil from blowing and improve water infiltration. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are mainly proper use of irrigation water, slow permeability, and maintenance of fertility. This soil is well suited to furrow or border irrigation methods. Land leveling is necessary in some areas to obtain uniform distribution of water. Length of runs should be designed to allow for infiltration of water because of the slow permeability. Incorporating crop residues in the surface soil increases infiltration and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton and sedge. Managing rangeland to maintain a balance between livestock and forage

production is highly essential on this soil. Contour furrowing or pitting aids in recovery of depleted vegetation on this soil by intercepting surface runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be managed by chemical control of these species.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of limited moisture and soil moisture relationship. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Rangeland wildlife such as antelope and cottontails, coyote and scaled quail are best adapted on this soil. Proper grazing management is necessary if wildlife and livestock share the range. Watering developments are also important and are utilized by various wildlife species. In nonirrigated and irrigated cropland areas, openland wildlife can be encouraged if food, cover, and undisturbed nesting areas are provided.

Where this soil is considered for homesites and other urban developments, the primary limiting soil features are slow permeability and high shrink-swell. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building and road designs must be utilized in order to overcome the shrink-swell condition. Capability subclass IVe nonirrigated, IIe irrigated.

67—Midway clay loam, 5 to 20 percent slopes. This is a shallow, well drained soil on upland ridges, hills, and break areas in the northwestern part of the county. It formed in calcareous, clayey materials weathered from clay shales of the Pierce Formation. The average annual precipitation ranges from 13 to 17 inches. Slopes are moderately sloping to moderately steep.

Included in this unit are small areas of Renohill loam, 5 to 9 percent slopes, and a few shale outcrops.

Typically the surface layer is a grayish brown clay loam about 2 inches thick. The underlying layer is light yellowish brown, calcareous clay loam about 8 inches thick. Below this is a light yellowish brown, calcareous clay shale at a depth of 10 inches.

Permeability is slow. Effective rooting depth is 6 to 20 inches. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is high.

This soil is used almost entirely for grazing. It is not suited for cropland because of its shallow depth to shale.

Rangeland vegetation of this soil consists of a sparse stand of blue grama, western wheatgrass, alkali sacaton, sideoats grama, winterfat and fourwing saltbush. Careful attention to proper grazing use is needed to prevent depletion of the range resource because it is difficult to revegetate. Water development, or other practices that cause local concentrations of livestock should be avoided. Periodic deferment of grazing benefits the vegetation by permitting forage plants to complete growth and mature seed. Reduction in stocking rate should be considered when appreciable areas of this soil are grazed along with more productive sites.

Windbreak and environmental plantings are generally not suited on this soil because of the shallow depth to shale.

Rangeland wildlife such as antelope, cottontail rabbit and coyote are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are depth to rock, high shrink-swell potential and slope. Intensive and costly compensating measures are needed to minimize these limiting soil features. Capability subclass VIIe nonirrigated.

68—Mitchell loam, 0 to 3 percent slopes. This is a deep, well drained soil on broad upland flats and fans. It formed in calcareous, loamy alluvial and eolian materials derived from weathered siltstone of the Brule Formation. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Keota loam on ridges. Also included are concave areas of Mitchell soil that are occasionally flooded.

Typically the surface layer is light brownish gray loam about 5 inches thick. The underlying layer is light gray and very pale brown, calcareous silt loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the soil blowing hazard is moderate, and the erosion hazard is slight.

This soil is used almost entirely for grazing. Some small isolated areas are used for nonirrigated cropland, with wheat and millet as the principal crops grown.

The rangeland vegetation of this soil consists of blue grama, buffalograss, sand dropseed, western wheatgrass, and winterfat beneath a sparse overstory of fourwing saltbush. Grazing management practices should be aimed at maintaining fourwing saltbush for its value as a source of protein during the winter for livestock or wildlife. Deferred grazing and adequate livestock water facilities are beneficial in maintaining a healthy and productive rangeland plant cover. Depleted plant cover can be improved by pitting or furrowing and seeding.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture in areas with slope.

Windbreaks and environmental plantings are difficult to establish on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

This soil produces habitat elements that are suitable for either rangeland wildlife, such as antelope, or openland wildlife including pheasants, cottontail, and mourning dove. Such items as types of fences, water developments, and proper grazing use are practices that should be considered to enhance rangeland wildlife. Production of crops, such as wheat, provides suitable habitat for openland wildlife, especially pheasant. Practices that would enhance openland wildlife include tree and shrub plantings and undisturbed nesting cover.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IVe nonirrigated.

69—Mitchell-Keota loams, 0 to 3 percent slopes. These nearly level to gently sloping soils are on upland flats and fans. The average annual precipitation ranges from 13 to 17 inches. Mitchell loam, 0 to 3 percent slopes, makes up about 50 percent of the mapping unit, and Keota loam, 0 to 3 percent slopes, makes up about 30 percent. The Mitchell soils are on the lower lying nearly level areas. Keota soils are on the gently sloping convex ridges where the siltstone bedrock is nearer the surface.

About 20 percent of the mapping unit is Epping loam, 1 to 3 percent slopes, on ridges.

The Mitchell soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials derived from weathered Brule Siltstone.

Typically the surface layer is light brownish gray loam about 5 inches thick. The underlying layer is light gray and very pale brown, calcareous silt loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

The Keota soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials derived from weathered Brule Siltstone.

Typically the surface layer is light brownish gray loam about 4 inches thick. The underlying layer is light brownish gray and very pale brown, calcareous loam about 14 inches thick. White siltstone of the Brule Formation is at 24 inches.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

These soils are used almost entirely for grazing. Some small isolated cultivated areas have been seeded back to grass.

The rangeland vegetation of both soils consists of blue grama, western wheatgrass, buffalograss, sand dropseed, and winterfat beneath a sparse overstory of fourwing saltbush. Grazing management practices should be aimed at maintaining fourwing saltbush for its value as a source of protein during the winter for livestock or wildlife. Deferred grazing and adequate water facilities are beneficial in maintaining a healthy and productive rangeland plant cover. Depleted plant cover can be improved by pitting or furrowing and seeding.

Windbreaks and environmental plantings are difficult to establish on this soil. Summer fallow a year in advance of planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Supplemental irrigation is also needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail rabbit and coyote are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species.

Where areas are considered for homesites and other urban developments the Mitchell soil is well suited and has only minor limiting features that can be easily modified. The Keota soils are limited by depth to bedrock. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly because of the bedrock at moderate depths. Capability subclass IVe nonirrigated.

70—Mitchell-Keota loams, 3 to 9 percent slopes. These gently sloping to moderately sloping soils are on upland ridges and hills. The average annual precipitation ranges from 13 to 17 inches. Mitchell loam, 3 to 5 percent slopes, makes up about 55 percent of the unit and Keota loam, 1 to 9 percent slopes, about 35 percent. The Mitchell soil is at midslope and on footslopes where the eolian deposits are thickest. The Keota soils are on ridge crests and knobs where the siltstone bedrock is near the surface.

About 10 percent of the mapping unit consists of areas of Epping loam, 5 to 9 percent slopes, on ridges and knobs.

The Mitchell soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials derived from weathered siltstone.

Typically the surface layer is light brownish gray loam about 5 inches thick. The underlying layer is light gray and very pale brown, calcareous silt loam that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Keota soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials derived from weathered Brule Siltstone.

Typically the surface layer is light brownish gray loam about 4 inches thick. The underlying layer is light brownish gray and very pale brown, calcareous loam about 20 inches thick. White siltstone of the Brule Formation is at a depth of about 24 inches.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is slow, the wind erosion hazard is moderate, and the erosion hazard is slight.

These soils are used almost entirely for grazing and wildlife. Some small areas, once cultivated, have been reseeded to grass.

Rangeland vegetation on both soils consists mainly of blue grama, western wheatgrass, buffalograss, sand dropseed, and winterfat beneath a sparse overstory of fourwing saltbush. Grazing management should be designed at maintaining fourwing saltbush for its value as a source of protection during the winter for livestock and wildlife. Periodic deferment of grazing benefits the vegetation by permitting forage plants to complete growth and mature seed. Contour pitting and furrows intercept surface runoff and increase water infiltration and thus speed up recovery of areas in fair and poor condition. Adequate water facilities should be provided to obtain livestock distribution.

Windbreaks and environmental plantings are difficult to establish on these soils. Summer fallow a year in advance of planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Supplemental irrigation is also needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail rabbit and coyote are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species.

Where areas are considered for homesites, roads and other urban developments, the Mitchell soil is well suited and has only minor limitations that can be easily modified. The Keota soil is limited by depth to bedrock. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly because of the moderate depth to bedrock. Capability subclass VIe nonirrigated.

71—Mitchell-Norka loams, 0 to 3 percent slopes. These are nearly level to gently sloping soils on broad upland flats in the Brule Siltstone area. The average annual precipitation ranges from 13 to 17 inches. The Mitchell loam, 0 to 3 percent slopes, makes up about 50 percent of the unit and Norka loam, 0 to 3 percent slopes, about 40 percent. The Mitchell soil is on the gently sloping, higher lying convex surfaces. The Norka soil is on the nearly level, lower lying concave areas that receive more surface runoff.

About 10 percent of this unit is Keota loam on narrow gently sloping convex ridges and knobs.

The Mitchell soil is a deep, well drained soil on broad upland flats and fans. It formed in calcareous, loamy alluvial and eolian materials derived from weathered siltstone.

Typically the surface layer is light brownish gray loam about 5 inches thick. The underlying layer is light gray and very pale brown, calcareous silt loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the soil blowing hazard is moderate, and the erosion hazard is slight.

The Norka soil is a deep, well drained soil on upland flats. It formed in calcareous loamy alluvial and eolian materials.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown light clay loam about 11 inches thick. The substratum is very pale brown, calcareous silt loam to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used almost entirely for grazing. Some small isolated areas are used for nonirrigated cropland. Wheat and some forage crops are grown.

The rangeland vegetation of the Mitchell soil consists of blue grama, western wheatgrass, buffalograss, sand dropseed, and winterfat beneath a sparse overstory of fourwing saltbush. The rangeland vegetation of the Norka soil consists of blue grama, western wheatgrass, buffalograss and sedge. Proper grazing use and planned grazing systems are the most important practices needed to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve organic matter content and soil tilth, and conserve moisture. Chiseling or subsoiling improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing surface runoff and conserving moisture.

Windbreaks and environmental plantings are difficult to establish on these soils. Summer fallow a year prior to planting, supplemental water by irrigation during planting

and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

These soils produce habitat elements for either rangeland wildlife such as antelope or openland wildlife including pheasants, cottontail and mourning doves. Types of fences, water developments, and proper grazing use are practices that should be considered to enhance rangeland wildlife. Production of crops such as wheat provide suitable habitat for openland wildlife, especially pheasant. Practices that would further enhance openland wildlife populations include tree and shrub plantings and undisturbed nesting cover.

These soils are well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIIe nonirrigated.

72—Mosher loam. This is a deep, somewhat poorly drained soil on terraces. It formed in calcareous, stratified clayey alluvium deposited by the South Platte River. It is extensive in the terrace area between Proctor and Crook. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Lebsack clay loam, saline.

Typically the surface layer is gray loam about 5 inches thick. The subsoil is dark gray heavy clay loam about 5 inches thick in the upper part and grayish brown and pale brown heavy clay loam about 11 inches thick in the lower part. The substratum is light gray and gray, calcareous sandy clay loam and clay loam extending to 60 inches. Mottles are common in the substratum. The subsoil and substratum are strongly alkaline.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is affected by a strongly alkali condition and a water table below 36 inches.

This soil is used mainly for grazing. Some small areas are used for irrigated cropland where they border areas of more productive soils. Crop yields are usually low because of the alkali condition. This soil is best suited for grazing.

Where this soil is used for irrigated cropland the alkali condition will influence the choice of crop and crop yield. Intensive management is required to reduce and minimize the salt content and alkali condition and maintain soil productivity. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Gypsum can also be used effectively in reducing the alkali condition if a reasonably priced source can be found. This soil is suited to border and furrow methods of irrigation. Land leveling is needed in some areas to obtain more uniform water distribution. Applications of manure and commercial fertilizers containing phosphorus and nitrogen are needed for soil fertility.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. These key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and water developments are effective in obtaining more uniform distribution of grazing.

Windbreak and environmental plantings are generally not suited to this soil because of the alkali condition.

Where areas are used for homesites or other urban developments, the primary limiting soil features are slow permeability, high shrink-swell potential, and the high water table. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability and high water table. Special compensating designs are needed for dwellings and roads in order to minimize the shrink-swell potential. Capability subclass VIs nonirrigated, IVw irrigated.

73—Mosher clay. This is a deep, somewhat poorly drained, strongly alkali affected soil on terraces. It formed in calcareous, stratified clayey alluvium deposited by the South Platte River. It occurs in the terrace area between Proctor and Crook. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Mosher loam and Lebsack clay loam.

Typically the surface layer is gray clay about 5 inches thick. The subsoil is dark gray clay about 5 inches thick in the upper part and grayish brown and pale brown heavy clay loam about 11 inches thick in the lower part. The substratum is light gray and gray, calcareous sandy clay loam and clay loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is affected by a strong saline-alkali condition. A fluctuating water table occurs below 36 inches during the winter and spring months.

This soil is used almost entirely for grazing. It is not suited for cropland because of the saline-alkali condition.

The rangeland vegetation of this soil consists mainly of inland saltgrass, alkali sacaton, western wheatgrass and fourwing saltbush. This soil is generally difficult to revegetate, and it is therefore especially important that livestock grazing management be carefully applied. Periodic rest from grazing during the growing season favors the main forage species. Chiseling or pitting reduces runoff, aids water infiltration and improves plant cover where it has been depleted and is in poor or fair range condition. Management of greasewood or rabbitbrush is sometimes needed where these shrubs have increased to a point that reduces forage production.

Windbreak and environmental plantings are generally not suited to this soil because of the strong saline-alkali condition.

Wildlife is limited on this soil. Some wetland wildlife, especially waterfowl, utilize these areas. The position of this soil in relation to irrigated cropland makes it valuable to both wetland and openland wildlife. Wildlife developments are difficult to establish.

This soil is severely limited for homesites and other urban developments. The limiting soil features are the high water table, high shrink-swell potential, slow permeability and inherent low strength. Intensive compensating measures are needed to minimize these soil conditions. Capability subclass VIIw nonirrigated.

74—Norka loam, 0 to 1 percent slopes. This is a deep, well drained soil on upland tablelands north of the South Platte River terrace. It formed in calcareous, loamy eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Wages loam and Keith loam. In leveled areas exposures of the underlying parent material are common.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil layer is dark grayish brown clay loam about 11 inches thick (fig. 14). The substratum is very pale brown, calcareous silt loam and loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used almost entirely for irrigated cropland. Some small areas are used for grazing. Corn, alfalfa, sugar beets and small grains are the main crops grown in irrigated areas.

Management concerns in irrigated areas are proper use of irrigation water and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Irrigation water management consisting of proper length of run is needed for efficient use of water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increases water infiltration and improves soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation on rangeland. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for use as homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIc nonirrigated, I irrigated.

75—Norka-Ulysses loams, 1 to 3 percent slopes. These gently sloping soils are on upland tablelands in the area north of the South Platte River terrace. The average annual precipitation ranges from 15 to 19 inches. Norka loam, 1 to 3 percent slopes, makes up about 50 percent of the mapping unit and Ulysses loam, 1 to 3 percent slopes, about 35 percent. The Norka soils are on the smoother flats and the Ulysses soils on the convex ridges.

Included in this unit are small areas of Keith loam and Wages loam. In land leveled areas exposures of the underlying substratum material are common.

The Norka soil is deep and well drained. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown light clay loam about 11 inches thick. The substratum is very pale brown, calcareous silt loam and loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

The Ulysses soil is deep and well drained. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is grayish brown loam about 5 inches thick. The subsoil is grayish brown and pale brown loam about 9 inches thick and is calcareous in the lower part. The substratum is light gray and light yellowish brown, calcareous very fine sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface

runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

These soils are used almost entirely for irrigated and nonirrigated cropland. The remaining small areas are used for grazing. Corn, alfalfa and sugar beets are the main crops grown in irrigated areas. Wheat and grain sorghum are principal crops in nonirrigated areas.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow or border irrigation methods. Land leveling is needed in some areas to obtain uniform application of water. Irrigation water management consisting of proper length of run is needed for efficient use of irrigation water and for keeping soil losses to a minimum. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increase water infiltration and improve soil tilth.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from soil blowing. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Rangeland vegetation of these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

Where used for homesites and other urban developments, this soil has only minor limitations that can be easily modified through the use of appropriate design and construction. Capability subclass IIc nonirrigated, IIe irrigated.

76—Nunn loam, 0 to 1 percent slopes. This is a deep, well drained soil on terraces. It formed in calcareous, loamy alluvium. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Nunn sandy loam and Nunn clay loam, water table. The areas with sandy loam surface layers border sandy eolian areas.

Typically the surface layer is grayish brown loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 20 inches thick over grayish brown, calcareous clay loam about 5 inches thick. The substratum is light gray and light grayish brown loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used almost entirely for irrigated cropland. Some small isolated areas are used for grazing. Corn, alfalfa, sugar beets and wheat are the main crops grown.

Management concerns in irrigated areas are mainly proper use of irrigation water, slow permeability and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is necessary in some areas to obtain uniform distribution of water. Length of runs should be designed to allow for infiltration of water because of the slow permeability. Incorporating crop residues increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation and other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition.

Windbreaks and environmental plants are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best

suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife.

Where the soil is used for homesites and other urban developments, the primary limiting soil features are high shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed to minimize the shrink-swell potential. Capability subclass IIIc nonirrigated, IIe irrigated.

77—Nunn loam, 1 to 3 percent slopes. This is a deep, well drained soil of upland flood plains and long concave drainageways. It formed in calcareous, loamy alluvium deposited by intermittent streams. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Rago clay loam having 0 to 2 percent slopes.

Typically the surface layer is grayish brown loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 20 inches thick over grayish brown, calcareous clay loam about 5 inches thick. The substratum is light gray and light grayish brown loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used for nonirrigated and irrigated cropland and for grazing. Wheat is the main crop grown in nonirrigated areas. Corn, sugar beets, alfalfa and wheat are the principal crops in irrigated areas.

In nonirrigated cropland areas the main objectives of management are conserving moisture and protecting soil from erosion. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration, improve soil tilth, and conserve moisture. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing surface runoff and conserving moisture.

Management concerns in irrigated areas are proper use of irrigation water, slow permeability, maintenance of fertility and control of soil erosion. This soil is suited to furrow and border irrigation. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil loss. Relatively short runs and small heads of water should be used because of the slow permeability and slope. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

Windbreaks and environmental plantings are suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are high shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed to minimize the shrink-swell potential. Capability subclass IIIc nonirrigated, IIe irrigated.

78—Nunn loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy alluvial and eolian materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are gently sloping.

Included in this unit are small areas of Kutch clay loam on midslope areas that are underlain by shale at 20 to 40 inches.

Typically the surface layer is a grayish brown loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 20 inches thick over grayish brown, calcareous clay loam about 5 inches thick. The substratum is light gray and light grayish brown loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for grazing. Some areas are used for nonirrigated cropland, with wheat as the main crop.

In nonirrigated cropland areas the main objectives of management are conserving moisture and protecting soil from erosion. Stubble mulch tillage and incorporating crop residues improve soil tilth and protect soil from erosion. Terracing and contour farming are essential to conserve water and prevent runoff. Chiseling or subsoiling improves water penetration. More intensive use of conservation practices is essential on these soils because of slope and the slow permeability. Tillage should be kept to a minimum. These soils form tillage pans easily if tilled when wet.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, and sedge. Managing rangeland to maintain a balance between livestock demands and forage production is highly beneficial. Contour furrowing or pitting aids in recovery of depleted vegetation on this soil by reducing surface runoff and increasing water infiltration. Areas of depleted vegetation having dense stands of pricklypear or rabbitbrush can be improved by chemical management of these species. Range seeding will speed the revegetation of depleted areas.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of limited moisture and soil moisture relationship. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management and water developments.

High shrink-swell potential and slow permeability are the primary limiting soil features where this soil is used for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell and offsetting structural construction are needed to minimize the high shrink-swell potential. Capability subclass IIIe nonirrigated.

79—Nunn loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are moderately sloping.

Included in this unit are small areas of Kutch clay loam.

Typically the surface layer is a grayish brown loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 20 inches thick over grayish brown, calcareous clay loam about 5 inches thick. The substratum is light gray and light grayish brown loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is rapid, and the erosion hazard is moderate.

This soil is used mainly for grazing. Some areas are used for nonirrigated cropland, with wheat as the main crop. This soil is best suited for grazing because of the erosion hazard and slow permeability.

In nonirrigated cropland areas the main objectives of management are conserving moisture and protecting soil from erosion. Stubble mulch tillage and incorporating crop residues improve soil tilth and protect soil from erosion. Terracing and contour farming are essential to prevent runoff and conserve water. Chiseling or subsoiling improves water penetration. Tillage pans form easily if this soil is tilled when wet.

Rangeland vegetation on this soil consists mainly of blue grama, western wheatgrass, buffalograss, and sedge. Managing rangeland to maintain a balance between livestock demands and forage production is highly beneficial on this soil. Contour furrowing or pitting aids in recovery of depleted vegetation by reducing runoff and increasing water infiltration. Areas of depleted vegetation having dense stands of pricklypear or rabbitbrush can be improved by chemical management of these species. Range seeding will speed revegetation of depleted areas.

Windbreaks and environmental plantings are difficult to establish on this soil because of limited moisture, soil moisture relationship and slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing

areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water development and fencing with types of fencing that permit unrestricted antelope movement.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are high shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed to minimize the shrink-swell potential. Capability subclass IVe nonirrigated.

80—Nunn clay loam, 1 to 3 percent slopes. This is a deep, well drained soil on upland flats and terraces. It formed in calcareous, loamy alluvium. The average annual precipitation ranges from 13 to 17 inches. Slopes are gently sloping.

Included in this unit are small areas of Manzanola clay loam.

Typically the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is grayish brown heavy clay loam and clay about 20 inches thick over light brownish gray calcareous clay loam about 5 inches thick. The substratum is light gray calcareous clay loam and loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland and grazing. Some small areas are used for irrigated cropland. Wheat is the main crop in nonirrigated cropland. Corn, alfalfa, sugar beets and wheat are the principal crops in irrigated areas.

In nonirrigated cropland areas management practices such as stubble mulch tillage and incorporating crop residues are needed to improve water infiltration. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are mainly proper use of irrigation water, slow permeability, and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is necessary in some areas to obtain uniform distribution of water. Length of runs should be designed to allow for infiltration of water because of the slow permeability. Incorporating crop residues in the surface soil increases infiltration and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton, and sedge. Managing rangeland to maintain a balance between livestock and forage production is highly essential. Contour furrowing or pitting aids in recovery of depleted vegetation by reducing runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be improved by chemical management of these species.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing that permit unrestricted antelope movement.

Where the soil is considered for use as homesites or other urban developments, the primary limiting soil features are slow permeability and high shrink-swell potential. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building and road designs must be utilized in order to minimize the shrink-swell potential. Capability subclass IIIs nonirrigated, IIs irrigated.

81—Nunn clay loam, 3 to 9 percent slopes. This is a deep, well drained soil on upland hills and ridges. It formed in calcareous, loamy alluvial and eolian materials. Average annual precipitation ranges from 13 to 17 inches. Slopes are gently sloping and moderately sloping.

Included in this unit are small areas of Stoneham loam and Kutch clay loam, both having 5 to 9 percent slopes. The Stoneham soils are on ridge crests. The Kutch soils are on midslope positions where the bedrock occurs within 20 to 40 inches of the surface.

Typically the surface layer is a grayish brown clay loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 14 inches thick over gray, calcareous clay loam about 6 inches thick. The substratum is light gray calcareous loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is rapid, and the erosion hazard is moderate.

This soil is used mainly for grazing. Some areas are used for nonirrigated cropland, with wheat as the main crop. This soil is best suited for grazing because of the slow permeability and moderate erosion hazard.

In nonirrigated cropland areas the main objectives of management are conserving moisture and protecting the soil from erosion. Stubble mulch tillage and incorporating crop residues improve soil tilth and protect the soil from erosion. Terracing and contour farming are essential to reduce surface runoff and conserve water. Chiseling or subsoiling improves water penetration. Tillage pans form easily if this soil is tilled when wet. More intensive use of conservation practices is essential on these soils because of slope. Tillage should be kept to a minimum.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton and sedge. Managing rangeland to maintain a balance between livestock and forage production is highly essential. Contour furrowing or pitting aids in recovery of depleted vegetation on this soil by reducing runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be improved by chemical management of these species.

Windbreaks and environmental plantings are difficult to establish on this soil because of limited moisture, soil moisture relationships and slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Rangeland wildlife such as antelope, cottontails and coyotes are best adapted on this soil. Forage production is typically low and proper grazing management is necessary if wildlife and livestock share the range. Watering developments are also important and are utilized by various wildlife species.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are high shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed to minimize the shrink-swell potential. Capability subclass IVe nonirrigated.

82—**Nunn clay loam, water table.** This is a deep, moderately well drained soil on terraces. It formed in calcareous, loamy alluvium deposited by the South Platte River and its larger tributaries. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Satanta loam, water table.

Typically the surface layer is grayish brown heavy clay loam about 10 inches thick. The subsoil is grayish brown heavy clay loam about 13 inches thick over grayish brown calcareous clay loam about 13 inches thick. The substratum is light gray and light grayish brown clay loam and loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 48 to 60 inches.

This soil is used almost entirely for irrigated cropland. Some small isolated areas are used for grazing. Corn, sugar beets, alfalfa and wheat are the main crops grown.

Management concerns in irrigated areas are mainly proper use of irrigation water, slow permeability, and maintenance of fertility. This soil is well suited to furrow and border irrigation. Land leveling is necessary in some areas to obtain uniform distribution of water. Length of runs should be designed to allow for infiltration of water because of the slow permeability. Incorporating crop residues in the surface soil increases infiltration and improves soil tilth. Subsoiling and deep chiseling are practices that also improve infiltration. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil productivity.

Rangeland vegetation of this soil consists mainly of inland saltgrass, alkali sacaton, sedge, switchgrass, western wheatgrass and rush. Managing rangeland to maintain a balance between livestock and forage production is highly essential. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and water developments are effective in obtaining uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail, mourning dove and miscellaneous songbirds are favored on this soil because of its high potential for growing habitat utilized by these kinds of wildlife. Under irrigation a great variety of crops and cover types can be grown. Some of the primary practices that would enhance openland wildlife populations include tree and shrub plantings and undisturbed nesting cover. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, fencing and water development.

Depth to the water table, slow permeability and high shrink-swell potential are the primary limiting features

where the soil is used for homesites or urban developments. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of slow permeability and a high water table. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed for roads and dwellings in order to minimize the shrink-swell potential. Wetness affects dwellings with basements and requires special designs. Capability subclass IIIs nonirrigated, IIs irrigated.

83—**Nunn clay loam, wet.** This is a deep, wet soil on terraces and flood plains. It formed in calcareous, loamy alluvium. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Satanta loam, wet, and Nunn clay loam, water table. Small localized areas of strongly saline-alkali affected Nunn clay loam commonly occur.

Typically the surface layer is grayish brown heavy clay loam about 10 inches thick. The subsoil is grayish brown heavy clay loam about 13 inches thick over grayish brown, calcareous clay loam about 13 inches thick. The substratum is light gray and light grayish brown clay loam and loam extending to 60 inches. Mottles and visible salts occur in the lower part of the subsoil and throughout the substratum.

Permeability is slow. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is affected by a high water table caused mainly by loss of irrigation water and overirrigation on adjacent soils.

This soil is used mainly for irrigated cropland. Some areas are used for grazing. Corn, alfalfa, sugar beets and wheat are the principal crops. Crop yields are affected by the high water table.

Management concerns in irrigated areas are proper irrigation water use, maintaining fertility and minimizing wetness. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management such as proper length of run is needed to compensate for the slow permeability and to avoid raising the water table. Tile drain systems and open drainage ditches are essential to lower the water table. Subsoiling is effective in improving water infiltration and allowing salts to leach downward. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil increases water infiltration and improves soil tilth.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and watering developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The high water table and abundant competing vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

Openland wildlife such as pheasant, cottontail, mourning dove and miscellaneous songbirds are favored on this soil because of its high potential for growing habitat utilized by these kinds of wildlife. Under irrigation a great variety of crops and cover types can be grown. Some of the primary practices that would enhance openland wildlife populations include tree and shrub plantings and undisturbed nesting cover. Rangeland wildlife, including antelope and jackrabbit, can be encouraged by grazing management, fencing and water developments.

Wetness, slow permeability, and high shrink-swell potential are the principal limiting features where this soil is used for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability and high water table. Compensating engineering designs and measures such as backfilling with materials with low shrink-swell potential and offsetting structural construction are needed for roads and dwellings in order to minimize the shrink-swell potential. The high water table seepage affects dwellings with basements and requires special designs. Capability subclass IIIw nonirrigated, IIw irrigated.

84—**Olney sandy loam, 3 to 5 percent slopes.** This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are gently sloping.

Included in this unit are small areas of Stoneham loam and Vona sandy loam soils.

Typically the surface layer is grayish brown sandy loam about 3 inches thick. The subsoil is grayish brown sandy clay loam about 12 inches thick and is calcareous in the lower part. The substratum is pale yellow and light brownish gray, calcareous sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

This soil is used for irrigated and nonirrigated cropland. Some areas are used for grazing. Corn, alfalfa, sugar beets and small grains are the principal crops grown in irrigated areas. Wheat is the main crop grown in nonirrigated areas.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and control of erosion. This soil is suited to contour furrow, contour ditch and sprinkler methods of irrigation. Land leveling and irrigation water management are needed to obtain uniform distribution and efficient use of water. Irrigation runs should be short and light heads of water used to minimize erosion. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops, and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Primary objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are essential practices that protect soil from blowing, improve soil tilth and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration in the subsoil. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage is best kept to a minimum. Intensive use of conservation practices is essential to protect this soil and maintain productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IVe nonirrigated, IIIe irrigated.

85—Olney sandy loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are moderately sloping.

Included in this unit are small areas of Stoneham loam and Vona sandy loam.

Typically the surface layer is grayish brown sandy loam about 3 inches thick. The subsoil is grayish brown sandy clay loam about 12 inches thick and is calcareous in the lower part. The substratum is pale yellow and light brownish gray, calcareous sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

This soil is used mainly for grazing. Some areas are used for irrigated and nonirrigated cropland. Corn, alfalfa, sugar beets and small grains are the principal crops in irrigated areas. Areas used for nonirrigated cropland are usually severely eroded and are best seeded back to grass.

In irrigated areas the main concerns of management are proper use of irrigation water, controlling soil erosion and maintaining and improving soil fertility. This soil is suited to contour furrow, contour ditch and sprinkler methods of irrigation. Land leveling is needed in most areas to obtain more uniform application of water. Frequent light irrigations or short runs are needed to control erosion. Incorporating crop residues is needed to reduce soil blowing during periods when soils are not protected by growing crops and improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve and maintain rangeland condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff, and are especially effective on range areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil because of slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, contour planting and con-

tinued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasant, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass VIe nonirrigated, IVe irrigated.

86—Peetz gravelly sandy loam, 5 to 25 percent slopes. This is a deep, well drained soil on upland ridges and knobs. It formed in calcareous, gravelly alluvium. The average annual precipitation ranges from 15 to 19 inches. Slopes are moderately sloping to moderately steep.

Included in this unit are small areas of Wages and Altvan soils, both having 5 to 9 percent slopes. They are on foot slope positions where sediments are thicker over very gravelly coarse sand.

Typically the surface layer is a very dark gray and dark grayish brown gravelly sandy loam about 9 inches thick. The underlying materials are light gray and white, calcareous gravelly coarse sandy loam about 19 inches thick over pale brown, calcareous very gravelly coarse sand that extends to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches. Available water capacity is low. Surface runoff is rapid, the erosion hazard is moderate, and the soil blowing hazard is moderate.

This soil is not suited for cropland because of the slope, the erosion hazard and the low available water capacity. It is used entirely for livestock grazing.

Rangeland vegetation consists mainly of sideoats grama, little bluestem, blue grama, buffalograss, and sedge. Controlled grazing is needed to maintain the key forage species in good vigor. Periodic summer deferment is essential for rangeland improvement or maintenance. Fencing and careful location of watering places improve distribution of grazing use.

Windbreaks and environmental plantings are difficult to establish on this soil. Limited available water capacity and slope are the principal concerns in establishing tree and shrub plantings. Summer fallow a year in advance of planting, continued cultivation for weed control, and supplemental irrigation during planting and establishment are needed to insure establishment and survival of plantings. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Wildlife such as mule deer, antelope and cottontail rabbit inhabit areas of this soil. The relief and vegetative growth, especially the few shrubs and trees occurring in the draws, provide food and cover. Wildlife can be encouraged by proper grazing management and installation of watering facilities.

The soil is suited for homesites and other urban developments, with only minor limitations that can be easily modified, except where slopes are greater than 15 percent. In areas with slopes greater than 15 percent, intensive compensating measures are needed. Capability subclass VIe nonirrigated.

87—Platner sandy loam, 0 to 3 percent slopes. This is a deep, well drained soil on upland flats. It formed in mixed calcareous alluvial and eolian deposits. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Haxtun sandy loam, 0 to 1 percent slopes, in concave depressional areas and Ascalon fine sandy loam, 0 to 3 percent slopes.

Typically the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is grayish brown and light brownish gray heavy clay loam about 14 inches thick and is calcareous in the lower part. The substratum is white and very pale brown, calcareous loam and fine sandy loam about 13 inches thick over brown, calcareous gravelly coarse sandy clay loam that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for nonirrigated cropland. Some areas are used for irrigated cropland where irrigation water is available. The remaining acreage is used for grazing. Wheat, corn and sorghum are the main crops on nonirrigated cropland areas. In irrigated areas alfalfa, corn, sugar beets and small grains are the principal crops grown.

The main objectives of management in nonirrigated cropland areas are conserving moisture and protecting soil from blowing. Stubble mulch tillage and incorporating crop residues are essential practices to protect soil from blowing, improve soil tilth and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration in the subsoil. Planting crops in alternate strips at right angles to the prevailing wind is also effective in protecting soil from blowing. Tillage is best kept to a minimum.

In irrigated areas the main concerns of management are proper use of irrigation water, slow permeability, soil fertility and soil blowing. This soil is suited to furrow, border or sprinkler irrigation methods. Leveling and good irrigation water management are necessary to obtain

uniform distribution and efficient use of water. Careful design of the irrigation system is needed because of the slow permeability. Incorporating crop residues is needed to reduce soil blowing during periods when the soil is not protected by growing crops. It also improves soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites, urban development and roads, with only minor limitations that can be easily modified. Capability subclass IIe nonirrigated, IIe irrigated.

88—**Platner loam, 0 to 1 percent slopes.** This is a deep, well drained soil on upland flats. It formed in calcareous, loamy alluvial and eolian deposits. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Rago loam.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is grayish brown and light brownish gray heavy clay loam about 14 inches thick and is calcareous in the lower part. The substratum layer is white and very pale brown, calcareous loam and fine sandy loam about 13 inches thick over brown, calcareous gravelly coarse sandy clay loam that extends to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

Nearly all of this soil is used for irrigated cropland. Corn, alfalfa, sugar beets and small grains are the main crops grown. Some small isolated areas are used for grazing.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water because of the slow permeability. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increase water infiltration and improve soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

The primary limiting soil features for homesites and other urban developments are the high shrink-swell potential and slow permeability of the subsoil. These limitations can be overcome through the use of appropriate design and construction. Septic tank filter fields

will not function properly because of the slow permeability. Capability subclass IIc nonirrigated, IIs irrigated.

89—Platner loam, 1 to 3 percent slopes. This is a deep, well drained soil on upland tablelands. It formed in calcareous eolian and alluvial deposits. It is extensive in hardland areas throughout the county. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level to gently sloping.

Included in this unit are small areas of Rago loam, 0 to 3 percent slopes, in the lower lying swale areas.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil layer is grayish brown heavy clay loam about 14 inches thick and is calcareous in the lower part. The substratum is white and very pale brown, calcareous loam and fine sandy loam about 13 inches thick over brown, calcareous gravelly coarse sandy clay loam that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland. Some areas are used for irrigated cropland and grazing. Wheat and grain sorghum are the principal crops grown in nonirrigated cropland. Corn, alfalfa and sugar beets are the main crops in irrigated areas.

In nonirrigated cropland areas the primary objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues (fig. 15) are essential to protect soil from possible blowing, improve water infiltration, improve soil tilth, and conserve moisture. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are proper use of irrigation water, maintenance of fertility and control of soil erosion. This soil is well suited to furrow and border irrigation. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water because of the slow permeability and for control of soil loss. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil in the more moist eastern part of the county. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation (fig. 16) for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

The primary limiting soil features for homesites and other urban developments are the high shrink-swell potential and slow permeability of the subsoil. These limitations can be overcome with careful design and construction. Septic tank filter fields will not function properly because of the slow permeability. Capability subclass IIc nonirrigated, IIe irrigated.

90—Platner loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland hills and ridges. It formed in calcareous, alluvial and eolian deposits and is extensive in hardland areas throughout the county. The average annual precipitation ranges from 14 to 19 inches. Slopes are gently sloping.

Included in this unit are small areas of Satanta loam, Ascalon sandy loam and Wages loam. The Ascalon and Wages soils are on ridge crests.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is grayish brown and light brownish gray heavy clay loam about 14 inches thick and is calcareous in the lower part. The substratum is white and very pale brown, calcareous loam and fine sandy loam about 13 inches thick over brown, calcareous gravelly sandy clay loam that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for irrigated and nonirrigated cropland. Remaining small acreages are used for grazing. Winter wheat is the main crop in nonirrigated areas. In irrigated areas alfalfa, corn, and sugar beets are the principal crops.

In nonirrigated cropland areas the main objectives of management are conserving moisture and protecting the soil from erosion. Stubble mulch tillage and incorporating

crop residues improve soil tilth and protect the soil from erosion. Terracing and contour farming are essential to conserve water and control runoff, thus reducing erosion. Tillage pans tend to form easily if this soil is tilled when wet. Chiseling or subsoiling improves water penetration and breaks up tillage pans. Tillage should be kept to a minimum. More intensive use of conservation practices is essential because of slope.

In irrigated areas the primary concerns of management are control of soil erosion, proper use of irrigation water, slow permeability and fertility maintenance. Contour ditch and contour furrow are the best suited methods of irrigation on this soil. Land leveling is needed in most areas to obtain more uniform distribution of irrigation water. More frequent irrigations with smaller amounts of water because of the slow permeability are needed to reduce soil loss. Incorporating crop residues improves water infiltration and soil tilth and helps control soil erosion. Applications of manure and commercial fertilizers containing nitrogen and phosphates are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil in the more moist eastern part of the county. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

The primary limiting soil features for homesites and other urban developments are the high shrink-swell potential and slow permeability of the subsoil. The high shrink-swell potential can be overcome with careful design and construction. Septic tank absorption fields will not function properly because of the slow permeability. Capability subclass IIIe nonirrigated, IIIe irrigated.

91—Platner-Rago-Dacono loams. These nearly level to gently sloping soils are on upland tablelands mainly in the northern part of the county. The average annual precipitation ranges from 17 to 19 inches. This unit is about 50 percent Platner loam, 0 to 3 percent slopes, about 30 percent Rago loam, 0 to 1 percent slopes, and 20 percent Dacono loam, 0 to 3 percent slopes. The Platner soil is on gentle slopes, the Rago soil is in nearly level concave swale areas and the Dacono soil is on the gently sloping convex ridges where the underlying gravel is close to the surface.

The Platner soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is grayish brown and light brownish gray heavy clay loam (fig. 17) about 14 inches thick and is calcareous in the lower part. The substratum is white and very pale brown, calcareous loam and fine sandy loam about 13 inches thick over brown, calcareous gravelly coarse sandy clay loam that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the water erosion hazard is slight, and the soil blowing hazard is moderate.

The Rago soil is a deep, well drained soil. It formed in calcareous, loamy eolian and alluvial deposits of two soil forming ages.

Typically the surface layer is a grayish brown loam about 4 inches thick. The upper subsoil is grayish brown and dark grayish brown loam and clay loam about 10 inches thick. The lower part of the subsoil is dark gray heavy clay loam about 8 inches thick over dark grayish brown clay loam about 4 inches thick. The substratum is light gray, very pale brown, and pale brown, calcareous loam and coarse sandy loam.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

The Dacono soil is a deep, well drained soil. It formed in calcareous, loamy alluvium and eolian materials moderately deep over coarse sand and gravel.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil layer is dark grayish brown heavy clay loam about 15 inches thick. The substratum is light gray and white, calcareous silt loam about 9 inches thick over light yellowish brown coarse sand and gravel that extends to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight.

These soils are used mainly for nonirrigated cropland. Small areas are used for irrigated cropland where irriga-

tion water is available. The remaining small acreages are used for grazing. Wheat is the principal crop grown in nonirrigated areas. Corn, alfalfa and small grains are the main crops grown in irrgated areas.

In nonirrigated cropland areas the main objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration, improve soil tilth, and conserve moisture. Terracing is also beneficial in reducing runoff and conserving moisture. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum.

Management concerns in irrigated areas are proper use of irrigation water, slow permeability, maintenance of fertility and control of soil erosion. This soil is well suited to furrow and border irrigation. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation systems must be carefully designed to overcome the slow permeability. Irrigation water management is needed for efficient use of water and control of soil loss. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of the three soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use coupled with planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation, and of other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on these soils. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

The primary limiting soil features for homesites and other urban developments are the high shrink-swell potential and slow permeability. The Dacono soil is also limited by excessive seepage below 20 to 40 inches. Septic tank absorption fields on the Rago and Dacono soils can be designed to overcome the slowly permeable subsoils by adjusting depth of system. Sealing methods are required on these soils to overcome the seepage in sewage lagoon sites. Compensating engineering designs and measures are needed to minimize the shrink-swell potential for dwellings and roads. Capability subclass IIc nonirrigated, IIe irrigated.

92—Rago loam. This is a deep, well drained soil of concave upland flats, swales and drainageways. It formed in calcareous, loamy eolian and alluvial deposits of two ages. Average annual precipitation ranges from 14 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Kuma loam and Albinas loam, both having slopes of 0 to 3 percent.

Typically the surface layer is a grayish brown loam about 4 inches thick. The upper subsoil is grayish brown and dark grayish brown loam and clay loam about 10 inches thick. The lower subsoil is dark gray heavy clay loam (fig. 18) about 8 inches thick over dark grayish brown clay loam about 4 inches thick. The substratum is light gray, very pale brown and pale brown, calcareous loam and coarse sandy loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland with wheat as the main crop. Some small areas are used for irrigated cropland and grazing. Alfalfa, corn and sugar beets are the main crops in irrigated areas.

In nonirrigated cropland areas the main objective of management is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration and soil tilth, and conserve moisture. Terracing is also beneficial in reducing runoff and conserving moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum.

Management concerns in irrigated areas are proper use of irrigation water, slow permeability, maintenance of fertility and control of soil erosion. This soil is well suited to furrow and border irrigation methods. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil loss. Irrigation systems must be carefully designed to overcome the slow permeability. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil features are moderate shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building and road designs must be utilized in order to overcome the shrink-swell potential. Capability subclass IIc nonirrigated, IIe irrigated.

93—Rago clay loam. This is a deep, well drained soil of upland swales and drainageways in the western part of the county. It formed in calcareous, loamy alluvial and eolian deposits of two ages. Average annual precipitation ranges from 13 to 18 inches. Slopes are nearly level.

Included in this unit are small areas of Nunn clay loam.

Typically the surface layer is a grayish brown clay loam about 4 inches thick. The upper part of the subsoil is grayish brown and dark grayish brown clay loam about 10 inches thick. The lower part is dark gray heavy clay loam about 8 inches thick over dark grayish brown clay loam about 4 inches thick. The substratum is light gray, very pale brown and pale brown, calcareous loam and coarse sandy loam extending to 60 inches.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used for nonirrigated cropland and grazing. Wheat is the principal crop.

Rangeland vegetation of this soil consists mainly of blue grama, western wheatgrass, buffalograss, green needlegrass, alkali sacaton, and sedge. Managing rangeland to maintain a balance between livestock and forage production is highly essential. Contour furrowing and pitting aid in recovery of depleted vegetation on this soil by reducing runoff and increasing water infiltration. Areas having dense stands of pricklypear or rabbitbrush can be improved by chemical management of these species.

In nonirrigated cropland areas the primary concerns of management are conserving moisture and the slow intake rates and permeability. Stubble mulch tillage and incorporating crop residues are essential conservation practices to increase water intake rates. Tillage pans form easily if this soil is tilled. Chiseling or subsoiling improves water penetration and breaks up tillage pans. Tillage should be kept to a minimum.

Windbreaks and environmental plantings are suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Where this soil is considered for homesites and other urban developments, the primary limiting soil features are moderate shrink-swell potential and slow permeability. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the slow permeability. Compensating building and road designs must be utilized in order to overcome the shrink-swell potential. Capability subclass IIIs nonirrigated.

94—Renohill-Shingle complex, 3 to 9 percent slopes. These gently to moderately sloping soils are on upland ridges and hills in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Renohill loam, 3 to 9 percent slopes, makes up about 60 percent of the unit and Shingle loam, 5 to 9 percent

slopes, makes up 20 percent. The Renohill soil is on footslopes and at midslope. Shingle soils are on ridge crests.

About 20 percent of this unit is Cushman loam and Stoneham loam.

The Renohill soil is a moderately deep, well drained soil. It formed in calcareous materials weathered from interbedded soft shale and sandstone.

Typically the surface layer is grayish brown loam about 5 inches thick. The subsoil is light olive brown and light yellowish brown heavy clay loam about 15 inches thick and is calcareous in the lower part. The substratum is yellowish brown, calcareous clay loam about 7 inches thick over interbedded soft shale and sandstone at a depth of about 27 inches.

Permeability is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

The Shingle soil is a shallow, well drained soil on upland ridges. It formed in calcareous loamy materials weathered from interbedded soft sandstone and shale.

Typically the surface layer is grayish brown loam about 2 inches thick. The underlying layers are light olive brown and light yellowish brown, calcareous clay loam about 8 inches thick over interbedded soft sandstone and shale at a depth of 10 inches.

Permeability is moderate. Effective rooting depth is 10 to 20 inches. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is moderate.

These soils are used mainly for grazing and nonirrigated cropland. Some small localized areas are used for irrigated cropland where irrigation water is available. Wheat is the principal crop grown in irrigated areas. These soils are best suited for rangeland because of the erosion hazard and the shallow to moderately deep rooting depth. Cultivated areas are usually severely eroded and are best seeded back to grass.

Rangeland vegetation on the Renohill soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Rangeland vegetation on the Shingle soil consists mainly of alkali sacaton, blue grama, western wheatgrass, fourwing saltbush, winterfat, and sideoats grama. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil. Limited rooting depth is the principal concern in establishing and maintaining tree and shrub plantings. Summer fallow a year in advance of planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail rabbit and coyote are best adapted on these soils. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various species.

In areas considered for homesites and other urban developments, the primary limiting soil features are depth to rock and moderate shrink-swell potential. Special sewage systems must be anticipated. Absorption fields will not function properly because of the depth to bedrock. Special engineering designs for buildings and roads are needed to minimize soil limitations. Capability subclass VIe nonirrigated.

95—Rock outcrop-Argiustolls complex, 9 to 35 percent slopes. Rock outcrop-Argiustolls consists of extremely stony shallow soils on strongly sloping and steep escarpments and of sandstone Rock outcrop on ledges. It is located in the western part of the county. Rock outcrop makes up about 70 percent of the unit and Argiustolls, 9 to 35 percent slopes, makes up about 30 percent.

Included in this unit are small areas of Kutch soil between the rock ledges.

Argiustolls are used entirely for grazing and wildlife habitat.

Rangeland vegetation on the Argiustolls in this unit consists mainly of plants from both medium and short grass communities, including mainly sideoats grama, little bluestem, western wheatgrass, sedge, needleandthread and blue grama.

Grazing management needed to maintain and improve production and range condition is deferred grazing and proper grazing use. Fencing and livestock water development are effective in obtaining more uniform distribution of grazing. Excessive trailing by livestock is a cause of gully erosion in this mapping unit.

Mule deer and antelope heavily utilize these areas for cover and food. In addition to the cover provided by the vegetation, the Rock outcrop also provides protective cover, especially for deer. Management of these areas for wildlife should include proper grazing management to prevent overgrazing. The relationship of this mapping unit to cropland makes it valuable for escape cover for wildlife.

In areas considered for windbreak plantings and homesites, special onsite investigations are required to select specific sites and determine management. Capability subclass VIIs nonirrigated.

96—Rosebud-Escabosa loams, 3 to 5 percent slopes. These gently sloping soils are on upland ridges and side slopes in the southeastern and northern parts of the county. The average annual precipitation ranges from 17 to 19 inches. Rosebud loam, 3 to 5 percent slopes, makes up about 50 percent of the unit and Escabosa loam, 3 to 5

percent slopes, about 30 percent. The Rosebud soil is at midslope and on footslopes. The Escabosa soil is on crests of ridges.

About 20 percent of this unit consists of Wages loam and Canyon gravelly loam. The Wages soil is at midslope and on foot slopes. The Canyon soil is on knobs where the calcareous indurated sandstone lies near the surface.

The Rosebud soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials over cemented calcareous sandstone of the Ogallala Formation.

Typically the surface layer is grayish brown loam about 5 inches thick. The subsoil is a dark grayish brown loam about 13 inches thick and is calcareous in the lower part. The substratum is light gray, calcareous loam about 15 inches thick over white, cemented calcareous sandstone at a depth of about 33 inches.

Permeability is moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is medium, and the erosion hazard is moderate.

The Escabosa soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials over cemented calcareous sandstone.

Typically the surface layer is grayish brown loam about 10 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam about 22 inches thick over white, cemented calcareous sandstone.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used mainly for nonirrigated cropland. Some small areas are used for irrigated cropland. The remaining acreage is used for grazing. Wheat is the principal crop grown in nonirrigated cropland areas. In irrigated areas alfalfa, corn and wheat are the main crops.

In nonirrigated cropland areas intensive management is needed to control soil erosion, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion. Terracing and contour tillage are essential to reduce runoff and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

In irrigated areas, special management is needed to protect these soils from erosion, to obtain uniform application and distribution of irrigation water and to maintain fertility. Contour ditch and contour furrow are irrigation methods best suited. Land leveling is needed to obtain uniform distribution of water and control soil loss. Before attempting land leveling, care must be taken in determining maximum depth of cut in these moderately deep soils. Crop residue use and applications of manure and commercial fertilizer are needed to maintain fertility.

Rangeland vegetation on both of these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this unit. Soil depth is a concern. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

Depth to bedrock is the primary limiting soil feature where these soils are considered for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the bedrock. Special engineering measures are needed for dwellings with basements because of the depth to rock. Capability subclass IVe nonirrigated, IVe irrigated.

97—Rosebud-Escabosa loams, 5 to 9 percent slopes. These are moderately sloping soils on hillslopes and convex ridges in the southeastern and northern parts of the county. The average precipitation ranges from 17 to 19 inches. Rosebud loam, 5 to 9 percent slopes, makes up about 50 percent of the unit and Escabosa loam, 5 to 9 percent slopes, about 30 percent. The Rosebud soil is on footslopes and at midslope. The Escabosa soil is on crests and tops of ridges.

About 20 percent of this unit is Wages loam and Canyon gravelly loam. The Wages soil is on mid and foot slopes. The Canyon soil is on knobs and narrow ridges. It is recognized in the landscape as white eroded areas with rock fragments on the surface.

The Rosebud soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian deposits underlain by cemented calcareous sandstone.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is a dark grayish brown loam about 13 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam about 15 inches thick over white cemented calcareous sandstone.

Permeability is moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

The Escabosa soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials underlain by cemented calcareous sandstone.

Typically the surface layer is grayish brown loam about 10 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam about 22 inches thick over white, cemented calcareous sandstone.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used mainly for nonirrigated cropland. Some areas are used for nonirrigated crops. Alfalfa and small grains are the principal crops grown in irrigated areas.

In nonirrigated cropland areas, intensive management is needed to control soil erosion, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion. Terracing and contour tillage are essential to reduce runoff and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

In irrigated areas, intensive management is needed to prevent soil loss and maintain productivity. Contour furrow and contour ditch are the best methods of irrigation. Land leveling or smoothing is needed in most areas to obtain better distribution of water. Before leveling or smoothing, care must be taken in determining maximum depth of cut in areas of these moderately deep soils. Irrigation water management is important in obtaining efficient use of water. To control soil loss, alfalfa, small grains and other close sown crops can be flood irrigated by contour ditches. Row crops are best planted on the contour. Incorporating crop residues improves soil tilth and increases soil infiltration. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility.

Rangeland vegetation on both of these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are somewhat difficult to establish on this unit because of slope and soil depth. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in planning for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

Depth to bedrock is the primary limiting soil feature where these soils are considered for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the depth to bedrock. Special engineering measures are needed for dwellings with basements because of the bedrock. Capability subclass IVe nonirrigated, IVe irrgated.

98—Rosebud-Escabosa-Iliff loams, 0 to 3 percent slopes. These soils are on nearly level to gently sloping upland tablelands. The average precipitation ranges from 17 to 19 inches. Rosebud loam, 0 to 3 percent slopes, makes up about 45 percent of the unit, Escabosa loam, 0 to 3 percent slopes, about 30 percent and Iliff loam, 0 to 3 percent slopes, about 25 percent. The Rosebud and Escabosa soils are on convex ridges. The Iliff soil is on the more level flats and in depressional areas.

The Rosebud soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian deposits underlain by cemented calcareous sandstone of the Ogallala Formation.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is a dark grayish brown loam about 13 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam about 15 inches thick over white, cemented calcareous sandstone at a depth of about 33 inches.

Permeability is moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is medium, and the erosion hazard is slight.

The Escabosa soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials underlain by cemented calcareous sandstone.

Typically the surface layer is grayish brown loam about 10 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam about 22 inches thick over white, cemented calcareous sandstone.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is slight, and the erosion hazard is slight.

The Iliff soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian deposits underlain by calcareous sandstone.

Typically the surface layer is grayish brown loam about 8 inches thick. The subsoil is very dark grayish brown heavy silty clay loam about 14 inches thick. The substratum is light gray, calcareous silt loam about 12 inches thick over white, calcareous sandstone at 34 inches.

Permeability is slow. Effective rooting depth ranges from 20 to 40 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

These soils are used mainly for nonirrigated cropland with wheat and grain sorghum as the main crops. Some small areas are used for grazing.

In nonirrigated cropland areas the main management concern is conserving moisture. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration and improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Rangeland vegetation on these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are suited on these soils. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, grazing management and types of fencing to permit unrestricted antelope movement.

Depth to rock is the primary limiting soil feature where these soils are considered for homesites and other urban developments. The Iliff soil is also limited by slow permeability and high shrink-swell potential in the subsoil. Offsetting engineering construction measures are needed for dwellings with basements, shallow excavations and sewage lagoons because of the depth to rock. In addition, compensating measures such as mixing and backfilling will be needed to minimize the shrink-swell condition in the Iliff soil. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the depth to bedrock and slow permeability. Capability subclass IIIs nonirrigated, IIIe irrigated.

99—Satanta loam, 0 to 1 percent slopes. This is a deep, well drained soil on terraces and upland flats. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 14 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Albinas loam, Nunn loam and Bridgeport loam. In leveled irrigated areas exposures of the underlying parent material are common.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is a dark grayish brown and grayish brown clay loam about 13 inches thick and is calcareous in the lower part. The substratum is light gray and very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

Almost the entire acreage of this soil is used for irrigated cropland. The remaining small areas are used for grazing. Corn, alfalfa and sugar beets are the principal crops.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining or-

ganic matter content increase water infiltration and improve soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting and early stages of growth and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, grazing management, and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIc nonirrigated, I irrigated.

100—Satanta loam, 1 to 3 percent slopes. This is a deep, well drained soil on terraces and upland flats. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 14 to 19 inches. Slopes are gently sloping.

Included in this unit are small areas of Platner loam, Wages loam and Nunn loam.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is a dark grayish brown and grayish brown clay loam about 13 inches thick and is calcareous in the lower part. The substratum is light gray and very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for irrigated and nonirrigated cropland. The remaining small acreage is used for grazing. In irrigated cropland areas corn, alfalfa, sugar beets and small grains are the main crops grown. Wheat and sorghum are the main crops grown in a crop-fallow system in nonirrigated cropland areas because precipitation is limited.

Management concerns in irrigated areas are proper use of irrigation water, maintenance of fertility and control of soil erosion. This soil is well suited to furrow and border irrigation. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil loss. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

In nonirrigated cropland areas the primary objective of management is conserving moisture. Stubble mulch tillage and incorporating crop residues are essential conservation practices to improve infiltration. Chiseling or subsoiling improves water penetration. Tillage should be kept to a minimum. Terracing is also beneficial in conserving water and reducing runoff.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

This soil is best suited for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing wildlife areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. This is especially true in areas of intensive agriculture. Rangeland wildlife, such as antelope, can be encouraged by development of watering facilities, proper grazing management, and range seeding where needed.

This soil is well suited for the construction of homesites and other urban developments, with only minor limita-

tions that can be easily modified. Capability subclass IIe irrigated, IIc nonirrigated.

101—Satanta loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 14 to 19 inches. Slopes are gently sloping to moderately sloping.

Included in this unit are small areas of Wages loam and Ascalon sandy loam.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is a dark grayish brown and grayish brown clay loam and loam about 13 inches thick and is calcareous in the lower part. The substratum is light gray and very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for nonirrigated and irrigated cropland. Some small areas are used for grazing. Wheat is the principal crop grown in nonirrigated areas. Alfalfa, corn, sugar beets and small grains are the main crops in irrigated areas.

In irrigated areas the primary concerns of management are control of soil erosion, proper use of irrigation water and maintenance of fertility. Contour ditch and contour furrow are the best suited methods of irrigation on this soil. Land leveling is needed in most areas to obtain more uniform distribution of irrigation water. Frequent irrigation with small heads of water are needed to reduce soil loss. Incorporating crop residues improves water infiltration, soil tilth and helps control soil erosion. Applications of manure and commercial fertilizers containing nitrogen and phosphates are needed to maintain soil fertility.

In nonirrigated cropland areas management is needed to control soil erosion, conserve moisture and maintain productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion. Terracing (fig. 19) and contour tillage are essential to reduce runoff and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improving water penetration. Tillage should be kept to a minimum.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

This soil is best suited for openland and rangeland wildlife. In cropland areas, habitat favorable for pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. This is especially true in areas of intensive agriculture. Rangeland wildlife, such as antelope, can be encouraged by development of watering facilities, grazing management, and range seeding where needed.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIIe nonirrigated, IIIe irrigated.

102—Satanta loam, water table. This is a deep, moderately well drained soil on terraces. It formed in calcareous, loamy alluvium. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level.

Included in this unit are small areas of Satanta loam and some small areas of Satanta sandy loam.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is a dark grayish brown and grayish brown clay loam and loam about 13 inches thick and is calcareous in the lower part. The substratum is light gray and very pale brown, calcareous loam extending to 60 inches. Mottles are common in the substratum below 40 inches.

Permeability is moderate. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table is at depths below 40 inches.

This soil is used almost entirely for irrigated cropland. Some small isolated areas are used for grazing. Corn, alfalfa, sugar beets and small grains are the main crops grown.

Management concerns in irrigated areas are proper irrigation water management and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water, to maintain the water table below 48 inches. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increase water infiltration and improve soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the

most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

Windbreaks and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

The water table is the primary limiting feature where this soil is considered for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly. There is also a possibility of contaminating the ground water. Dwellings with basements will require compensating engineering designs to minimize the effects of the water table. Capability subclass IIIw nonirrigated, IIw irrigated.

103—Satanta loam, wet. This is a deep, wet soil on terraces. It formed in calcareous, loamy alluvium. The average annual precipitation ranges from 14 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Nunn clay loam, saline. In leveled irrigated areas, exposures of the underlying parent material are common.

Typically the surface layer is grayish brown loam about 13 inches thick. The subsoil is a dark grayish brown and grayish brown clay loam and loam about 10 inches thick and is calcareous in the lower part. The substratum is light gray and very pale brown, calcareous loam extending to 60 inches or more. A fluctuating water table occurs below 74 inches. Some visible salt also occurs as thin seams and streaks.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight. This soil is affected by a seeped water table caused by water losses from irrigated land at higher elevations and from irrigation supply systems.

This soil is used mainly for irrigated cropland. Some areas are used for grazing. Corn, alfalfa, sugar beets and small grains are the principal crops grown.

Management concerns in irrigated areas are proper irrigation water use, maintenance of fertility and the high water table. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water, to prevent adding to the water table. Tile drainage and open drainage ditches are essential to lower the water table to minimize the wetness. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increases water infiltration and improves soil tilth.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge and rush. Key forage grasses can be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. This soil can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and watering developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are generally well suited to this soil. The high water table and abundant natural vegetation are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, grazing management and types of fencing that permit unrestricted antelope movement.

The high water table is the primary limiting feature where this soil is used for homesites and other urban developments. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly. Contamination of the ground water may also occur. Dwellings with basements

will require compensating engineering measures such as drainage to minimize the water table. Capability subclass IIIs nonirrigated, IIw irrigated.

104—Shingle loam, 1 to 9 percent slopes. This is a shallow, well drained soil on upland ridges in the northwestern part of the county. It formed in calcareous, loamy materials weathered from interbedded soft sandstone and shale. The average annual precipitation ranges from 13 to 15 inches. Slopes are gently to moderately sloping.

Included in this unit are small areas of Renohill loam, 3 to 9 percent slopes.

Typically the surface layer is grayish brown loam about 2 inches thick. The underlying layers are light olive brown and light yellowish brown, calcareous clay loam about 8 inches thick over interbedded soft sandstone and shale at a depth of about 14 inches (fig. 20).

Permeability is moderate. Effective rooting depth is 10 to 20 inches. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is high.

This soil is not suited for cropland because of the shallow rooting depth and high erosion hazard. It is best suited and used mainly for livestock grazing.

Rangeland vegetation of this soil consists of a sparse stand of blue grama, sideoats grama, alkali sacaton, western wheatgrass, winterfat and fourwing saltbush. Careful attention to proper grazing use is needed to prevent depletion because the soil is difficult to revegetate. Water developments or other practices that cause local concentrations of livestock should be avoided. Periodic deferment of grazing benefits the vegetation by permitting forage plants to complete growth and mature seed. Adjustments in stocking rate should be considered when appreciable areas of this soil are grazed along with more productive areas.

Windbreaks and environmental plantings are generally not suited to this soil because of the shallow depth to bedrock.

Rangeland wildlife, such as antelope, cottontail rabbit and coyote, are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are beneficial and are utilized by wildlife.

This soil is severely limited for the construction of homesites, roads and other urban developments because of depth to bedrock. Intensive designs and measures are needed to overcome this limitation. Capability subclass VIIe nonirrigated.

105—Stoneham sandy loam, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges bordering intermittent drainageways mainly in the western part of the county. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are gently sloping to moderately sloping.

Included are small areas of Stoneham loam and Olney sandy loam. Areas of gravelly knobs and escarpments with steeper slopes are also included.

Typically the surface layer is grayish brown sandy loam about 4 inches thick. The subsoil is grayish brown and light brownish gray clay loam about 9 inches thick and is calcareous in the lower part. The substratum layer is a very pale brown, calcareous loam that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is high.

This soil is used almost entirely for grazing. Only a few small areas are used for nonirrigated cropland and are best seeded back to grass.

Rangeland vegetation of this soil consists mainly of plants from both medium and short grass communities, including sideoats grama, little bluestem, western wheatgrass, needleandthread and blue grama. This soil erodes readily when rangelands are overgrazed. Grazing management needed to maintain and improve production and range condition is deferred grazing and proper grazing use. Contour furrowing and pitting improve water penetration and speed up recovery of areas in fair and poor condition. Fencing and water developments are effective in obtaining more uniform distribution of grazing. Excessive trailing by livestock is a cause of gully erosion on this soil.

Windbreaks and environmental plantings are difficult to establish on this soil because of slope and limited moisture. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

This soil has slight limitations for homesites and other urban developments. The minor limitations can be easily modified. Capability subclass VIe nonirrigated.

106—Stoneham loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are gently sloping.

Included in this unit are small areas of Wages loam and Olney sandy loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is a grayish brown and light brownish gray clay loam about 9 inches thick and is calcareous in the lower part. The substratum is very pale brown, calcareous loam that extends to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for nonirrigated and irrigated cropland and grazing. Wheat is the principal crop grown in nonirrigated cropland areas. Alfalfa, corn and small grains are the main crops in irrigated areas.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting the soil from erosion. Stubble mulch tillage and incorporating crop residues improve soil tilth and protect soil from erosion. Terracing and contour farming are essential to conserve water and reduce runoff and erosion. Chiseling or subsoiling improves water penetration. More intensive use of conservation practices is essential on these soils because of slope. Tillage should be kept to a minimum. Areas of this soil that have been severely eroded in the past are best seeded back to grass. Windbreaks and contour stripcropping are effective in protecting soil from soil blowing.

In irrigated areas the primary concerns of management are control of soil erosion, proper use of irrigation water and maintenance of fertility. Contour ditch and contour furrow are the best suited methods of irrigation on this soil. Land leveling is needed in most areas to obtain more uniform distribution of irrigation water. More frequent irrigation with small amounts of water are needed to reduce soil loss. Incorporating crop residues increases water infiltration, improves soil tilth and helps control soil erosion. Applications of manure and commercial fertilizers containing nitrogen and phosphates are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil because precipitation is limited. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IVe nonirrigated, IIIe irrigated.

107—Stoneham loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy eolian and alluvial materials. The average annual precipitation ranges from 13 to 15 inches. Slopes are moderately sloping.

Included in this unit are small areas of Wages loam and Olney sandy loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is grayish brown and light brownish gray clay loam about 9 inches thick and is calcareous in the lower part. The substratum is a very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for nonirrigated cropland and grazing. It is best suited for rangeland. Areas that are in cropland are usually severely eroded and are best seeded back to grass.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting (fig. 21) are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil because of slope and limited moisture. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides

and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

This soil is well suited for homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass VIe nonirrigated, IVe irrigated.

108—Stoneham-Cushman complex, 3 to 9 percent slopes. These gently to moderately sloping soils are on upland ridges and hills mainly in the western part of the county. The average annual precipitation ranges from 13 to 15 inches. Stoneham loam, 3 to 9 percent slopes, makes up about 65 percent of the unit and Cushman loam, 3 to 9 percent slopes, makes up about 35 percent. The Stoneham soil is on footslopes and at midslope. The Cushman soil is on crests of ridges where shale is nearest to the surface.

The Stoneham soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is grayish brown and light brownish gray clay loam about 9 inches thick and is calcareous in the lower part. The substratum is a very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

The Cushman soil is a moderately deep, well drained soil. It formed in calcareous, eolian and alluvial loamy materials weathered from interbedded soft shale and sandstone.

Typically the surface layer is grayish brown loam about 3 inches thick. The subsoil is grayish brown and light brownish gray clay loam about 12 inches thick. The substratum is light gray, calcareous loam about 7 inches thick over interbedded soft shale and sandstone at a depth of about 22 inches.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used mainly for grazing. Some small areas are used for nonirrigated cropland but are best seeded back to grass. Wheat and forage sorghums are the main crops grown in nonirrigated cropland areas.

Rangeland vegetation on both of these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are difficult to establish on this soil. Limited available water capacity and rooting depth are the principal concerns in establishing tree and shrub plantings. Summer fallow a year in advance of planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best adapted are skunkbush sumac and lilac.

Rangeland wildlife such as antelope, cottontail rabbit, and coyote are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species.

Where areas are considered for homesites and other roads and urban developments, the Stoneham soil is well suited and has only minor limitations that can be easily modified. The Cushman soil is limited by a moderate depth to bedrock. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly because of the bedrock. Capability subclass VIe nonirrigated.

109—Thedalund-Kim-Shingle complex, 9 to 20 percent slopes. These strongly sloping to moderately steep soils are on upland ridges and break areas in the western part of the county. The average annual precipitation ranges from 13 to 15 inches. Thedalund loam, 9 to 15 percent slopes, which makes up about 45 percent of the unit, is at midslope. Kim loam, 9 to 15 percent slopes, which makes up about 30 percent, is on footslopes. Shingle loam, 15 to 20 percent slopes, which makes up about 25 percent, is on ridge crests and knolls.

Areas of this unit are dissected by gullies and small drainageways. Escarpments and shale exposures are common.

The Thedalund soil is a moderately deep, well drained soil on upland ridges. It formed in calcareous, loamy alluvial material derived from interbedded soft shale and sandstone.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is light brownish gray and light yellowish brown, calcareous loam about 27 inches thick over pale yellow soft interbedded shale and sandstone at 31 inches.

Permeability is moderate. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is rapid, and the erosion hazard is high.

The Kim soil is a deep, well drained soil. It formed in calcareous, loamy alluvial and eolian materials.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam and sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is rapid, and the erosion hazard is high.

The Shingle soil is a shallow, well drained soil on upland ridges. It formed in calcareous loamy materials weathered from interbedded soft sandstone and shale.

Typically the surface layer is grayish brown loam about 2 inches thick. The underlying layer is light olive brown and light yellowish brown, calcareous clay loam about 8 inches thick. Interbedded soft sandstone and shale is at a depth of about 10 inches.

Permeability is moderate. Effective rooting depth is 10 to 20 inches. Available water capacity is low. Surface runoff is rapid, and the erosion hazard is high.

These soils are used entirely for grazing. They are not suited for cropland because of the high erosion hazard.

Rangeland vegetation of the Thedalund and Shingle soils consists of a sparse stand of blue grama, western wheatgrass, alkali sacaton, sedge, sideoats grama, winterfat and fourwing saltbush. Rangeland vegetation of the Kim soil consists of blue grama, western wheatgrass, needleandthread, sideoats grama, little bluestem, squirreltail and sedge. Careful attention to proper grazing use is needed to prevent depletion on this unit because it is difficult to revegetate. Water developments or other practices that cause local concentrations of livestock should be avoided. Periodic deferment of grazing benefits the vegetation by permitting forage plants to complete growth and mature seed.

Windbreaks and environmental plantings are generally not suited on this unit because of the high erosion hazard and variable depth to bedrock.

Rangeland wildlife, such as antelope, cottontail, coyote, and scaled quail, are best adapted on these soils. The relief provides good escape cover for wildlife. Forage production is typically low, and proper grazing management is necessary if wildlife and livestock share the range.

The primary limiting soil features for homesites and other urban developments are variable depth to bedrock and slope. Intensive and costly compensating measures are needed to minimize the limiting soil features. Capability subclass VIIe nonirrigated.

110—Ulysses-Norka loams, 3 to 5 percent slopes. These are gently sloping soils on upland ridges and hills mainly in the south central part of the county. The average annual precipitation ranges from 15 to 19 inches. Ulysses loam, 3 to 5 percent slopes, makes up about 50 percent of the mapping unit and Norka loam, 3 to 5 percent slopes, about 30 percent. The Ulysses soil is on slope crests and at midslope. The Norka soil is on footslopes and in coves.

About 20 percent of this unit is small areas of Keith loam and Colby loam. The Colby soil is on ridge crests and is recognizable in the landscape as light colored areas.

The Ulysses soil is a deep, well drained soil. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is grayish brown and pale brown loam about 9 inches thick and is calcareous in the lower part. The substratum layer is light gray and light yellowish very fine sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Norka soil is a deep, well drained soil. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is a grayish brown loam about 4 inches thick. The subsoil is dark grayish brown and light brownish gray clay loam 11 inches thick and is calcareous in the lower part. The substratum is very pale brown, calcareous silt loam and loam extending to 60 inches or more.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

These soils are used mainly for nonirrigated cropland. The remaining acreage is used for grazing. Wheat and grain sorghum are the principal crops, grown in a crop-fallow system.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from soil blowing and erosion. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from erosion and blowing, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and erosion and conserving moisture.

Rangeland vegetation on both of these soils consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are suited on these soils. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to these soils. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, proper grazing management, and types of fencing to permit unrestricted antelope movement.

Where used for homesites and other urban developments, these soils have only minor limitations that can be easily modified through the use of appropriate construction designs. Capability subclass IIIe nonirrigated.

111—Ulysses-Norka-Colby loams, 5 to 9 percent slopes. These soils are on moderately sloping upland ridges and hills in the south central part of the county. The average precipitation ranges from 15 to 19 inches. Ulysses loam, 5 to 9 percent slopes, makes up about 50 percent of this unit, Norka loam, 5 to 9 percent slopes, about 25 percent, and Colby loam, 5 to 9 percent slopes, about 20 percent. The Ulysses soil is at midslope. The Norka soil is on the less sloping footslopes, and the Colby soil is on ridge crests.

Included with this unit are small areas of Colby loam, 9 to 12 percent slopes. Also included are severely eroded areas occurring mainly on slope crests.

The Ulysses soil is a deep, well drained soil. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is grayish brown loam about 5 inches thick. The subsoil is grayish brown and pale brown loam about 9 inches thick and is calcareous in lower part. The substratum layer is light gray and light yellowish very fine sandy loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Norka soil is a deep, well drained soil. It formed in calcareous, loamy eolian deposits.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil layer is dark grayish brown clay loam about 11 inches thick. The substratum is very pale brown, calcareous silt loam extending to 60 inches or more.

Permeability is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Colby soil is a deep, well drained soil. It formed in calcareous, loamy eolian materials.

Typically the surface layer is grayish brown loam about 4 inches thick. The underlying layer is pale brown and very pale brown, calcareous loam extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is rapid, the erosion hazard is high, and the soil blowing hazard is moderate.

These soils are used for nonirrigated cropland and grazing. Wheat is the principal crop grown in a crop-fallow system.

In nonirrigated cropland areas intensive management is needed to control soil erosion and soil blowing, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion and blowing. Terracing (fig. 22) and contour tillage are essential to reduce runoff, control erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

Rangeland vegetation on all of these soils consists mainly of plants from both medium and short grass communities, including mainly sideoats grama, little bluestem, western wheatgrass, needleandthread and blue grama. These soils erode easily when the vegetation is overgrazed. Grazing management needed to maintain and improve production and range condition is deferred grazing and proper grazing use. Contour furrowing and pitting reduce runoff and erosion, improve water penetration and speed up recovery of areas in fair and poor condition. Fencing and water developments are effective in obtaining uniform distribution of grazing.

Windbreaks and environmental plantings are somewhat difficult to establish on these soils because of slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, grazing management and types of fencing to permit unrestricted antelope movement.

Where used for homesites and other urban developments, these soils have only minor limitations that can be easily modified through the use of appropriate design and construction. Capability subclass IVe nonirrigated.

112—Ustic Torriorthents. Ustic Torriorthents consist of strongly sloping to steep, shallow, well drained soils

bordering intermittent drainageways, gullies and escarpments located mainly in the western part of the county. The soils are extremely variable. They are most commonly light colored, have thin surface layers and range from sandy loams to clay loams. Exposures of parent materials and a few outcrops of sandstone and siltstone are common. Runoff is rapid, and the erosion hazard is high.

Included are small areas of nearly level to gently sloping, loamy alluvial soils, similar to the Haverson soils, on narrow flood plains that are frequently flooded.

These soils are not suitable for cultivation because of the slope and erosion hazard. They are used mainly for limited grazing and wildlife. The steep slopes have sparse stands of vegetation. The narrow flood plains provide good stands of forage.

Rangeland vegetation of Ustic Torriorthents consists mainly of plants from both medium and short grass communities, including mainly sideoats grama, little bluestem, western wheatgrass, needleandthread and blue grama. These soils erode easily when the rangeland vegetation is overgrazed. Grazing management needed to maintain and improve production and range condition are deferred grazing and proper grazing use. Where slopes are not steep, contour furrowing and pitting reduce runoff, improve water penetration and speed up recovery of areas in fair and poor condition. Fencing and water developments are effective in obtaining uniform distribution of grazing.

Mule deer and antelope utilize these soils for cover and food. The relationship of this unit to cropland makes it valuable for escape cover for wildlife. Management of these soils for wildlife includes proper grazing management and water developments.

Where these soils are considered for windbreaks and environmental plantings and homesites, special onsite investigations are required to select specific sites and determine necessary management. Capability subclass VIIs nonirrigated.

113—Valent sand, 0 to 1 percent slopes. This is a deep, excessively drained soil on toe slopes where upland sand ridges border terraces. It formed in noncalcareous eolian sand deposits. The average annual precipitation ranges from 13 to 15 inches. Slopes are nearly level.

Typically the surface layer is grayish brown loamy sand about 3 inches thick. The underlying layers are brown and pale brown loamy sand and fine sand extending to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the soil blowing hazard is high, and the erosion hazard is slight.

This soil is used mainly for irrigated cropland and grazing. Alfalfa, corn and sugar beets are the principal crops grown.

Proper use of irrigation water, fertility maintenance and soil blowing are the main concerns of management. This soil is best suited for the sprinkler method of irrigation because of the rapid permeability. Most areas of this soil, however, are small and are irrigated with the surrounding soils by border and furrow methods of irrigation. Short irrigation runs are needed to obtain uniform water applications, make efficient use of irrigation water, and prevent excessive leaching. Cover crops grown after harvesting row crops are needed to protect the soil from blowing. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility. Crop residues incorporated into the soil improve organic matter content and help reduce soil blowing. Windbreaks at right angles to the prevailing winds will also reduce soil blowing.

Windbreaks and environmental plantings are difficult to establish on this soil. Soil blowing and low available water capacity are the principal concerns in establishing trees and shrubs. Trees need to be planted in shallow furrows, and vegetative cover maintained between the rows. Supplemental irrigation is needed to insure survival. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine and Siberian elm. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Rangeland vegetation of this soil consists mainly of sand bluestem, switchgrass, sand reedgrass, little bluestem, needleandthread, sideoats grama, sand dropseed, sedge and blue grama. These grasses furnish most of the forage. Sand sagebrush is scattered in the vegetation. Grazing management must be aimed at the maintenance or improvement of range condition through proper grazing use. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective in management systems for livestock use. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Seeding is essential if severely depleted areas develop. Fencing and livestock watering places aid in obtaining more uniform distribution of grazing. Care must be taken not to locate water developments in places where serious soil blowing can result.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, the inclusion of undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing that permit unrestricted antelope movement.

Soil blowing and seepage are the primary limiting soil features for homesites and other urban development and roads. Sealing methods are required to overcome the excessive seepage condition when the soil is used for sewage lagoons or landfill areas. This soil should be pro-

tected at all times by utilization of mulches and vegetative cover to keep soil blowing to a minimum. Capability subclass IVe irrigated, VIe nonirrigated.

114—Valent sand, 15 to 40 percent slopes. This is a deep, excessively drained soil on upland sandhills. It formed in noncalcareous, eolian sand deposits and is extensive in the sandhill area that parallels the South Platte River on the south. The average annual precipitation ranges from 13 to 19 inches. Slopes are hilly with steep abrupt slopes on the windward side.

Included are small areas of blowouts and very sparsely vegetated steep ridges, and areas of Valent loamy sand, 3 to 15 percent slopes.

Typically the surface layer is grayish brown loamy sand about 3 inches thick. The underlying layers are brown and pale brown loamy sand and fine sand that extends to 60 inches or more.

Permeability is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is very high.

All of this soil is used for grazing. It is unsuited for cropland because of slope, low available water capacity and very high soil blowing hazard.

The rangeland vegetation consists mainly of sand reedgrass, sand bluestem, sand dropseed, needleandthread, blue grama, sandhill muhly and Indian ricegrass. Careful grazing management is essential on this soil to prevent overgrazing because a serious soil blowing problem can result when the protective plant cover is destroyed. Livestock watering places should not be located on these soils because they create destructive concentrations of animals causing depletion of rangeland cover. Range seeding is not practical on this soil because of the very high soil blowing hazard. Fencing aids in protecting and facilitating grazing management on areas of this soil.

Windbreak and environmental plantings are generally not suited to this soil because of the very high soil blowing hazard, low available water capacity and lack of irrigation water.

Wildlife is limited because of limited food and cover. Habitat can be improved by fencing and controlled grazing.

Where this soil is used for homesites and other urban developments, the primary limiting soil features are slope and severe soil blowing. Intensive and costly compensating measures are needed to minimize these limiting soil features. Capability subclass VIIe nonirrigated.

115—Valent loamy sand, 3 to 15 percent slopes. This is a deep, excessively drained soil on upland sandhills. It formed in noncalcareous, eolian sand deposits and is extensive in the sandhill area that parallels the South Platte River on the south. The average annual precipitation ranges from 13 to 19 inches. Slopes are gently rolling to strongly rolling.

Included in this unit are small areas of Dailey loamy sand and Julesburg loamy sand, both having slopes of 3 to 9 percent.

Typically the surface layer is grayish brown loamy sand about 3 inches thick. The underlying layers are brown and pale brown loamy sand and fine sand that extend to 60 inches or more.

Permeability is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the soil blowing hazard is high, and the erosion hazard is slight.

This soil is used principally for grazing. Some small isolated areas are used for irrigated cropland.

Rangeland vegetation on this soil consists mainly of sand bluestem, switchgrass, sand reedgrass, little bluestem, sideoats grama, sedge, needleandthread, sand dropseed and blue grama. These grasses furnish most of the forage. Sand sagebrush is scattered in the vegetation. Grazing management must be aimed at the maintenance or improvement of range condition through proper grazing use. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective in management systems for livestock use. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Seeding is essential if severely depleted areas develop. Fencing and livestock watering places aid in obtaining more uniform distribution of grazing. Care must be taken not to locate water developments in places where serious soil blowing can result.

Windbreak and environmental plantings are generally not suited to this soil because of the low available water capacity, lack of irrigation water and high soil blowing hazard.

Rangeland wildlife, such as antelope, cottontail rabbit and coyote, are best adapted on this soil. Proper grazing management is necessary if wildlife and livestock share the range. Watering developments are also important and are utilized by various wildlife species. Where this soil is under irrigation, openland wildlife can be encouraged if food and cover are provided through various means of wildlife development.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Where the soil is considered for a sewage lagoon system, special sealing methods will be required to overcome excessive seepage. Special engineering designs will be needed in order to compensate for slopes greater than 7 percent. During construction, special care, such as use of mulches, is needed to protect soil from blowing. Capability subclass VIe nonirrigated, VIe irrigated.

116—Vona loamy sand, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, eolian sandy materials. It is extensive in the southwestern part of the county. The average annual precipitation ranges from 13 to 15 inches. Slopes are moderately sloping to strongly sloping.

Included are small areas of Vona sandy loam and Manter sandy loam, both having slopes of 5 to 9 percent.

Typically the surface layer is grayish brown loamy fine sand about 3 inches thick. The subsoil is brown fine sandy loam about 13 inches thick and is calcareous in the lower part. The substratum is pale brown, calcareous fine sandy loam and loamy sand that extends to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is low or moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is high.

This soil is used mainly for grazing. It is not suited to nonirrigated cropland because of slope and high soil blowing hazard. Many areas cultivated at one time have been seeded back to grass and are used for grazing. Some small localized areas are used for irrigated cropland, with alfalfa as the principal crop grown.

The rangeland vegetation of this soil consists of blue grama, sand dropseed, sand bluestem, switchgrass, sand reedgrass, little bluestem, sideoats grama and needleandthread as the main forage species. Sand sagebrush is scattered in the vegetation. Grazing management of this soil is needed to maintain or improve productive range condition. Periodic deferment of grazing during the growing season is beneficial. This soil can be seeded to rangeland grasses if it becomes denuded by grazing or farming. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use. Mechanical treatment is not generally applicable on this soil.

In irrigated cropland areas the main concerns of management are the soil blowing hazard and maintenance of organic matter and fertility. This soil is best suited to the sprinkler method of irrigation because of the rapid intake rate. Special care consisting of cover crops grown after row crop harvest and incorporating crop residues during periods when no growing crop is present is needed to protect the soil. Applications of manure and use of crop residues help maintain and improve soil tilth and organic matter content. Applications of commercial fertilizers containing nitrogen and phosphorus are required for high yield of all crops.

Windbreak and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree row and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and during dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Where the soil is considered for a sewage lagoon system, special sealing methods are required to overcome excessive seepage. During construction, special care consisting of straw mulches should be used to protect soil from blowing. Capability subclass VIe nonirrigated, IVe irrigated.

117—Vona fine sandy loam, 3 to 9 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous eolian sands and fine sandy loams and is extensive in sandy land areas in the southwestern part of the county. The average annual precipitation ranges from 13 to 15 inches. Slopes are moderately sloping to strongly sloping.

Included are small areas of Manter sandy loam, 3 to 5 percent slopes, on foot slopes and Vona loamy sand, 5 to 9 percent slopes, on ridge crests.

Typically the surface layer is grayish brown fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam about 13 inches thick and is calcareous in the lower part. The substratum is pale brown, calcareous fine sandy loam and loamy sand that extends to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is slow, the erosion hazard is slight, and the soil blowing hazard is moderate.

This soil is used mainly for grazing. Some small areas are used for irrigated cropland with corn and alfalfa as the principal crops grown. This soil is not suited for nonirrigated cropland because of the low to moderate available water capacity and limited precipitation. Areas that are in nonirrigated cropland are usually severely eroded and are best seeded back to grass.

The rangeland vegetation of this soil consists of blue grama, little bluestem, sand reedgrass, switchgrass, sand bluestem, sand dropseed, and needleandthread as the main forage species. Sand sagebrush is scattered in the vegetation. Grazing management of this soil is needed to maintain or improve productive range condition. Periodic deferment of grazing during the growing season is beneficial. This soil can be seeded to rangeland grasses if it becomes denuded by grazing or farming. Deferred grazing is highly effective in management systems for livestock use. Brush management is needed in areas where sand sagebrush forms a dense stand because of continued heavy grazing use.

In irrigated areas the main concerns of management are proper use of irrigation water, soil fertility and control of soil blowing. This soil is suited to contour furrow, contour ditch and sprinkler methods of irrigation. Land leveling and irrigation water management are needed to obtain uniform distribution and efficient use of water. Short irrigation runs are needed to minimize erosion losses. Incorporating crop residues is needed to reduce soil blowing during periods when the soils are not protected by growing crops and to improve soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are needed in maintaining soil fertility.

Windbreak and environmental plantings are generally suited to this soil. Soil blowing is the principal concern to establishing trees and shrubs. This hazard can be overcome by cultivating only in the tree rows and by leaving a strip of vegetative cover between the rows. Supplemental irrigation is necessary at the time of planting and dur-

ing dry periods. Trees best suited and having good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac and Siberian peashrub.

Rangeland wildlife, such as antelope, cottontail rabbit and coyote are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species. The position of this soil in relation to croplands makes it valuable as escape cover areas for openland wildlife, especially pheasants. Where this soil is under irrigation, openland wildlife can be encouraged by providing food and cover through various means of wildlife development.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Where the soil is considered for a sewage lagoon system, special sealing methods will be required to overcome excessive seepage. Capability subclass VIe nonirrigated, IVe irrigated.

118—Wages loam, 0 to 3 percent slopes. This is a deep, well drained soil on upland flats. It formed in calcareous, loamy alluvial and eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are nearly level to gently sloping.

Included in mapping are small areas of Satanta loam and Norka loam. The Santanta soil is in the more level areas. In some irrigated cropland areas the thin surface layer and subsoil have been tilled together. In leveled areas exposures of the underlying parent material are also common.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam (fig. 23) extending to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for irrigated and nonirrigated cropland. Some small areas are used for grazing. In irrigated areas alfalfa, sugar beets, and corn are the principal crops grown. Wheat and grain sorghum are the main crops in nonirrigated areas.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain uniform application of water. Irrigation water management consisting of proper length of run is needed for efficient use of irrigation water. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil and maintaining organic matter content increase water intake rates and improve soil tilth.

In nonirrigated cropland areas the primary objectives of management are conserving moisture and protecting soil from erosion. Management practices such as stubble mulch tillage and incorporating crop residues are essential to protect soil from erosion, improve water infiltration, improve soil tilth, and conserve moisture. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and erosion and conserving moisture.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreak and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by grazing management, water developments and types of fencing to permit unrestricted antelope movement.

Where used for homesites and other urban developments, this soil has only minor limitations that can be easily modified through the use of appropriate design and construction. Capability subclass IIc nonirrigated, IIe irrigated.

119—Wages loam, 3 to 5 percent slopes. This is a deep, well drained soil on upland ridges and hills. It formed in calcareous, loamy alluvial and eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are gently sloping.

Included in this unit are small areas of Satanta loam and Ascalon fine sandy loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown light clay loam about 10 inches thick and is calcareous in the lower part. The substratum is light gray, calcareous loam and fine sandy loam extending to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for irrigated and nonirrigated cropland. The remaining acreage is used for grazing. Alfalfa, sugar beets and corn are the principal crops grown in irrigated areas. Wheat is the main crop grown in nonirrigated areas.

In irrigated areas the primary concerns of management are control of soil erosion, proper use of irrigation water and maintenance of fertility. Contour ditch and contour furrow are the best suited methods of irrigation on this soil. Land leveling is needed in most areas to obtain more uniform distribution of irrigation water. More frequent irrigation with smaller amounts of water is needed to reduce soil loss because of slope. Incorporating crop residues improves water infiltration and soil tilth and helps control soil erosion. Applications of manure and commercial fertilizers containing nitrogen and phosphates are needed to maintain soil fertility.

In nonirrigated cropland areas, management is needed to control soil erosion, conserve moisture and maintain productivity. Stubble mulch tillage and incorporating crop residues are essential to reduce runoff and erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation and other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreak and environmental plantings are generally well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, grazing management, and types of fencing to permit unrestricted antelope movement.

This soil is well suited for the construction of homesites and other urban developments, with only minor limitations that can be easily modified. Capability subclass IIIe nonirrigated, IIIe irrigated.

120—Wages loam, 5 to 9 percent slopes. This is a deep, well drained soil on upland side slopes and ridges. It formed in calcareous, mixed, loamy alluvial and eolian deposits. The average annual precipitation ranges from 15 to 19 inches. Slopes are moderately sloping.

Included in this unit are small areas of Satanta loam and Ascalon fine sandy loam.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown light clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam extending to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for irrigated and nonirrigated cropland. The remaining acreage is used for grazing. Alfalfa, sugar beets and corn are the principal crops grown in irrigated areas. Wheat is the main crop grown in nonirrigated areas.

In nonirrigated cropland areas, management is needed to control soil erosion, conserve moisture and maintain productivity. Stubble mulch tillage and incorporating crop residues are essential to reduce runoff and erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

In irrigated areas proper use of irrigation water, controlling soil erosion and maintaining soil fertility are the main concerns of management. Under good management this soil can be cultivated safely. Because of slope, this soil needs to be kept in close growing crops at least half the time to minimize possible erosion losses. Some land leveling is generally needed in order to obtain more uniform distribution of irrigation water. Frequent irrigations with smaller amounts of water are needed to reduce soil loss and obtain uniform application of irrigation water. Contour furrow and contour ditch are the best suited methods of irrigation on this soil. Incorporating crop residues is important in controlling soil erosion, maintaining fertility and improving soil tilth. Applications of manure and commercial fertilizer containing nitrogen and phosphates are needed to maintain soil fertility.

Rangeland vegetation consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are somewhat difficult to establish on this soil because of slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, contour planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged with water developments, grazing management, and fencing that permits unrestricted antelope movement.

Where used for homesites and other urban developments, this soil has only minor limitations that can be easily modified. Capability subclass IVe nonirrigated, IVe irrigated.

121—Wages-Altvan complex, 5 to 9 percent slopes. These moderately sloping soils are on upland ridges in the northern part of the county. The average annual precipitation ranges from 15 to 19 inches. Wages loam, 5 to 9 percent slopes, makes up about 55 percent of the map unit and Altvan sandy loam, 5 to 9 percent slopes, about 25 percent. The Wages soil is on footslopes and at midslope. The Altvan soil is on ridge crests.

About 20 percent of this unit is Dix gravelly sandy loam and Eckley sandy loam. These soils are on ridge crests and knobs.

The Wages soil is a deep, well drained soil. It formed in calcareous eolian and alluvial materials.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is dark grayish brown clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam extending to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

The Altvan soil is a deep, well drained upland soil. It formed in calcareous, water and windlain deposits over sand and gravel.

Typically the surface layer is a grayish brown sandy loam about 5 inches thick. The subsoil is a dark grayish brown heavy sandy loam and sandy clay loam about 18 inches thick. The substratum is calcareous, light brownish gray sandy clay loam about 18 inches thick over light brown coarse sand and gravel extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate.

This soil is used for irrigated and nonirrigated cropland and grazing. Alfalfa and small grains are the main crops grown in irrigated areas. Wheat is the principal crop grown on nonirrigated cropland.

In nonirrigated cropland areas, intensive management is needed to control soil erosion, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion. Terracing (fig. 24) and contour tillage are essential to reduce runoff and erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum. Special care and a combination of practices are essential on these soils to maintain productivity and protect them from erosion.

In irrigated areas, intensive management is needed to prevent soil loss and maintain productivity. Contour furrow and contour ditch are the best methods of irrigation suited to this soil. Land leveling or smoothing is needed in most areas to obtain better distribution of water. Before attempting to level or smooth these soils, care must be taken in determining maximum depth of cut in areas of the Altvan soil. Irrigation water management is important in obtaining efficient use of water. Frequent irrigations on short runs with smaller amounts of water are required to reduce soil loss and obtain more efficient use of irrigation water. To control soil loss, alfalfa, small grains and other close sown crops can be irrigated by flooding from contour ditches. Row crops are best planted in the contour. Incorporating crop residues improves soil tilth, increases soil infiltration and helps control soil loss. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedges. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy

grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on range areas in poor and fair condition.

Windbreak and environmental plantings are somewhat difficult to establish on these soils because of slope. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, planting on the contour, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

These soils are well suited for homesites and other urban developments, with only minor limitations that can be easily modified. The Altvan soil requires sealing to overcome the excessive seepage if used for sewage lagoon sites. Capability subclass IVe nonirrigated, IVe irrigated.

122—Wages-Manter complex, 3 to 9 percent slopes. These gently sloping to moderately sloping soils are on upland ridges and hills in the northern part of the county. Slopes are dissected by many intermittent drainageways originating in the adjacent area of moderately steep gravelly soils. The average precipitation ranges from 15 to 19 inches. Wages loam, 3 to 9 percent slopes, makes up about 50 percent of the mapping unit and Manter sandy loam, 3 to 9 percent slopes, about 30 percent. The Wages soil is at midslope and on tops of ridges. The Manter soil is on toe slopes and tops of ridges where sandy eolian materials are deposited.

About 20 percent of this unit is Chappell sandy loam having 3 to 5 percent slopes and occupying foot slopes.

The Wages soil is a deep, well drained soil. It formed in calcareous, mixed loamy alluvial and eolian deposits.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is very dark grayish brown clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam extending to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

The Manter soil is a deep, well drained soil. It formed in calcareous, sandy loam eolian and alluvial materials.

Typically the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil is brown and light brownish gray sandy loam about 18 inches thick and is calcareous in the lower part. The substratum is light gray, calcareous sandy loam and loamy sand extending to 60 inches or more.

Permeability is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

These soils are used mainly for grazing because they are strongly dissected by the many intermittent drainageways. Some small areas are used for nonirrigated cropland. These soils are most commonly eroded and are best seeded back to grass.

Rangeland vegetation of the Wages soil consists of blue grama, buffalograss, western wheatgrass and sedge. Rangeland vegetation of the Manter soil consists of blue grama, sand dropseed, sand reedgrass, little bluestem, switchgrass, sand bluestem, and needleandthread as the main forage species. Sand sagebrush is scattered in the vegetation. Grazing management of these soils is needed to maintain or improve productive range condition. Periodic deferment of grazing during the growing season is beneficial. These soils can be seeded to rangeland grasses if they become denuded by grazing or farming. Contour furrow or pitting are practices that improve water infiltration and reduce runoff and erosion and are especially effective on range areas in poor and fair condition. Combinations of stockwater development and fencing also help improve grazing distribution and maintain range condition.

Windbreaks and environmental plantings are somewhat difficult to establish on the steeper sloping areas of these soils. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. The Manter soil is subject to soil blowing. This hazard can be overcome by leaving a strip of vegetative cover between the rows. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Rangeland wildlife, such as antelope, cottontail, and coyote, are best adapted on this soil. Proper grazing management is necessary if livestock and wildlife share the range. Watering facilities are also important and are utilized by various wildlife species. The relationship of these soils to croplands makes them valuable as escape cover areas for openland wildlife, especially pheasants.

These soils are suited for use as homesites and other urban developments with only minor limitations that can be easily modified. Seepage is the primary limiting soil feature of the Manter soil. Sealing is required for sewage

lagoon sites. Due to the number of intermittent drainageways, special site selection is required on this unit. Capability subclass VIe nonirrigated.

123—Wages-Rosebud loams, 3 to 5 percent slopes. These gently sloping soils are on upland ridges and hills in the northern part of the county. The average annual precipitation ranges from 15 to 19 inches. Wages loam, 3 to 5 percent slopes, makes up about 60 percent of the mapping unit and Rosebud loam, 3 to 5 percent slopes, about 30 percent. The Wages soil is on footslopes and at midslope. The Rosebud soil is on crests of ridges and hills.

About 10 percent of this unit is Escabosa loam on crests and knobs.

The Wages soil is a deep, well drained upland soil. It formed in calcareous, loamy alluvial and eolian deposits.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is a dark grayish brown clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam extending to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches. Available water capacity is high. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Rosebud soil is a moderately deep, well drained soil. It formed in calcareous, loamy alluvial and eolian deposits over cemented calcareous sandstone.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is a dark grayish brown loam about 13 inches thick. The substratum is a light gray, calcareous loam about 15 inches thick over white, calcareous cemented sandstone at a depth of about 33 inches.

Permeability is moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate or high. Surface runoff is medium, and the erosion hazard is moderate.

These soils are used mainly for nonirrigated and irrigated cropland. The remaining areas are used for grazing. Wheat and grain sorghum are the main crops in nonirrigated cropland areas. Alfalfa, sugar beets and corn are the main crops in irrigated areas.

In nonirrigated cropland areas management concerns are controlling soil erosion, conserving moisture and maintaining soil productivity. Special care is essential on these soils to maintain productivity and protect them from erosion. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion and blowing. Terracing and contour tillage are essential to reduce runoff, control erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

In irrigated areas, management concerns are to control soil erosion and maintain productivity in these soils. Contour furrow and contour ditch are the best methods of irrigation suited to this soil. Land leveling or smoothing is needed in most areas to obtain better distribution of water. Before attempting to level or smooth these soils, care must be taken in determining maximum depth of cut in areas of the Rosebud soil. Irrigation water management is important in obtaining efficient use of water. To control soil loss, alfalfa, small grains and other close sown crops can be irrigated by contour ditches. Row crops are best planted in the contour. Incorporating crop residues in the surface improves soil tilth and increases soil infiltration. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred growing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are suited on these soils. Rooting depth is a concern on the Rosebud soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments, proper grazing management, and types of fencing to permit unrestricted antelope movement.

The Wages soil is well suited for use as homesites and other urban developments, with only slight limitations that can be easily modified. Depth to bedrock is the primary limiting soil feature on the Rosebud soil. Special sewage systems must be anticipated. Septic tank absorption fields and sewage lagoons will not function properly because of the moderate depth to bedrock. Onsite investigation may be needed to determine a desirable soil location. Capability subclass IVe nonirrigated, IVe irrigated.

124—Wages-Rosebud loams, 5 to 9 percent slopes. These moderately sloping soils are on upland ridges and hills in the northern part of the county. The average annual precipitation ranges from 15 to 19 inches. Wages loam, 5 to 9 percent slopes, makes up about 50 percent of the mapping unit and Rosebud loam, 5 to 9 percent slopes, about 30 percent. The Wages soil is on footslopes and at midslope. The Rosebud soil is on ridge crests.

About 20 percent of this unit is Escabosa loam, 5 to 9 percent slopes, and Canyon gravelly loam, 9 to 12 percent slopes. These soils are on ridge crests.

The Wages soil is a deep, well drained upland soil. It formed in calcareous, loamy alluvial and eolian deposits.

Typically the surface layer is grayish brown loam about 4 inches thick. The subsoil is a dark grayish brown clay loam about 10 inches thick and is calcareous in the lower part. The substratum is a light gray, calcareous loam and fine sandy loam extending to a depth of 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, the erosion hazard is moderate, and the soil blowing hazard is moderate.

The Rosebud soil is a moderately deep, well drained soil. It formed in calcareous, loamy eolian and alluvial deposits overlying calcareous indurated sandstone.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is a very dark grayish brown loam about 13 inches thick. The substratum is a light gray, calcareous loam about 15 inches thick over light gray, calcareous indurated sandstone at about 33 inches.

Permeability is moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is moderate. Surface runoff is moderate, and the erosion and soil blowing hazards are moderate.

These soils are used for irrigated cropland, nonirrigated cropland and grazing. Corn, sugar beets, alfalfa and small grains are the main crops grown in irrigated areas. Wheat is the principal crop in nonirrigated areas. These soils can be cultivated safely if slope and erosion limitations are recognized and the necessary practices implemented.

In nonirrigated cropland areas, intensive management is needed to control soil erosion, conserve moisture and maintain soil productivity. Stubble mulch tillage and incorporating crop residues are essential in improving soil tilth, conserving moisture and protecting the soil from erosion and blowing. Terracing and contour tillage are essential to reduce runoff and erosion and conserve moisture. Chiseling or subsoiling is effective in breaking up tillage pans and improves water penetration. Tillage should be kept to a minimum.

In irrigated areas, management concerns are to control soil erosion and maintain productivity in these soils. Contour furrow and contour ditch are the best methods of irrigation suited to this soil. Land leveling or smoothing is needed in most areas to obtain better distribution of water. Before attempting to level or smooth these soils, care must be taken in determining maximum depth of cut in areas of the Rosebud soil because of depth to bedrock. Irrigation water management is important in obtaining efficient use of water. Frequent irrigations are needed on this soil because of slope. To control soil loss, alfalfa, small grains and other close sown crops can be irrigated by close-spaced contour ditches. Row crops are best planted on the contour. Incorporating crop residues in the surface improves soil tilth and increases soil infiltration. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain soil fertility.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreaks and environmental plantings are suited on these soils. Rooting depth of the Rosebud soil and slope are the main concerns in establishing plantings. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water development and types of fencing to permit unrestricted antelope movement.

The Wages soil is well suited for homesites and other urban developments with only slight limitations that can be easily modified. Depth to bedrock is the primary limiting soil feature on the Rosebud soil. Special sewage systems must be anticipated. Septic tank absorption fields will not function properly because of the bedrock. Onsite investigation is needed in order to determine a desirable site location. Capability subclass IVe nonirrigated, IVe irrigated.

125—Weld loam, 0 to 1 percent slopes. This is a deep, well drained soil on uplands. It formed in calcareous,

loamy eolian deposits and is extensive in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Slopes are nearly level.

Included in this unit are small areas of Rago loam.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is grayish brown heavy silty clay loam about 11 inches thick and is calcareous in the lower part. The substratum is light gray, calcareous loam extending to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

Almost the entire acreage of this soil is used for irrigated cropland. The remaining small areas are used for grazing. Corn, alfalfa, and sugar beets are the principal crops.

Management concerns in irrigated areas are proper irrigation water use and maintenance of fertility. This soil is well suited to furrow and border irrigation methods. Land leveling is needed in some areas to obtain more uniform application of water. Good irrigation water management consisting of proper length of run is needed for efficient use of irrigation water because of the slow permeability. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are needed to maintain fertility. Incorporating crop residues into the soil helps maintain organic matter content, increases water infiltration and improves soil tilth.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality of desirable vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreak and environmental plantings are well suited on this soil. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged on grasslands by livestock water developments and types of fencing to permit unrestricted antelope movement.

The primary limitations of this soil for homesites and other urban developments are high shrink-swell potential and slow permeability. These limitations can be modified by special engineering designs and measures such as backfilling with more desirable materials. Capability subclass IIIc nonirrigated, IIs irrigated.

126—Weld loam, 1 to 3 percent slopes. This is a deep, well drained soil on upland tablelands. It formed in calcareous, loamy eolian deposits and is extensive in the western part of the county. The average annual precipitation ranges from 13 to 17 inches. Slopes are gentle.

Included in this unit are small areas of Rago loam, 0 to 1 percent slopes, and Platner loam, 1 to 3 percent slopes.

Typically the surface layer is grayish brown loam about 7 inches thick. The subsoil is grayish brown heavy silty clay loam about 11 inches thick and is calcareous in the lower part. The substratum is light gray, calcareous loam extending to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

This soil is used mainly for nonirrigated cropland. Some areas are used for irrigated cropland and grazing. Wheat and sorghum are the principal crops grown in a crop fallow system in nonirrigated cropland areas because of the low precipitation. Corn, sugar beets, alfalfa and small grains are the main crops grown in irrigated areas.

In nonirrigated cropland areas the primary objective of management is conserving moisture because moisture is limiting. Management practices such as stubble mulch tillage and incorporating crop residues are essential to improve water infiltration, improve soil tilth, and conserve moisture. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. Terracing is also beneficial in reducing runoff and conserving moisture.

Management concerns in irrigated areas are proper use of irrigation water, maintenance of fertility and control of soil erosion. This soil is well suited to furrow or border irrigation methods. Land leveling is necessary in most areas to obtain uniform distribution of water. Irrigation water management is needed for efficient use of water and control of soil loss. The use of small amounts of water is effective in controlling soil loss by irrigation. Incorporating crop residues into the surface soil increases infiltration, reduces soil loss and improves soil tilth. Applications of manure and commercial fertilizers containing nitrogen and phosphorus are important in maintaining soil productivity.

Rangeland vegetation of this soil consists mainly of blue grama, buffalograss, western wheatgrass, and sedge. Proper grazing use and planned grazing systems are the most important practices to maintain quantity and quality

of desirable rangeland vegetation. Range seeding will speed the revegetation of areas depleted by heavy grazing, cultivation or other disturbances. Combinations of stockwater development, fencing and deferred grazing help improve grazing distribution and maintain range condition. Contour furrowing and pitting are practices that improve water infiltration and reduce runoff and are especially effective on rangeland areas in poor and fair condition.

Windbreak and environmental plantings are suited on this soil. The main concern is limited moisture. Summer fallow a year prior to planting, supplemental water during planting and early stages of growth, and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees best suited and having best survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive and hackberry. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Openland wildlife such as pheasant, cottontail rabbit and mourning dove are suited to this soil. In cropland areas favorable habitat can be developed by establishing areas for nesting and escape cover. For pheasants, undisturbed nesting cover is vital and should be included in plans for habitat development. Tree and shrub plantings along fence lines, irrigation ditches, roadsides and streambanks also help encourage wildlife. Rangeland wildlife, including antelope and jackrabbits, can be encouraged by water developments and types of fencing to permit unrestricted antelope movement.

High shrink-swell potential and slow permeability are the primary limiting soil features for homesites and other urban developments. These limitations can be modified by special engineering design and measures such as backfilling with desirable materials. Capability subclass IIIc nonirrigated, IIIe irrigated.

127—**Westplain silty clay loam.** This is a deep, somewhat poorly drained soil on bottomlands and concave parts of low terraces. It formed in a thin mantle of clayey alluvium overlying sand and gravel deposited by the South Platte River. The average annual precipitation ranges from 13 to 19 inches. Slopes are nearly level.

Included in this unit are small areas of Alda loam and Fluvaquentic Haplaquolls, both having slopes of 0 to 1 percent. The Alda loam soils are in higher lying positions bordering the concave areas.

Typically the surface layer is dark gray, calcareous heavy silty clay loam about 14 inches thick. The underlying layer is mottled brown, calcareous very gravelly clay loam about 3 inches thick over light gray, mottled sand and gravel extending to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 12 and 24 inches during the winter and spring months. This soil is subject to frequent flooding in spring.

This soil is used for irrigated cropland and grazing. Alfalfa and corn are the main crops.

In irrigated areas the main concerns of management are proper use of irrigation water, flooding and fertility maintenance. Special care is required on this soil in applying irrigation water. Irrigation methods that are suitable are furrows, borders or sprinkler. Land leveling is difficult because this soil is shallow to sand and gravel. Short irrigation runs and frequent irrigations are needed to control the fluctuating water table. Drainage ditches may also be required. Flood control dikes can be used to protect the soil from damage. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility. Incorporating crop residues reduces soil loss and improves soil tilth.

Rangeland vegetation consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge, and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock watering developments are effective in obtaining more uniform distribution of grazing.

Windbreaks and environmental plantings are suited to this soil. The high fluctuating water table, abundant competing vegetation and depth to sand and gravel are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its use for cropland and its proximity to the South Platte River. Under irrigation, it is important for food production for wildlife such as waterfowl, pheasants and deer utilizing crop residues that occur as aftermath following harvest. Wildlife values can be enhanced on this soil by habitat developments such as tree and shrub plantings and an undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Frequent flooding, seepage and a water table at 12 to 24 inches limit use of these soils for homesites and other urban developments. Intensive and costly engineering design and measures are needed in order to overcome these conditions. Capability subclass VIw nonirrigated, IVw irrigated.

128—**Westplain-Alda complex.** These are nearly level, somewhat poorly drained soils on low terraces and bottomlands along the South Platte River. The average annual precipitation ranges from 13 to 19 inches. Westplain silty clay loam, 0 to 1 percent slopes, makes up about 55 percent of the mapping unit and Alda loam, 0 to 1 percent slopes, about 35 percent. The Westplain soils are in

swales and old channel areas. The Alda soils are on the raised terraces of the area.

About 10 percent of this unit is Fluvaquentic Haplaquolls, also having 0 to 1 percent slopes.

The Westplain soil is a deep, somewhat poorly drained soil. It formed in a thin mantle of clayey alluvium overlying mottled and stratified sand and gravel deposited by the South Platte River.

Typically the surface layer is dark gray, calcareous heavy silty clay loam about 14 inches thick. The underlying layer is mottled, brown, calcareous very gravelly clay loam about 3 inches thick over light gray mottled sand and gravel extending to 60 inches or more.

Permeability is slow. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. This soil is subject to frequent flooding in spring. A fluctuating water table occurs between 12 to 24 inches during the winter and spring months.

The Alda soil is a deep, somewhat poorly drained soil. It formed in calcareous, stratified loamy alluvium overlying mottled sand and gravel deposited by the South Platte River.

Typically the surface layer is dark grayish brown loam about 10 inches thick. The underlying layers are light brownish gray and light gray, calcareous loam and fine sandy loam mottled in the lower part and about 24 inches thick over mottled coarse sand and gravel extending to 60 inches or more.

Permeability is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. A fluctuating water table occurs between 24 and 60 inches during the winter and spring months. This soil is subject to occasional flooding during late spring and early summer months.

These soils are used for irrigated cropland and grazing. Alfalfa, corn, and sugar beets are the principal crops.

In irrigated areas the main concerns of management are proper use of irrigation water, wetness, flooding and fertility maintenance. Special care is required on this soil in applying irrigation water to avoid raising the fluctuating water table. Irrigation methods suitable are furrows, borders or sprinklers. Land leveling is difficult because the Westplain soil is shallow to sand and gravel. Short irrigation runs and frequent irrigations are needed to control the fluctuating water table. Drainage ditches may also be required. Flood control dikes can be used to protect the soil from flooding. Applications of manure and commercial fertilizer containing nitrogen and phosphorus are important to maintain fertility. Incorporating crop residues reduces soil loss and improves soil tilth.

Rangeland vegetation on both of these soils consists mainly of alkali sacaton, inland saltgrass, switchgrass, western wheatgrass, sedge and rush. Key forage grasses need to be maintained by proper grazing use and grazing management that includes deferment during the growing season at well-timed intervals. These soils can be seeded to rangeland species or adapted introduced grasses such as tall wheatgrass. Fencing and livestock water developments are effective in obtaining more uniform distribution of grazing.

Windbreak and environmental plantings are generally well suited to these soils. The high water table, abundant competing vegetation, and depth to sand and gravel are the principal concerns in establishing tree and shrub plantings. Summer fallow, continued cultivation for weed control and selection of adapted plants are needed to insure establishment and survival of plantings. Trees best suited and having good survival are plains cottonwood, golden willow, Colorado blue spruce, Rocky Mountain juniper and eastern redcedar. Shrubs best suited are American plum, purple willow, common chokecherry and redosier dogwood.

This is an important soil for wildlife because of its use for cropland and its proximity to the South Platte River. Under irrigation, it is important for food production for wildlife such as waterfowl, pheasants and deer utilizing crop residues occurring as aftermath following harvest. Wildlife values can be enhanced on this soil by habitat developments such as tree and shrub plantings and undisturbed nesting cover consisting of grasses and legumes. In the presence of a water supply, waterfowl can be attracted to the area by development of shallow water areas.

Flooding, seepage and a high water table are the primary limiting soil features where these soils are used for homesites and other urban developments. Intensive and costly engineering design and measures are needed to overcome these conditions. Capability subclass VIw nonirrigated, IVw irrigated.

Use and Management of the Soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, and as sites for buildings, highways and other transportation systems, sanitary facilities, parks

and other recreation facilities, and wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and Pasture

JOSEPH F. KREBS, district conservationist, SCS, and CLIFFORD WILLIAMS, State agronomist, SCS, assisted with this section

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the needed management practices. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil Maps for Detailed Planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

About 48 percent of the total acreage of Logan County is used as cropland. Of this percentage, about 137,620 acres is used for irrigated cropland and pasture, with 9,400 acres under sprinkler irrigation, and about 433,500 acres is used for nonirrigated cropland.

Logan County is an area of diverse topography and soils, with an annual precipitation ranging from 13 inches in the western part to approximately 19 inches in the eastern part of the county. The area is subject to detrimental hailstorms during the late spring and summer months. Management concerns for maintaining production and controlling wind and water erosion vary widely throughout the county because of the diversity in farming methods.

The potential for increased production on some soils presently being farmed is excellent. About 11,320 acres of potential cropland is presently in wet and saline meadows. This acreage could be used for field crops if appropriate reclamation procedures were applied. Production on land presently under cultivation could be increased by utilizing better crop production technology. This soil survey can facilitate the application of such technology and aid in making land use decisions.

Soil erosion is a major management consideration for all soils in the county. Irrigated land with slopes above 3 percent and nonirrigated cropland present the greatest problem. In areas where the surface layers have been eroded by wind or water, capacity for production is substantially reduced.

Using water efficiently, distributing it uniformly, protecting the soil from erosion, and maintaining soil fertility are the main management aims on irrigated soils. Irrigation grades, length of runs, width between borders, the amount and duration of flow, and frequency of irrigation should all be considered. Land leveling is needed on most soils in the county to permit more uniform distribution of water and to reduce runoff and erosion. Border and furrow irrigation methods are suited to soils with 0 to 3 percent slopes. Soils with slopes of from 3 to 9 percent are suited to contour furrow and contour ditch methods of irrigation.

Sprinkler irrigation systems are suited to all soils utilizing pump water for irrigation. Crop residue utilization will improve the organic matter content, soil tilth and water intake rates. The application of manure and commercial fertilizers containing nitrogen and phosphorus are very important in maintaining soil fertility on all irrigated soils.

Sprinkler irrigation is commonly used on the sandy soils in the county, such as the Dailey, Manter, Julesburg, and Haxtun series. Soil blowing is the main hazard on these soils. Water erosion is also a common problem in the wheel tracks of the sprinkler systems. The soil blowing hazard can be reduced by leaving crop residues in adequate quantities on the soil surface and by using cover crops. Wheel track water erosion can be controlled by vegetation, the placement of gravel or fibrous material in track areas, and in some instances by changing the direction of the sprinkler.

Soil drainage is a management need on some soils used for irrigated cropland and pasture. Soils occurring on the low terraces of the South Platte River, such as Alda, Westplain, Hayford and Lebsack soils, have a naturally fluctuating water table that cannot be drained because they lack outlets. These somewhat poorly drained soils can be farmed without drainage by choosing adapted crops and by maintaining near constant water table levels by careful control of irrigation water. Soils affected by

wetness and salinity caused by seepage from irrigation canals in upland areas may be reclaimed by open and tile drainage systems or by lining canals. Examples of these soils are Satanta loam, wet, Manter sandy loam, wet, and Argiustolls, wet. A combination of surface and subsurface drainage is often needed for intensive cropping. Tile drains and open "V" shaped drainage ditches are effective in minimizing the seeped condition. Drainage spacing will depend upon soil permeability.

Irrigated pasture crops consist of alfalfa and warm and cool season grasses. Management practices applicable on irrigated pastures include the deferment of grazing until plants have become firmly established and have attained a suitable height and an adequate cover to ensure protection from erosion. Timely application of irrigation water is important to supply water during periods of peak consumptive use. The establishment of irrigated pasture or hayland on sloping irrigated cropland soils minimizes the hazards of both wind and water erosion. Additional management practices, such as controlled grazing, cross-fencing, proper distribution of stock-watering facilities, and salt block distribution, are beneficial for maintaining production on irrigated pastures.

The amount of rainfall is important in management of nonirrigated soils. Wheat is the principal nonirrigated crop. Corn and grain sorghum are grown on selected soils in the eastern part of the county where moisture conditions are more favorable. Some millet and forage sorghum are also grown. Yields are higher in the 17 to 19 inch precipitation area of the northern and southeastern parts of the county. Applications of commercial fertilizers are limited by the availability of moisture.

Controlling wind and water erosion and conserving soil moisture are the major management concerns on nonirrigated cropland areas. Because of limited precipitation, a crop-fallow system is used in which crops are grown only in alternate years. Stubble mulch tillage and incorporating crop residues in adequate amounts will protect fallowed soils from soil blowing and water erosion, and allow them to readily absorb and retain moisture. Sweeps, blades, chisels or rod-weeders are used for most tillage. Soils with sandy loam and loamy sand surface layers are highly susceptible to soil blowing. Loamy soils on more sloping areas are susceptible to water erosion because of surface runoff, especially during high intensity storms.

Soil blowing can be controlled by wind stripcropping on nearly level to gently sloping soils. On sloping sandy soils, contour stripcropping is effective against soil blowing and water erosion. On sloping loamy soils, terraces and contour cultivation are needed to control water erosion and to conserve moisture. Chiseling and subsoiling help to break up plowpans and compact subsoils to improve water penetration. Diversions are often needed to prevent water from running onto cultivated fields from adjacent rangeland. Tillage should be kept to a minimum to prevent soil compaction.

Moderately to severely eroded areas of nonirrigated cropland presently being farmed are best converted to permanent pasture. Seeding on a well prepared seedbed may require a cover crop before the intended forage grasses can be established. Grazing should be deferred until the grass is well established. Controlled grazing systems must be practiced for stand maintenance and production. Grass production, when properly managed, controls erosion and is usually more profitable than cropland farming on marginal soils.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes climatically suited to the area and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the

management concerns and productivity of the soils for these crops.

Capability Classes and Subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system (*6*), all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Range

THOMAS EAMAN, State range conservationist, Soil Conservation Service, assisted in preparing this section.

About 51 percent of Logan County is rangeland and is used for grazing. Range covers approximately 598,160 acres. Cattle grazing and feeding make up a large part of the agricultural economy in the county. The size of ranches varies with the broad diversity of agriculture found throughout the county.

The relationship of the use of rangeland with cropland is highly significant to the agricultural economy of the county. Cow-calf types of cattle operations are the most common on Logan County ranches. Several ranches follow a practice of pasturing steers on rangeland during the spring and summer months before entering feedlots in the fall. On many ranches the forage produced on rangeland is supplemented by such crops as hay, sugarbeet tops, grain and winter wheat pasture.

The native vegetation in many parts of the survey area has been depleted by continued heavy use. The amount of forage now produced is less than that originally produced. Productivity of the range can be increased by using management practices that are effective for specific kinds of soil and range sites.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in Table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well-managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Common plant names of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. Because only major species are listed, percentages do not necessarily total 100. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat and protects soil and water resources.

The rangelands of Logan County have significantly different kinds of native plant communities or range sites. These sites fall into three broad soil areas as they relate to the geography of the county.

North of the South Platte River and southeastern part of the county is the locally called "hardland" soil area of deep loam and clay loam soils. Also included are lesser acreages of shallow and moderately deep soils over shale and siltstone in the western part of the county. The range sites supported by these soils are characterized by short and mid grasses.

The second general area consists of terrace and flood plain soils along the river and its tributaries. Some of these range sites are benefited by a water table and produce high yields of forage. Some are affected by salinity and grow mostly salt-tolerant plants. Bottomlands and natural meadows occur in this area and produce high yields. Occasionally they are mowed for hay.

A third broad area of rangeland is located on sandy soils parallel to the South Platte River on the south, with a few scattered areas to the north. The deep sands and sandy plains of this area have the potential for producing high yields of excellent forage. The deep sands with their tall grasses resemble the grasslands of the tall-grass prairie region farther to the east. Soil blowing is a hazard in this area.

Proper grazing use is the major management concern of rangeland conservation. This requires the control of grazing so that the kinds and amounts of plants that make up the potential plant community are reestablished and maintained. To achieve this, 50 percent of the seasonal growth should remain at the end of the grazing period.

Deferment of grazing favors the improvement or maintenance of the condition of a range site. Deferment is the postponement of grazing during the main part of the growing season of key forage plants. When deferment is worked into planned grazing systems on a recurring basis, each unit receives the periodic benefit of allowing key forage plants to produce seed.

Fencing, properly located watering areas, and salt block distribution are important management tools in obtaining more uniform distribution of grazing.

Rangeland furrowing, chiseling, and pitting are mechanical treatments designed to capture runoff water, improve water intake, prevent erosion, and speed recovery of vegetation. All have been used in areas of poor and fair range condition in a few of the range sites of Logan County. Range seeding may be necessary to convert dry cropland to range, or to improve depleted rangeland. Brush control is beneficial in areas where competitive shrubs have increased beyond the amount they make up in the potential vegetation.

Sound range management based on soil survey information and rangeland inventories, when applied, can result in increased productivity of the rangeland in the area.

Woodland

SHERMAN FINCH, woodland conservationist, Soil Conservation Service, assisted in preparing this section.

Logan County has a limited growth of natural trees and shrubs. Since the early 1900's, cottonwoods and willows have grown naturally along the channels of the South Platte River, Pawnee Creek, and Cedar Creek, primarily in the Fluvaquent (fig. 25) and Fluvaquentic Haplaquoll soil mapping units.

The present stand along these drainageways is about 95 percent plains cottonwood and 5 percent willows with an average crown density of 25 to 35 percent. Diameter growth is about 1/4 inch per year as compared to 1/2 inch

per year or better on commercial stands. Even though the stands are noncommercial, they do provide valuable cover for wildlife and protection for livestock during blizzards.

In the break areas located in the north and northwest parts of the county, scattered stands of Rocky Mountain juniper are found dominantly on the Ustic Torriorthent, Badland and Argiustoll-Rock outcrop complex soil mapping units. In the past, fence posts have been cut from these stands, but currently there are only a few trees of commercial value left. Native shrubs in this area are yellow currant, common chokecherry, squawbush, snowberry, wild plum, and wild rose. These shrubs grow in sheltered areas along intermittent drainageways, break areas, and river bottoms where moisture conditions are favorable.

Windbreaks and Environmental Plantings

SHERMAN FINCH, woodland conservationist, soil conservationist, Soil Conservation Service, assisted in preparing this section.

Windbreaks are established to protect livestock, buildings, and yards from winds and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well-prepared site and maintained in good condition can insure a high degree of plant survival.

Establishing windbreak and environmental plantings in Logan County is not easy because of limited moisture, but can be accomplished by: (1) planting species adapted to the climate and soil conditions; (2) timely cultivation; (3) providing supplemental water during planting and early stages of growth; and (4) carefully selecting and preparing the site.

The species of trees and shrubs adapted to the survey area are limited because of climatic conditions and therefore need to be selected carefully. Timely cultivation is important because it reduces the hazard of destructive fires and also reduces competition from weeds and grass, which is important to survival and proper growth.

Providing supplemental water to newly planted trees and shrubs is very beneficial and will increase survival. Adequate water should be supplied during planting and early stages of growth. Special attention to supplemental water is needed in nonirrigated cropland areas in the western part of the survey area where precipitation ranges from 13 to 17 inches.

Locations for windbreak plantings must be selected carefully. For information about specific soils, the reader should refer to mapping unit descriptions. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from the local office of the Soil Conservation Service or the Colorado State Forest Service.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this section are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to: (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures

already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building Site Development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a high seasonal water table, the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary Facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table could be installed or the size of the absorption field could be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness may be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

In the trench type of landfill, ease of excavation also affects the suitability of a soil for this purpose, so the soil must be deep to bedrock and free of large stones and boulders. Where the seasonal water table is high, water seeps into trenches and causes problems in filling.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction Materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The

performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 13 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slopes, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water Management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 10 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 10 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability, texture, depth to bedrock, hardpan, or other layers that affect the rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

ELDIE W. MUSTARD, biologist, Soil Conservation Service, assisted in preparing this section.

Outdoor recreation in Logan County is primarily oriented toward the hunting and fishing opportunities prevalent in the county. Tourism, in the usually accepted definition, is not important except for overnight campgrounds along the major transcontinental highways.

Large irrigation reservoirs, especially North Sterling, Prewitt, and Jumbo, attract numerous fishermen and campers from all parts of the county and from the Denver metropolitan area. There are fishing opportunities also in many of the small private irrigation reservoirs and ponds.

Hunting, chiefly near the large reservoirs and in the Tammarack Wildlife Management Area operated by the Colorado Division of Wildlife, attracts many local and visiting hunters from metropolitan areas along Colorado's Front Range. Pheasant hunting is excellent in the cropland areas, as is bobwhite hunting, because the bottomland riparian vegetation is adjacent to cropland.

The croplands, together with numerous reservoirs, also support large duck populations. The importance of Canada geese populations is becoming greater each year as the local population develops.

Mainly, because large numbers of nonresidents are attracted to Logan County for fishing and hunting opportunities, there is an increasing need for campgrounds and picnic areas strategically located to cater to this demand.

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife Habitat

ELDIE MUSTARD, biologist, Soil Conservation Service, assisted in preparing this section.

Historically, the grasslands of what is now Logan County supported large populations of bison, antelope, and prairie chickens. The bison was extirpated. Present

antelope populations on the remaining grasslands are abundant enough to furnish sport hunting. The prairie chicken is represented only by rare, scattered flocks.

Some of the wildlife found in present-day Logan County include species that are economically important for recreational hunting, such as antelope, white-tailed jackrabbit, mule deer, cottontail rabbit, mourning dove, geese, ducks, bobwhite quail, and the ever popular pheasant. Other wildlife important for esthetic and scientific reasons include the prairie dog, prairie rattlesnake, burrowing owl, Swainson's hawk, prairie falcon, meadowlark, horned lark, and Colorado's State bird, the lark bunting. Notable predators include the great horned owl, bald and golden eagles, coyote, kit fox, badger, and skunk.

In the fall and spring, multitudes of migratory birds pass over Logan County. The flocks of lesser sandhill crane are perhaps the most impressive.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, grain sorghum, wheat, oats, barley, and millet. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, lovegrass, switchgrass, bromegrass, timothy, orchardgrass, alfalfa, trefoil, crownvetch, and clover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod, yucca, yellow clover, sunflowers, sand dropseed, western wheatgrass, and grama. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are sand sagebrush, western snowberry, flowering saltbush, snakeweed, currants, gooseberry, and low sagebrush. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, inland saltgrass, prairie cordgrass, cattail, and rushes, sedges, and reeds. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, watering developments, and beaver ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant (fig. 26), meadowlark, field sparrow, killdeer, cottontail rabbit, sandhill crane, antelope, and deer.

Wetland habitat consists of open, marshy or swampy, shallow-water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, rails, kingfishers, shore birds, muskrat, mink, beaver, and raccoon.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, prairie dog, white-tailed jackrabbit, prairie chicken, rattlesnake, mule deer, meadowlark, and lark bunting.

Soil Properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classification, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present pertinent soil and water features.

Engineering Properties

Table 13 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 13 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil Series and Morphology."

Texture is described in table 13 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

In table 13 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are

based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted in table 13.

Physical and Chemical Properties

Table 14 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 14. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 15 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on

measurements made in many soil borings and on other observations during the soil mapping. The kind of bedrock and its hardness as related to ease of excavation are also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Classification of the Soils

In this section, the soil series recognized in the survey area are described, the current system of classifying soils is defined, and the soils in the area are classified according to the current system.

Soil Series and Morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil Maps for Detailed Planning."

Albinas Series

The Albinas series consists of deep, well drained soils that formed in calcareous alluvial materials. Albinas soils are on upland flood plains and alluvial fans and in drainageways and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 19 inches and mean annual temperature is about 48 degrees F.

Albinas soils are similar to the Satanta and Haxtun soils. They are near the Satanta, Rago, Kuma, and Keith soils. Satanta and Keith soils have dark colored surface layers extending to less than 20 inches. Haxtun, Rago and Kuma soils have buried sola within 40 inches.

A typical pedon of Albinas loam is located 72 feet west and 240 feet south of the northeast corner of section 28, T.12N., R.51W.

Ap—0 to 6 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral (pH 7.0); abrupt smooth boundary. (4 to 8 inches thick)

B1—6 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic parting to moderate subangular blocky structure, hard, friable; very thin patchy clay films on faces of peds; neutral (pH 7.2); clear smooth boundary (3 to 6 inches thick)

B21t—12 to 18 inches, grayish brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) moist, moderate medium prismatic parting to moderate subangular blocky structure, hard, friable; thin patchy clay films on faces of peds; neutral (pH 7.2); clear smooth boundary. (6 to 10 inches thick)

B22t—18 to 29 inches; grayish brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin patchy clay films on faces of peds; neutral (pH 7.2); clear smooth boundary (8 to 14 inches thick)

B3ca—29 to 32 inches, gray (10YR 6/1) loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable, thin patchy clay films on ped faces, calcareous; mildly alkaline (pH 7.8); clear smooth boundary. (3 to 5 inches thick)

C1ca—32 to 43 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; massive; hard, very friable; calcareous with thin lime seams and streaks, moderately alkaline (pH 8.2); gradual smooth boundary. (9 to 14 inches thick)

C2—43 to 52 inches, light brownish gray (10YR 6/2) very fine sandy loam, brown (10YR 5/3) moist, massive; slightly hard, very friable; calcareous, mildly alkaline (pH 7.8); clear smooth boundary. (9 to 17 inches thick)

IIC3—52 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand, brown (10YR 5/2) moist; single grained, loose, dry and moist; calcareous; mildly alkaline (pH 7.6).

Thickness of the mollic epipedon ranges from 20 to 40 inches. Depth to horizons of calcium carbonate accumulations is 20 to 30 inches. Contrasting C horizons are common below depths of 40 inches.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a loam or fine sandy loam. Texture of the B2t horizon is loam, clay loam or sandy clay loam. Texture of the C horizon is a loam, silt loam or fine sandy loam.

Alda Series

The Alda series consists of deep, somewhat poorly drained soils that formed in calcareous, stratified alluvium underlain by a mixture of sand and gravel. Alda soils are on low terraces and bottomlands and have slopes of 0 to 1 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 49 degrees F.

Alda soils are similar to the Loveland soils. They are near the Loveland, Hayford and Westplain soils. Loveland soils have loam and light clay loam underlying layers. Hayford soils have heavy clay loam or clay B2t horizons. Westplain soils have sand and gravel at depths less than 20 inches.

A typical pedon of Alda loam is located 690 feet west and 500 feet north of the SE corner of section 33, T.10N., R.50W.

A11—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, soft, very friable; calcareous, mildly alkaline (pH 7.4); clear smooth boundary. (3 to 5 inches thick)

A12—3 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, calcareous; mildly alkaline (pH 7.8); clear smooth boundary. (7 to 12 inches thick)

AC—10 to 17 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable, calcareous, moderately alkaline (pH 8.0); clear smooth boundary. (5 to 9 inches thick)

C1ca—17 to 22 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist, with few fine prominent mottles of light olive brown (2.5Y 5/6) moist; massive, hard, friable; calcareous moderately alkaline (pH 8.4); gradual smooth boundary. (5 to 12 inches thick)

C2g—22 to 27 inches, light gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) moist, with common fine prominent mottles of light olive brown (2.5Y 5/6) and dark brown (7.5YR 4/4) moist; massive; hard, very friable; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (4 to 8 inches thick)

C3g—27 to 34 inches; light yellowish brown (2.5Y 6/4) loamy sand, light olive brown (2.5Y 5/4) moist, with many medium prominent mottles of light olive brown (2.5Y 5/6) and yellowish brown (10YR 5/8) moist; massive; hard, very friable; calcareous; mildly alkaline (pH 7.8); gradual smooth boundary

IIC4g—34 to 60 inches; light gray (2.5Y 7/2) coarse sand and gravel, light brownish gray (2.5Y 6/2) moist; single grained; loose dry and moist; neutral (pH 7.3).

Depth to underlying sand and gravel ranges from 20 to 40 inches. The water table fluctuates from 20 inches to below 60 inches.

The A horizon has 10YR hue, value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a loam or sandy loam. The C horizon is stratified. It is commonly a loam, but ranges from loam to loamy sand.

Altvan Series

The Altvan series consists of deep, well drained soils that formed in calcareous loamy eolian and alluvial materials underlain by coarse sand and gravel. Altvan soils are on upland ridges, knobs and valley sides. Slopes are 3 to 25 percent. Average annual precipitation ranges from 15 to 19 inches and mean annual temperature is about 48 degrees F.

Altvan soils are similar to Ascalon and Dacono soils. They are near the Eckley, Dacono, Dix, and Wages soils. Ascalon and Wages soils lack sand and gravel within depths of 40 inches. Dacono soils have clay loam and clay B2t horizons. Eckley and Dix soils have sand and gravel at depths of less than 20 inches.

A typical pedon of Altvan sandy loam is located 300 feet south and 800 feet west of the north quarter corner of section 17, T.11N., R.52W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; hard, very friable; neutral (pH 7.0), clear smooth boundary. (4 to 9 inches thick)

B1—5 to 8 inches; dark gray (10YR 4/1) sandy loam, very dark brown (10YR 2/2) moist, weak coarse subangular blocky structure; hard, very friable; very thin patchy clay films on faces of peds; neutral (pH 7.0); clear smooth boundary. (2 to 5 inches thick)

B21t—8 to 13 inches; dark grayish brown (10YR 4/2) heavy sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure; hard, friable; very thin patchy clay films on faces of peds, neutral (pH 7.2), clear smooth boundary. (4 to 7 inches thick)

B22t—13 to 19 inches; dark grayish brown (10YR 4/2) sandy clay loam, very dark grayish brown to dark brown (10YR 3/3) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin nearly continuous clay films on faces of peds; neutral (pH 7.2); gradual smooth boundary. (5 to 9 inches thick)

B3—19 to 23 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure; hard, friable; thin, patchy clay films; mildly alkaline (pH 7.6); gradual smooth boundary. (2 to 5 inches thick)

C1ca—23 to 30 inches; light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; massive; hard, friable, 10 percent lime coated gravel; calcareous with lime occurring as concretions and as thin seams and streaks; moderately alkaline (pH 8.2); clear smooth boundary.

IIC2—30 to 60 inches; light brown (7.5YR 6/4) coarse sand and gravel, brown (7.5YR 5/4) moist; massive; soft, very friable; moderately alkaline (pH 8.2).

Thickness of solum ranges from 16 to 30 inches. Depth to coarse sand and gravel ranges from 20 to 40 inches. Coarse fragments range from 0 to 15 percent throughout the solum.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is commonly a sandy loam but ranges to loam. The texture of the B2t horizon is dominantly sandy clay loam, clay loam, or loam but ranges to heavy sandy loam.

Arvada Series

The Arvada series consists of deep, well drained soils that formed in calcareous, eolian and alluvial materials derived from sedimetary rocks. Arvada soils are on upland alluvial fans and in swales and depressions. Slopes are 0 to 3 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual temperature is about 48 degrees F.

Arvada soils are similar to the Manzanola soils. They are near the Manzanola and Mitchell soils. Manzanola soils lack the strongly alkaline subsoil. Mitchell soils lack B2t horizons.

A typical pedon of Arvada silt loam is located 580 feet south and 260 feet west of the north quarter corner of section 22, T.11N., R.54W.

A1—0 to 2 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; mildly alkaline (pH 7.4); clear smooth boundary. (0 to 4 inches thick)

A2—2 to 4 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable; mildly alkaline (pH 7.4); abrupt smooth boundary. (1 to 4 inches thick)

B21t—4 to 7 inches; grayish brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; very hard, firm; thin, nearly continuous clay films on faces of peds; calcareous; strongly alkaline (pH 9.0); clear smooth boundary. (3 to 5 inches thick)

B22t—7 to 11 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin nearly continuous clay films on faces of peds; calcareous; very strongly alkaline (pH 9.2); gradual smooth boundary. (3 to 8 inches thick)

B3ca—11 to 15 inches; light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; weak medium prismatic structure; hard, friable; thin patchy clay films on faces of peds; calcareous, lime accumulations occur as concretions and thin seams and streaks; very

strongly alkaline (pH 9.2), gradual smooth boundary. (3 to 8 inches thick)

C1casa—15 to 20 inches, light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable; visible soluble salts; calcareous, lime occurs as thin seams and streaks; very strongly alkaline (pH 9.2); clear smooth boundary. (3 to 6 inches thick)

C2—20 to 60 inches; light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable; calcareous; very strongly alkaline (pH 9.2).

The thin A1 horizons may be absent in some pedons. Light colored A2 horizons are commonly present but are absent in some pedons. They may have platy structure. Reaction of the B2t horizon and C horizon ranges from pH 8.8 to 10.0.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry, 3 through 5 moist and chroma of 2 or 3. Moist values of 3 extend to depths of less than 5 inches Texture of the B2t horizon is commonly a silty clay loam or clay.

Ascalon Series

The Ascalon series consists of deep, well drained soils that formed in calcareous, alluvial and eolian materials. Ascalon soils are on upland ridges and flats and have slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 49 degrees F.

Ascalon soils are similar to the Satanta, Wages and Rosebud soils. They are near the Satanta, Platner, Manter and Haxtun soils. The Satanta soils have less than 35 percent fine or coarser sand in the B2t horizon. Wages soils have solums less than 15 inches thick. Rosebud soils have bedrock at depths of 20 to 40 inches. Platner soils have B2t horizons with more than 35 percent clay. Manter soils have fine sandy loam or sandy loam B2t horizons with less than 18 percent clay. Haxtun soils have dark surface layers exceeding 20 inches thick and buried subsoils.

A typical pedon of Ascalon fine sandy loam is located 50 feet south and 1,200 feet west of the north quarter corner, section 13, T.8N., R.54W.

A1—0 to 4 inches; grayish brown (10YR 5/2) dry, fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 7 inches thick)

B1—4 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; hard, very friable; very thin patchy clay films on faces of soil peds; neutral (pH 7.2); clear smooth boundary. (3 to 4 inches thick)

B2t—7 to 14 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate coarse subangular blocky; hard, friable; thin patchy clay films on soil ped faces, mildly alkaline (pH 7.4); clear smooth boundary (6 to 10 inches thick)

B3ca—14 to 23 inches; very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) moist; weak medium prismatic structure; hard, very friable; thin patchy clay films on faces of peds and in pores; calcareous; moderately alkaline (pH 8.2); gradual smooth boundary. (4 to 9 inches thick)

C1ca—23 to 30 inches; very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) moist; massive, hard, very friable; calcareous, visible lime accumulations occur as concretions and in thin seams and streaks, moderately alkaline (pH 8.2), gradual smooth boundary. (6 to 15 inches thick)

C2—30 to 44 inches; very pale brown (10YR 7/4) sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; calcareous with visible lime occurring as concretions, in thin seams and streaks; moderately alkaline (pH 8.0); gradual smooth boundary.

C3—44 to 60 inches; very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) moist, massive; slightly hard, very friable; strongly calcareous; moderately alkaline (pH 8.0).

Depth to calcareous material ranges from 12 to 30 inches. Thickness of solum ranges from 15 to 40 inches. Coarse fragments range from 0 to 10 percent, but are commonly less than 5 percent.

The A horizon has a value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. Texture of the B2t horizon is commonly sandy clay loam or heavy sandy loam with more than 35 percent sand, fine sand or coarser. Texture of the C horizon is commonly a fine sandy loam but ranges to loam and loamy sand. Unconformable sand and gravelly materials are common in some areas below 40 inches

Bankard Series

The Bankard series consists of deep, somewhat excessively drained soils that formed in highly stratified, recent sandy alluvium deposited by intermittent streams. Bankard soils are on flood plains and low terraces and have slopes of 0 to 3 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual temperature is about 47 degrees F.

There are no similar soils in the survey area. The Bankard soils are near Glenberg and Haverson soils. Glenberg soils have sandy loam underlying layers. The Haverson soils have loamy underlying layers.

A typical pedon of Bankard sand is located 1,000 feet south and 150 feet east of the northwest corner of section 8, T.11N., R.50W.

A1—0 to 3 inches; brown (10YR 5/3) sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 7 inches thick)

AC—3 to 8 inches; yellowish brown (10YR 5/4) gravelly sand, dark brown (10YR 4/3) moist; massive; soft, very friable, neutral (pH 7.0), gradual smooth boundary. (4 to 12 inches thick)

C—8 to 60 inches; very pale brown (10YR 7/3) gravelly sand, stratified with thin lenses of sandy loam and loam; pale brown (10YR 6/3) moist, single grained; loose when dry and moist; calcareous; mildly alkaline (pH 7.8).

These soils are typically calcareous below the surface layer, but some pedons are noncalcareous throughout. The control section is variable in texture because of stratification. Sand or gravelly sand are most common.

The A horizon has a value of 3 or 4 moist, 5 or 6 dry and chroma of 2 or 3 moist and dry. Moist value of 3 extends to depths of 6 inches or less. Texture is commonly sand but ranges to loamy sand or sandy loam.

Bayard Series

The Bayard series consists of deep, well drained soils that formed in calcareous, alluvial and eolian materials. Bayard soils are on upland ridges, foot slopes and flats and have slopes of 1 to 19 percent. Average annual precipitation ranges from 17 to 19 inches and mean annual temperature is about 48 degrees F.

Bayard soils are similar to the Dailey soils. They are near the Dailey, Canyon, Haxtun and Manter soils. Dailey soils lack calcareous underlying layers and have less clay. Canyon soils have bedrock at depths of less than 20

inches. Haxtun soils have sandy loam B2t horizons overlying dark colored B2tb horizons. Manter soils have sandy loam B2t horizons.

Typical pedon of Bayard loamy sand 155 feet east and 500 feet north of the southwest corner of section 1, T.8N., R.49W.

A1—0 to 12 inches, grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; neutral (pH 7.2); clear wavy boundary. (6 to 12 inches thick)

AC—12 to 16 inches; light brownish gray (10YR 6/2) light sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, calcareous; mildly alkaline (pH 7.8); clear smooth boundary (4 to 8 inches thick)

Cca—16 to 33 inches; light gray (10YR 7/2) sandy loam, grayish brown (10YR 5/2) moist; weak coarse subangular blocky structure; soft, very friable; calcareous; moderately alkaline (pH 8.0), smooth gradual boundary. (12 to 20 inches thick)

C2—33 to 60 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable; calcareous; moderately alkaline (pH 8.0)

Depth to calcareous materials is less than 16 inches. Calcareous sandstone fragments are scattered throughout the profile, ranging from 0 to 15 percent in volume. Horizons of reddish colored gravelly sandy loam weathered from the Ogallala Formation are common below 40 inches

The A horizon has color values of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is commonly a loamy sand ranging to loamy fine sand and sandy loam. The AC and C horizons are somewhat stratified, ranging in texture from loamy fine sand to fine sandy loam. They are dominantly sandy loam.

Bridgeport Series

The Bridgeport series consists of deep, well drained soils that formed in calcareous loamy alluvium. Bridgeport soils have slopes of 0 to 2 percent and are on terraces and flood plains. Average annual precipitation ranges from 17 to 19 inches and mean annual temperature is about 48 degrees F.

Bridgeport soils are similar to the Haverson and Satanta soils. They are near the Satanta soils. Haverson soils lack dark colored A horizons that extend to 10 inches or more. Satanta soils have B2t horizons.

A typical pedon of Bridgeport loam is located 180 feet east and 75 feet north of the southwest corner of section 23, T.11N. and R.48W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable; calcareous; mildly alkaline (pH 7.4), clear smooth boundary. (6 to 12 inches thick)

B2—10 to 17 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, weak coarse prismatic structure, slightly hard, friable, very thin patchy clay films on faces of peds; calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (6 to 12 inches thick)

B3ca—17 to 21 inches; gray (10YR 6/1) silt loam, grayish brown (10YR 5/2) moist; weak coarse prismatic structure; slightly hard, friable; calcareous; moderately alkaline (pH 8.4), gradual smooth boundary. (3 to 5 inches thick)

C1ca—21 to 30 inches; light gray (10YR 7/1) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable, calcareous; moderately alkaline (pH 8.4); gradual smooth boundary (8 to 14 inches thick)

C2—30 to 60 inches; light gray (10YR 7/2) very fine sandy loam, light brownish gray (10YR 6/2) moist, massive; slightly hard, very friable; calcareous; moderately alkaline (pH 8.4)

This soil is commonly calcareous to the surface, but some pedons are leached to 8 inches

The A horizon has 10YR hue, value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3. It is a loam or light clay loam. Texture of the B2 horizon is loam or silt loam. The C horizon is a loam, silt loam or very fine sandy loam but may be stratified with fine sandy loams.

Canyon Series

The Canyon series consists of shallow, well drained soils that formed in a thin mantle of calcareous, alluvial and eolian materials underlain by calcareous sandstone. Canyon soils are on upland ridge crests, knobs and tablelands and have slopes of 0 to 25 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual temperature is about 49 degrees F.

Canyon soils are similar to the Epping and Shingle soils. They are near the Escabosa and Rosebud soils. Epping soils formed in materials weathered from siltstone. Shingle soils have fewer coarse fragments and formed in material weathered from calcareous sandstone. Escabosa soils lack bedrock above 20 inches. Rosebud soils have B2t horizons and lack bedrock above 20 inches.

A typical pedon of Canyon gravelly loam is located 710 feet north and 110 feet east of the west quarter corner of section 15, T.7N., R.49W.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist, weak very fine granular structure; soft, very friable; 15 percent calcareous sandstone fragments; calcareous, mildly alkaline (pH 7.6); clear smooth boundary. (3 to 5 inches thick)

AC—3 to 5 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable; 15 percent calcareous sandstone fragments; calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (2 to 5 inches thick)

C1ca—5 to 11 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive; hard, very friable; 25 percent calcareous sandstone fragments; calcareous; moderately alkaline (pH 8.2), clear wavy boundary. (5 to 8 inches thick)

IICr—11 to 30 inches; white (10YR 8/2) calcareous sandstone of the Ogallala Formation, light gray (10YR 7/2) moist.

Depth to bedrock ranges from 6 to 20 inches. Rock fragments range in volume from 5 to 25 percent. The underlying bedrock is calcareous sandstone of the Ogallala Formation, which varies in degree of consolidation.

The A horizon has color value of 4 or 5 dry, 3 or 4 moist,and chroma of 2 or 3. Moist value of 3 extends to depths of 6 inches or less. The A horizon is commonly a gravelly loam but ranges to gravelly fine sandy loam. The C horizon is gravelly loam, gravelly fine sandy loam or gravelly sandy clay loam.

Chappell Series

The Chappell series consists of deep, well drained soils that formed in stratified alluvial deposits. Chappell soils have slopes of 0 to 5 percent and are on flood plains and alluvial fans. Average annual precipitation ranges from 15 to 19 percent and the mean annual temperature is about 48 degrees F.

Chappell soils are similar to the Altvan soils. They are near the Altvan, Dix, Eckley and Manter soils. Altvan soils have sandy clay loam and loam B2t horizons. Dix and Eckley soils have coarse sand and gravel at depths of less than 20 inches. Manter soils have B2t horizons.

A typical pedon of Chappell sandy loam is located 135 feet south and 50 feet west of the center of section 21, T.11N., R.50W.

A1—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; neutral (pH 6.8); clear smooth boundary. (4 to 8 inches thick)

B1—6 to 12 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure; slightly hard, friable; very thin patchy clay films on faces of peds; 5 percent fine gravel; neutral (pH 7.2); clear smooth boundary. (3 to 8 inches thick)

B2—12 to 19 inches; dark grayish brown (10YR 4/2) coarse sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, friable; thin patchy clay films on faces of peds; 10 percent fine gravel; mildly alkaline (pH 7.4); gradual smooth boundary (6 to 10 inches thick)

B3—19 to 30 inches; grayish brown (10YR 5/2) coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure; slightly hard, very friable; 10 percent fine gravel; mildly alkaline (pH 7.6), gradual wavy boundary. (8 to 12 inches thick)

C1—30 to 41 inches, brown (10YR 5/3) loamy coarse sand, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; 10 percent fine gravel; mildly alkaline (pH 7 6); clear wavy boundary. (8 to 18 inches thick)

C2ca—41 to 60 inches; pale brown (10YR 6/3) gravelly loamy coarse sand, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable; 20 percent fine gravel; calcareous; moderately alkaline (pH 8.0); clear wavy boundary.

The thickness of the mollic epipedon ranges from 10 to 20 inches Some pedons are noncalcareous to depths of 60 inches. Gravel content in the soil profile ranges in volume from 5 to 25 percent.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a sandy loam or gravelly coarse sandy loam. Texture of the B2 horizon is a sandy loam or coarse sandy loam and may be gravelly. The C horizon is stratified and is a sandy loam or loamy coarse sand and may be gravelly. If the 10 to 40 inch control section is mixed, the average texture is coarse sandy loam.

Colby Series

The Colby series consists of deep, well drained soils that formed in calcareous, eolian materials. Colby soils are on upland ridge crests and hills. Slopes are 5 to 18 percent. Average annual precipitation ranges from 17 to 19 inches and the mean annual temperature is about 48 degrees F.

Colby soils are similar to the Mitchell soils. They are near the Ulysses, Norka and Keith soils. Mitchell soils have less than 18 percent clay in the underlying layers. Ulysses soils have dark surface layers and B2 horizons. Norka and Keith soils have dark surface layers and B2t horizons.

A typical pedon of Colby loam is located 175 feet north and 450 feet east of the south quarter corner, section 21, T.6N., R.51W.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; calcareous; mildly alkaline (pH 7.6); clear smooth boundary. (3 to 6 inches thick)

AC—4 to 10 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak coarse prismatic structure; hard, very friable; calcareous; moderately alkaline (pH 7.9); clear smooth boundary. (4 to 8 inches thick)

C1ca—10 to 19 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; massive; hard, very friable; calcareous with visible calcium carbonate occurring as concretions and thin seams and streaks, moderately alkaline (pH 8.2); gradual smooth boundary. (7 to 20 inches thick)

C2—19 to 60 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist, massive; slightly hard, very friable; calcareous; moderately alkaline (pH 8.0).

This soil is commonly calcareous throughout, but may be leached 1 to 4 inches in some pedons.

The A horizon has color value of 4 or 5 dry, 3 or 4 moist and chroma of 2 or 3 Value of 3 moist extends to a depth of less than 6 inches. The A horizon is commonly a loam but ranges to silt loam or fine sandy loam Texture of the C horizon is dominantly a loam or silt loam, but includes strata of very fine sandy loam

Cushman Series

The Cushman series consists of moderately deep, well drained soils formed in calcareous, eolian and alluvial materials weathered from interbedded shale and sandstone. Cushman soils are on upland ridges and hills with slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is about 49 degrees F.

Cushman soils are similar to the Renohill and Stoneham soils. They are near the Renohill and Stoneham soils. Renohill soils have clay loam and clay B2t horizons. Stoneham soils lack bedrock above 40 inches.

A typical pedon of Cushman loam is located 120 feet north and 150 feet west of the south quarter corner of section 34, T.10N., R.54W.

A1—0 to 3 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular structure, soft, very friable; neutral (pH 7.0); clear smooth boundary (2 to 5 inches thick)

B2t—3 to 10 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin continuous clay films on faces of peds, 5 percent shale fragments and iron concretions; neutral (pH 7 3); clear smooth boundary. (5 to 8 inches thick)

B3ca—10 to 15 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak moderate prismatic structure; thin patchy clay films on faces of peds; hard, friable; moderately alkaline (pH 8.2); clear smooth boundary. (3 to 5 inches thick)

C1ca—15 to 22 inches; light gray (2 5Y 7/3) loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure, hard, friable, 5 percent shale fragments; moderately alkaline (pH 8.4), clear smooth boundary. (7 to 24 inches thick)

C2—22 to 60 inches, olive colored interbedded shale and sandstone.

Depth to calcareous materials ranges from 7 to 12 inches Depth to bedrock ranges from 20 to 40 inches.

The A horizon has 10YR or 2.5Y hue, value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 or 3. Moist values of 3 extend to depths of 5 inches or less. The A horizon is commonly a loam ranging to fine sandy loam. Texture of the B2t horizon is a loam, clay loam or sandy clay loam.

Dacono Series

The Dacono series consists of deep, well drained soils formed in calcareous alluvial and eolian materials underlain by sand and gravel. Dacono soils are on upland flats and ridges and have slopes of 0 to 5 percent. Average annual precipitation ranges from 17 to 19 inches and mean annual temperature is about 48 degrees F.

The Dacono soils are similar to the Altvan and Platner soils. They are near the Altvan, Platner and Rago soils. Altvan soils have sandy clay loam B2t horizons. Platner and Rago soils lack sand and gravel at depths above 40 inches.

A typical pedon of Dacono loam is 2,490 feet north and 15 feet west of the southeast corner of section 10, T. 11N., R. 48W.

A1—0 to 4 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; 5 percent gravel; neutral (pH 7.0), clear smooth boundary. (4 to 8 inches thick)

B1—4 to 7 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure; hard, friable; 5 percent fine gravel, thin continuous clay films on faces of peds; neutral (pH 7.0); clear smooth boundary. (3 to 6 inches thick)

B2t—7 to 13 inches; dark grayish brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; strong medium and fine prismatic parting to strong medium and fine subangular blocky structure, hard, firm; moderately thick, nearly continuous clay films on faces of peds; 5 percent gravel, mildly alkaline (pH 7.4), clear smooth boundary. (5 to 12 inches thick)

B3—13 to 19 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; weak medium prismatic structure; hard, friable, thin patchy clay films; mildly alkaline (pH 7.4); clear smooth boundary. (3 to 8 inches thick)

C1ca—19 to 28 inches, white (10YR 8/2) silt loam, light brownish gray (10YR 6/2) moist; massive; hard, friable, calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (5 to 12 inches thick)

IIC2—28 to 60 inches; light yellowish brown (7.5YR 6/4) stratified coarse sand and gravel, yellowish brown (7.5YR 5/4) moist; single grained; loose, dry and moist; mildly alkaline (pH 7.6).

Thickness of the solum ranges from 15 to 24 inches. Depth to the contrasting IIC horizon ranges from 20 to 40 inches. Rock fragments range from 0 to 15 percent in the solum

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3. It is a loam or light clay loam. The B2t horizon is commonly heavy clay loam or light clay The IIC horizon has a hue of 10YR or 7.5YR.

Dailey Series

The Dailey series consists of deep, somewhat excessively drained soils that formed in noncalcareous, eolian materials. Dailey soils are in upland valleys and on convex ridges and hills. Slopes are 0 to 9 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual temperature is about 48 degrees F.

Dailey soils are similar to the Valent soils. They are near the Valent, Julesburg and Haxtun soils. Valent soils lack dark surface layers extending to 10 inches or more. Julesburg and Haxtun soils have B2t horizons.

A typical pedon of Dailey loamy sand is located 375 feet east and 10 feet north of the southwest corner of section 21, T.9N., R.48W.

A1—0 to 16 inches, grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, soft, very friable; neutral (pH 6.8); gradual wavy boundary. (10 to 20 inches thick)

C—16 to 60 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; single grained, loose, dry and moist, neutral (pH 7 0)

The mollic epipedon ranges from 10 to 20 inches thick. It is noncalcareous to a depth of 40 inches or more.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. The C horizon is commonly a loamy sand but ranges to a sand.

The thick surface phase mapped in this survey is a taxadjunct to the Dailey series. The mollic epipedon is thicker than 20 inches The underlying layers consist of buried A and B2 horizons and are loamy sand and sandy loam.

Dix Series

The Dix series consists of deep, somewhat excessively drained soils formed in very gravelly alluvial sediments with a thin mantle of loamy alluvium. Dix soils are on upland ridges and knolls with slopes of 3 to 25 percent. Average annual precipitation ranges from 15 to 19 inches and mean annual temperature is about 48 degrees F.

The Dix soils are similar to the Peetz and Eckley soils. They are near the Peetz, Eckley and Chappell soils. Peetz soils are calcareous throughout. Eckley soils have B2t horizons. Chappell soils have sand and gravel at depths of 20 to 40 inches.

A typical pedon of Dix gravelly sandy loam is located 900 feet south and 600 feet east of west quarter corner of section 29, T.11N., R.52W.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; 30 percent gravel and cobbles; neutral (pH 7.0); clear smooth boundary. (3 to 5 inches thick)

B2—4 to 10 inches; dark grayish brown (10YR 4/2) gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure; hard, very friable; thin patchy clay films on faces of peds and in root channels; neutral (pH 7.0); clear smooth boundary. (3 to 9 inches thick)

B3—10 to 18 inches, brown (7.5YR 5/4) gravelly loamy coarse sand, dark brown (7.5YR 4/4) moist; weak medium prismatic parting to weak medium subangular blocky structure; hard, friable; few thin patchy clay films on faces of peds; 40 percent fine gravel, neutral (pH 7.0); gradual smooth boundary. (2 to 8 inches thick)

C1—18 to 60 inches; reddish yellow (7.5YR 6/6) very gravelly sand, brown (7.5YR 5/4) moist, massive; slightly hard, very friable; neutral (pH 7.2)

Thickness of the mollic epipedon ranges from 7 to 15 inches. Thickness of the solum ranges from 8 to 20 inches. Commonly these soils are noncalcareous in the area of the reddish Ogallala parent materials. In areas of more recent outwash deposits they have calcareous materials at 12 to 24 inches.

The A horizon has a color value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 or 3. It is gravelly sandy loam or gravelly loam.

Eckley Series

The Eckley series consists of deep, well drained soils formed in stratified, reddish colored, gravelly alluvial

deposits of the Ogallala Formation. Eckley soils are on upland ridges and knobs and have slopes of 5 to 13 percent. Average annual precipitation ranges from 15 to 19 inches and mean annual temperature is about 49 degrees F.

The Eckley soils are similar to the Altvan soils. They are near the Altvan, Dix and Dacono soils. Altvan and Dacono soils have sand and gravel at depths between 20 and 40 inches. Dix soils have B2 horizons with weak grades of structure.

A typical pedon of Eckley sandy loam is located 1,600 feet west and 15 feet north of the southeast corner of section 11, T.7N., R.51W.

A1—0 to 3 inches, dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist, weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 5 inches thick)

B1—3 to 6 inches; dark grayish brown (10YR 4/2) gravelly sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure, slightly hard, friable, neutral (pH 7.0); clear smooth boundary. (2 to 4 inches thick)

B2t—6 to 15 inches, dark brown (7.5YR 4/2) gravelly sandy clay loam, dark brown (7.5YR 3/2) moist; moderate coarse prismatic parting to moderate coarse subangular blocky structure; hard, firm, thick continuous clay films on face of peds; neutral (pH 7.2), clear wavy boundary. (6 to 10 inches thick)

B3—15 to 20 inches, brown (7.5YR 5/4) gravelly coarse sandy loam, dark brown (7.5YR 4/4) moist; weak coarse prismatic structure; hard, very friable; neutral (pH 7.2), gradual wavy boundary. (3 to 5 inches thick)

IIC1—20 to 43 inches; light brown (7.5YR 6/4) gravelly loamy coarse sand, dark brown (7.5YR 4/4) moist; massive; hard, very friable, mildly alkaline (pH 7.4); gradual wavy boundary.

IIC2—43 to 60 inches; light brown (7.5YR 6/4) coarse sand and gravel, brown (7.5YR 5/4) moist, single grained; loose, dry and moist; calcareous with some gravel lime coated mainly on the underside; mildly alkaline (pH 7.6).

Depth to the contrasting IIC horizon ranges from 12 to 20 inches. These soils are commonly noncalcareous, but some pedons have weak accumulations of calcium carbonate below depths of 40 inches

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is a gravelly sandy loam or gravelly loam. The B2t horizon has a hue of 10YR or 7.5YR.

Els Series

The Els series consists of deep, somewhat poorly drained soils formed in alluvium overlying sand and gravel. Els soils are on low terraces and bottomlands of the South Platte River and have slopes of 0 to 1 percent. Average annual precipitation ranges from 13 to 19 inches and mean annual temperature is about 48 degrees F.

Els soils are similar to the Alda soils. They are near the Alda and Westplain soils. Alda and Westplain soils have dark surface layers with moist color values of 3 or less.

A typical pedon of Els loamy sand is located 1,150 feet east and 225 feet north of the southwest corner of sec. 16, T.10N., R.49W.

A1—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (4 to 7 inches thick)

AC1—6 to 13 inches, light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist, weak coarse subangular blocky structure; soft, very friable, neutral (pH 7.0); gradual smooth boundary. (5 to 8 inches thick)

AC2—13 to 17 inches, light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; calcareous; mildly alkaline (pH 7.4), clear smooth boundary. (4 to 8 inches thick)

C1ca—17 to 25 inches; light gray (10YR 7/2) loamy fine sand, grayish brown (10YR 5/2) moist; massive; soft, very friable; calcareous; mildly alkaline (pH 7.4); clear smooth boundary. (7 to 10 inches thick)

C2—25 to 58 inches; light gray (2.5Y 7/2) loamy fine sand, with thin strata of silt loam, grayish brown (2.5Y 5/2) moist, with common medium distinct yellowish brown (10YR 5/8) moist mottles; massive; soft, very friable; calcareous; mildly alkaline (pH 7.4), smooth boundary. (20 to 35 inches thick)

IIC3—58 to 60 inches; brown (10YR 5/3) moist with common medium brown (7.5YR 5/4) moist mottles, mixture of coarse sand and gravel; single grained, loose, dry and moist; neutral (pH 7.2).

Sand and gravel occurs below depths of 40 inches.

The A horizon has a color value of 4 through 6 dry, 3 or 4 moist and chroma of 2 or 3. Moist values of 3 extend to depths of less than 7 inches. The A horizon is commonly a loamy fine sand but ranges to fine sand. The C horizon is a loamy fine sand or fine sand and is stratified

Epping Series

The Epping series consists of shallow, well drained soils that formed in calcareous materials weathered from Brule siltstone. Epping soils are on upland ridges and have slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is about 49 degrees F.

Epping soils are similar to the Canyon and Shingle soils. They are near the Keota and Mitchell soils. Canyon soils have 15 to 35 percent coarse fragments and formed in materials weathered from calcareous sandstone. Shingle soils formed in materials weathered from interbedded soft shale and sandstone. Keota and Mitchell soils have bedrock at depths below 20 inches.

A typical pedon of Epping loam is located 390 feet west and 38 feet north of the quarter corner, section 35, T.11N., R.52W.

A1—0 to 3 inches, light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure, soft, very friable, calcareous, mildly alkaline (pH 7.4); clear smooth boundary. (3 to 5 inches thick)

AC—3 to 7 inches; very pale brown (10YR 7/3) loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure; slightly hard, very friable; 5 percent weathered Brule siltstone fragments; calcareous, moderately alkaline (pH 8.0); clear smooth boundary. (4 to 7 inches thick)

Cca—7 to 11 inches; light gray (10YR 7/2) loam, brown (10YR 5/3) moist; massive, hard, very friable; 20 percent weathered fragments of Brule siltstone, calcareous with lime occurring as concretions and in thin seams and streaks, moderately alkaline (pH 8.4); clear wavy boundary (3 to 8 inches thick)

Cr—11 to 60 inches, very pale brown (10YR 8/3) siltstone of the Brule Formation, brown (10YR 5/3) moist; calcareous.

The depth to bedrock ranges from 10 to 20 inches Fragments of partially weathered Brule siltstone are common on the surface and throughout the soil with a range of 0 to 15 percent.

The A horizon has a color value of 5 through 7 dry, 3 or 4 moist and chroma of 2 or 3. Moist values of 3 extend to depths of less than 5

inches. The A horizon is a loam or silt loam. Texture of the C horizon is loam or silt loam.

Escabosa Series

The Escabosa series consists of moderately deep, well drained soils formed in calcareous, mixed eolian and alluvial materials underlain by calcareous sandstone of the Ogallala Formation. Escabosa soils are on upland ridge crests and flats with slopes of 1 to 9 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual temperature is 48 degrees F.

Escabosa soils are similar to the Rosebud soils. They are near the Rosebud, Canyon, Wages and Iliff soils. Rosebud and Iliff soils have B2t horizons. Canyon soils have bedrock at depths of 10 to 20 inches. Wages soils are deep.

A typical pedon of Escabosa loam is located 1,000 feet south and 70 feet east of the west quarter corner of section 27, T.7N., R.50W.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral (pH 7.0); clear smooth boundary. (4 to 7 inches thick)

AC1—4 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; hard, friable; 5 percent fragments of calcareous sandstone; calcareous; moderately alkaline (pH 8.0); clear smooth boundary (6 to 8 inches thick)

AC2—10 to 15 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; hard, friable; 5 percent fragments of calcareous sandstone; calcareous; moderately alkaline (pH 8.2); gradual smooth boundary. (4 to 7 inches thick)

C1ca—15 to 32 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive; hard, friable; 10 percent fragments of calcareous sandstone; calcareous; moderately alkaline (pH 8.4); gradual smooth boundary. (5 to 12 inches thick)

Cr—32 inches; white (10YR 8/2) calcareous sandstone of the Ogallala Formation, light gray (10YR 7/2) moist.

Depth to bedrock ranges from 20 to 40 inches. Fragments of sandstone range from 0 to 15 percent by volume.

The A horizon has value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is commonly a loam but ranges to fine sandy loam. The AC and C horizons are loam or light clay loam.

Glenberg Series

This Glenberg series consists of deep, well drained soils that formed in calcareous, stratified loamy alluvium. Glenberg soils are on flood plains and low terraces and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual air temperature is 47 degrees F.

Glenberg soils are similar to Haverson soils. They are near the Haverson and Bankard soils. The Haverson soils have dominantly loam or clay loam control sections. The Bankard soils have sand or loamy sand control sections.

A typical pedon of Glenberg fine sandy loam is located 220 feet north and 140 feet west of the east quarter corner of section 14, T.8N., R.55W.

A1—0 to 3 inches, dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 7 inches thick)

AC—3 to 13 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak coarse prismatic structure; hard, very friable, calcareous; moderately alkaline (pH 8.2), clear smooth boundary. (7 to 12 inches thick)

C1ca—13 to 19 inches; very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) moist; massive; hard, very friable; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (5 to 12 inches thick)

C2—19 to 60 inches, very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) moist; massive; hard, very friable, calcareous; moderately alkaline (pH 8.2).

Typically these soils are noncalcareous in the upper 8 or 10 inches, but may be calcareous throughout in some pedons

Depth to contrasting sand and gravel strata is greater than 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 4 through 6 dry, 3 or 4 moist, and chroma of 2 or 3 Moist values of 3 extend to depths of less than 7 inches The A horizon is a fine sandy loam Texture of the C horizon is sandy loam or fine sandy loam but may have thin loamy sand strata.

Haverson Series

The Haverson series consists of deep, well drained soils that formed in stratified, calcareous alluvium derived from mixed sources. Haverson soils are on flood plains and alluvial fans of intermittent streams and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual air temperature is about 49 degrees F.

Haverson soils are similar to the Glenberg soils. They are near the Glenberg and Bridgeport soils. Glenberg soils are dominantly sandy loam or fine sandy loam. Bridgeport soils have dark colored A horizons thicker than 7 inches.

A typical pedon of Haverson loam is located 165 feet south and 15 feet east of the northwest corner of section 21, T.7N., R.53W.

A1—0 to 4 inches, grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, very friable; calcareous; mildly alkaline (pH 7.8); clear smooth boundary. (4 to 8 inches thick)

AC—4 to 11 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure; slightly hard, friable; calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (5 to 12 inches thick)

C1ca—11 to 19 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure, slightly hard, friable; calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (7 to 14 inches thick)

C2—19 to 60 inches; light yellowish brown (2.5Y 6/4) loam, stratified with thin lenses of silt loam, fine sandy loam, and coarse sandy loam, to light olive brown (2.5Y 5/4) moist; massive, slightly hard, very friable; calcareous; moderately alkaline (pH 8.0)

In irrigated cropland areas the Ap horizon is 6 to 12 inches thick. The surface layer and a part of the underlying layer have been tilled together.

The A horizon has a 10YR or 2.5Y hue, value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 or 3. Value of 3 moist extends to depths of 6 inches or less. Texture of the A horizon is commonly a loam but ranges to fine sandy loam. Texture of the AC and C horizons is dominantly a loam or light clay loam, but is commonly stratified with thin lenses of coarse sandy loam to silt loam.

Haxtun Series

The Haxtun series consists of deep, well drained soils that formed in sandy eolian materials overlying an older buried soil that formed in calcareous, loamy eolian and alluvial materials. Haxtun soils are on upland valleys and flats and have slopes of 0 to 5 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 49 degrees F.

Haxtun soils are similar to the Kuma and Albinas soils. They are near the Julesburg and Dailey soils. Kuma soils have silt loam subsoils. Albinas soils lack B2tb horizons. Julesburg and Dailey soils are sandy throughout and have dark surface layers less than 20 inches thick.

A typical pedon of Haxtun loamy sand is located 240 feet north and 110 feet east of the southwest corner of section 13, T.8N., R.48W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); abrupt smooth boundary. (5 to 10 inches thick)

B1—8 to 14 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; hard, very friable; neutral (pH 7.0), clear smooth boundary. (4 to 10 inches thick)

B2t—14 to 21 inches, grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; hard, very friable; thin patchy clay films on faces of peds and in pores, few gravel; neutral (pH 7.0), clear smooth boundary. (6 to 12 inches thick)

B2tb—21 to 29 inches; dark grayish brown (10YR 2/2) clay loam, very dark brown (10YR 2/2) moist; strong medium prismatic parting to strong medium subangular blocky structure, hard, friable, common thin continuous clay films on faces of peds and in pores; few fine gravel; neutral (pH 7.0), clear smooth boundary. (6 to 12 inches thick)

B3tb—29 to 35 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist with dark grayish brown (10YR 3/2) streaks moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin continuous clay films on faces of peds and in pores; neutral (pH 7.2); clear smooth boundary. (4 to 10 inches thick)

C1cab—35 to 47 inches; white (2.5Y 8/2) loam, grayish brown (2.5Y 5/2) moist, massive; hard, friable; calcareous, visible calcium carbonate occurs as concretions and thin seams and streaks; moderately alkaline (pH 8.2); gradual wavy boundary. (6 to 18 inches thick)

C2b—47 to 60 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 5/4) moist; massive; hard, friable; calcareous, visible calcium carbonate occurs as concretions and seams; moderately alkaline (pH 8.2).

The mollic epipedon ranges from 20 to 40 inches thick. Depth to calcareous material ranges from 24 to 40 inches. Rock fragments range from 0 to 10 percent by volume Depth to the buried soil ranges from 16 to 24 inches.

The A horizon has value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3 It is a sandy loam or loamy sand. Texture of the B2t horizon is commonly sandy loam or light sandy clay loam. The B2tb horizon has a value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 or 2. It is commonly a clay loam ranging to loam or sandy clay loam.

Hayford Series

The Hayford series consists of deep, somewhat poorly drained soils formed in calcareous alluvium underlain by mottled sand and gravel. Hayford soils are on terraces and have slopes of 0 to 1 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 47 degrees F.

Hayford soils are similar to the Loveland soils. They are near the Loveland, Alda and Nunn soils. Loveland soils lack B2t horizons and have loam and light clay loam underlying layers. Alda soils lack B2t horizons. Nunn soils are well drained and lack sand and gravel at a depth of 20 to 40 inches.

A typical pedon of Hayford silty clay loam is located 1,350 feet north and 820 feet east of the center of section 2, T.8N., R.52W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure, slightly hard, friable; calcareous; moderately alkaline (pH 7.9); abrupt smooth boundary (6 to 10 inches thick)

B21t—7 to 10 inches, dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, firm; thin continuous clay films on faces of peds and in pores; calcareous, moderately alkaline (pH 7.9), clear smooth boundary. (2 to 8 inches thick)

B22t—10 to 19 inches; gray (10YR 5/1) silty clay, very dark brown (10YR 2/2) moist; strong medium and fine prismatic parting to strong medium and fine subangular blocky structure; hard, firm; thin continuous clay films on faces of peds and in pores; calcareous; moderately alkaline (pH 7.9); clear smooth boundary. (5 to 14 inches thick)

B3ca—19 to 22 inches; gray (10YR 6/1) silty clay loam, grayish brown (10YR 5/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, firm, thin patchy clay films on some peds; calcareous with visible secondary calcium carbonate occurring as nodules and in thin seams and streaks; moderately alkaline (pH 8.2); clear smooth boundary. (2 to 8 inches thick)

C1ca—22 to 26 inches; light gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; massive; very hard, firm; calcareous with visible calcium concretions and fine streaks, moderately alkaline (pH 8.2); clear smooth boundary. (2 to 6 inches thick)

C2g—26 to 32 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist with common fine distinct light olive brown (2.5Y 5/6) mottles; weak coarse prismatic structure; hard, firm; calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (3 to 8 inches thick)

IIC3g—32 to 60 inches; light brownish gray (2.5Y 6/2) fine sand and gravel, grayish brown (2.5Y 5/2) moist with common, coarse prominent, dark reddish brown (5YR 3/4) and yellowish brown (10YR 5/8) mottles; single grained; loose, dry and moist; calcareous; mildly alkalme (pH 7.4).

Thickness of the mollic epipedon ranges from 7 to 20 inches Depth to the sand and gravel substratum ranges from 20 to 40 inches.

The A horizon has a color value of 4 or 5, 2 or 3 moist, and chroma of 1 or 2. Texture is commonly silty clay loam ranging to clay loam or clay Texture of the B2t horizon includes silty clay loam, clay loam or clay. The Cca horizon is moderately or strongly alkaline.

Heldt Series

The Heldt series consists of deep, well drained soils that formed in calcareous, stratified clayey alluvium derived from shale. Heldt soils are on upland flood plains and terraces and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is about 49 degrees F.

Heldt soils are similar to the Manzanola soils. They are near the Renohill, Cushman, Thedalund and Shingle soils. Manzanola soils have B2t horizons with moderate or strong grades of structure. Renohill, Cushman and Thedalund soils have shale at depths of 20 to 40 inches. Shingle soils have shale at less than 20 inches.

A typical pedon of Heldt clay loam is located 120 feet north and 1,485 feet east of the southwest corner of section 31, T.9N., R.53W.

A1—0 to 3 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak coarse subangular blocky structure; very hard, firm; neutral (pH 7.2); clear smooth boundary. (3 to 6 inches thick)

B1—3 to 6 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure; very hard, firm, few thin clay films on faces of peds; mildly alkaline (pH 7.6); clear smooth boundary. (0 to 6 inches thick)

B2ca—6 to 31 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; very hard, firm; few thin continuous clay films on faces of peds; few scattered shale fragments; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (12 to 30 inches thick)

B3ca—31 to 35 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; very hard, firm; fine, thin continuous clay films on ped faces; fine shale fragments; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (3 to 7 inches thick)

C1ca—35 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, firm; few gypsum crystals; few fine shale fragments; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks, strongly alkaline (pH 8.6).

These soils are usually noncalcareous in the upper 4 to 8 inches but some pedons are calcareous throughout. Shale fragments range from 0 to 5 percent.

The A horizon has 2.5Y or 10YR hue, value of 4 through 6 dry, 3 or 4 moist, and chroma of 2 or 3. Moist values of 3 extend to depths of less than 5 inches. The A horizon is a clay loam, clay or silty clay loam. Texture of the B2 horizon is clay loam, silty clay loam or silty clay.

Iliff Series

The Iliff series consists of moderately deep, well drained soils that formed in calcareous, silty eolian materials underlain by calcareous sandstone of the Ogallala Formation. Iliff soils are on upland flats and have slopes of 0 to 3 percent. Average annual precipitation ranges from 17 to 19 inches and the mean annual air temperature is about 47 degrees F.

Iliff soils are similar to the Weld and Platner soils. They are near the Weld, Platner and Rosebud soils. The Weld and Platner soils are deep and lack bedrock at depths of 20 to 40 inches. Rosebud soils have loam or clay loam subsoils.

A typical pedon of Iliff loam is located 1,205 feet north and 40 feet east of the southwest corner of section 27, T.7N., R.50W.

A11—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; neutral (pH 7.0); clear smooth boundary. (2 to 5 inches thick)

A12—3 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable; neutral (pH 7.0), abrupt smooth boundary. (2 to 4 inches thick)

A2—6 to 8 inches, light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure, slightly hard, friable; neutral (pH 7.0); abrupt smooth boundary. (1 to 3 inches thick)

B2t—8 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist, strong medium and fine prismatic structure parting to strong medium and fine angular blocky; hard, firm; continuous thin clay films on faces of peds and in pores; gray, clean silt grain coatings on the prism tops and upper sides; mildly alkaline (pH 7.8); clear smooth boundary. (4 to 12 inches thick)

B3ca—15 to 22 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; thin patchy clay films on faces of peds; calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (4 to 12 inches thick)

C1ca—22 to 29 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, calcareous; moderately alkaline (pH 8.2); gradual smooth boundary. (4 to 10 inches thick)

C2—29 to 34 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; massive, soft, very friable; calcareous, moderately alkaline (pH 8.2); gradual smooth boundary. (3 to 12 inches thick)

C3r—34 inches; white (10YR 8/1) calcareous sandstone of the Ogallala Formation, light gray (10YR 7/2) moist.

Calcareous materials are at depths of 14 to 21 inches. Depth to calcareous sandstone is commonly 30 to 40 inches but ranges from 20 to 40 inches.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3. Texture is commonly a loam ranging to very fine sandy loam. The A2 horizon has a value of 6 or 7 dry, 3 through 5 moist, and chroma of 1 or 2. Most cultivated areas have the A1 and A2 horizons tilled together. Texture of the B2t horizon is heavy silty clay loam or clay.

Julesburg Series

The Julesburg series consists of deep, well drained soils that formed in noncalcareous, sandy eolian and alluvial materials. They are on upland ridges, in valleys and on high terraces bordering uplands and have slopes of 0 to 9 percent. Average annual precipitation ranges from 15 to 19 inches, and the mean annual temperature is about 49 degrees F.

Julesburg soils are similar to the Manter soils. They are near the Manter, Dailey, Haxtun and Valent soils. Manter soils are calcareous above a depth of 40 inches and have secondary calcium carbonate accumulations. Dailey soils lack B horizons. Haxtun soils have dark colored buried subsoils. Valent soils lack B horizons and have light colored surface layers.

A typical pedon of Julesburg fine sandy loam is located 95 feet south and 510 feet west of the north quarter corner of section 5, T.8N., R.51W.

A1—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, soft, very friable; neutral (pH 7.0); clear smooth boundary. (4 to 8 inches thick)

B1—5 to 10 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist, weak coarse prismatic structure, slightly hard, very friable; very thin patchy clay films on faces of peds and in root channels and pores; neutral (pH 7.0); clear smooth boundary. (4 to 8 inches thick)

B2t—10 to 16 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; hard, very friable; thin patchy clay films on faces of peds and in pores; neutral (pH 7.0); gradual smooth boundary. (5 to 10 inches thick)

B3—16 to 31 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; hard, very friable; very thin patchy clay films on faces of peds and in pores; neutral (pH 7.2); gradual smooth boundary. (4 to 15 inches thick)

C1—31 to 37 inches; brown (10YR 5/3) loamy sand, dark grayish brown (10YR 4/2) moist; massive; hard, very friable; neutral (pH 7.2); gradual smooth boundary. (5 to 18 inches thick)

C2—37 to 46 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; massive; slightly hard, very friable; neutral (pH 7.2); gradual smooth boundary.

C3—46 to 60 inches; light brownish gray (2.5Y 6/2) sand, grayish brown (2.5Y 5/2) moist; single grained; loose, dry and moist; neutral (pH 7.2).

Commonly, this soil is noncalcareous throughout, but some pedons have calcareous material below 40 inches.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. Texture of the A horizon is fine sandy loam or loamy sand. Texture of the B2t horizon is commonly a sandy loam but ranges to fine sandy loam. The C horizon is commonly a sand ranging from fine sand to loamy sand.

Keith Series

The Keith series consists of deep, well drained soils that formed in calcareous, loamy eolian materials. Keith soils are on upland flats and hills and have slopes of 0 to 9 percent. Average annual precipitation ranges from 15 to 19 inches and mean annual temperature is about 48 degrees F.

Keith soils are similar to the Norka and Satanta soils. They are near the Norka, Satanta, Kuma and Rosebud soils. Norka soils have sola less than 15 inches thick. Satanta and Rosebud soils have B2t horizons with more than 15 percent fine sand or coarser. Kuma soils have dark colored surface layers thicker than 20 inches.

A typical pedon of Keith loam is located 520 feet north of the southeast corner of section 36, T.11N., R.54W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (4 to 8 inches thick)

B1—6 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; few very thin patchy clay films on faces of peds; slightly hard, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 6 inches thick)

B2t—10 to 18 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure; thin nearly continuous clay films on faces of peds; slightly hard, very friable; neutral (pH 7.2); clear smooth boundary. (7 to 14 inches thick)

B3ca—18 to 25 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; thin patchy clay films on faces of peds; slightly hard, very friable; mildly alkaline (pH 7.6); clear smooth boundary. (2 to 8 inches thick)

C1ca—25 to 37 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; slightly hard, very friable; calcareous with visible secondary calcium carbonate occurring as concretions, in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (8 to 15 inches thick)

C2—37 to 60 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; calcareous with visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.2).

Thickness of the solum ranges from 15 to 28 inches. The mollic epipedon ranges from 8 to 20 inches in thickness. Contrasting gravelly sand IIC horizons are common below depths of 48 inches.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 through 3. It is commonly a loam but ranges to a silt loam or fine sandy loam. Texture of the B2t horizons is commonly a loam or clay loam but ranges to silt loam or silty clay loam. The C horizon is a loam, silt loam or fine sandy loam.

Keota Series

The Keota series consists of moderately deep, well drained soils that formed in calcareous, loamy alluvial and eolian materials derived from Brule siltstone. Keota soils are on upland ridges and hills with slopes of 1 to 9 percent. Average annual precipitation ranges from 13 to 17 inches, and mean annual temperature is about 48 degrees F.

The Keota soils are similar to the Epping and Mitchell soils. They are near the Epping and Mitchell soils. Epping soils have bedrock at depths of less than 20 inches. Mitchell soils lack bedrock above 40 inches.

A typical pedon of Keota loam is located 520 feet west and 40 feet north of the southeast corner of section 36, T.11N., R.54W.

A1—0 to 4 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate very fine granular structure; soft, very friable; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (3 to 6 inches thick)

AC—4 to 10 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; calcareous; moderately alkaline (pH 8.4); gradual smooth boundary. (4 to 8 inches thick)

C1—10 to 24 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; 10 percent weathered Brule siltstone fragments; calcareous with some visible secondary calcium carbonate occurring as soft concretions; moderately alkaline (pH 8.4); clear smooth boundary. (13 to 26 inches thick)

C2r—24 to 40 inches; Brule siltstone.

These soils are commonly calcareous throughout, but some pedons are leached from 0 to 6 inches. Depth to bedrock ranges from 20 to 40 inches. Weathered Brule siltstone fragments range from 0 to 15 percent by volume throughout the profile.

The A horizon has color value of 4 or 5 dry, 3 or 4 moist and chroma of 2 or 3. Moist values of 3 extend to depths of less than 5 inches. Texture of the underlying layers is commonly loam or silt loam.

Kim Series

The Kim series consists of deep, well drained soils that formed in calcareous, eolian and alluvial material. Kim soils are on uplands, ridges, hills and fans and have slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual air temperature is about 47 degrees F.

Kim soils are similar to the Thedalund soils. They are near the Thedalund, Shingle and Stoneham soils. Thedalund soils have bedrock between 20 and 40 inches. Mitchell soils have less than 15 percent fine sand and more coarse silt in their underlying layers. Shingle soils have bedrock above 20 inches. Stoneham soils have B2t horizons.

A typical pedon of Kim loam is located 90 feet east and 525 feet north of the west quarter corner of section 9, T.10N., R.50W.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, slightly hard, very friable; noncalcareous; mildly alkaline (pH 7.4); clear smooth boundary. (3 to 7 inches thick)

AC—4 to 16 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; hard, friable; strongly calcareous; moderately alkaline (pH 8.0); gradual smooth boundary (4 to 8 inches thick)

C1ca—16 to 25 inches, light gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; hard, friable; strongly calcareous, moderately alkaline (pH 8.2); gradual smooth boundary. (7 to 20 inches thick)

C2—25 to 60 inches, light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive, slightly hard, very friable; strongly calcareous; moderately alkaline (pH 8.2).

Depth to soft shale is commonly more than 60 inches, but in places it is 40 to 60 inches. Content of coarse fragments ranges from 0 to 15 percent throughout the profile.

The A horizon has a color value of 3 or 4 moist, 4 or 5 dry and chroma of 2 or 3 moist or dry. Value of 3 moist extends to depths of 6 inches or less. The A horizon is commonly loam but ranges to fine sandy loam. The C horizon is typically a loam, fine sandy loam or sandy loam.

Kuma Series

The Kuma series consists of deep, well drained soils formed in calcareous, eolian materials of two soil forming periods. Kuma soils are on upland flats and in depressions and have slopes of 0 to 3 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual air temperature is about 48 degrees F.

Kuma soils are similar to the Rago and Albinas soils. They are near the Keith and Rago soils. Rago soils have subsoils with more than 35 percent clay. Albinas soils lack dark colored buried subsoils. Keith soils have dark surface layers less than 20 inches thick.

A typical pedon of Kuma loam is located about 1,800 feet east and 125 feet north of the southeast corner of section 20, T.6N., R.51W.

Ap—0 to 5 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable; neutral (pH 7.0); abrupt smooth boundary. (4 to 6 inches thick)

B1—5 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable; thin patchy clay films on faces of peds and in pores, neutral (pH 7.0), clear smooth boundary. (3 to 6 inches thick)

B21t—8 to 17 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, weak medium prismatic parting to moderate medium subangular blocky structure, slightly hard, very friable; thin patchy clay films on faces of peds; neutral (pH 7 2), clear smooth boundary. (7 to 12 inches thick)

B22tb—17 to 23 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure, slightly hard, very friable, thin continuous clay films on faces of peds; neutral (pH 7.2); clear smooth boundary. (5 to 10 inches thick)

B23tb—23 to 28 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist, moderate medium prismatic parting to moderate medium subangular blocky structure; thin continuous clay films on faces of peds, neutral (pH 7.2); clear smooth boundary. (3 to 7 inches thick)

B3cab—28 to 32 inches, light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable, thin patchy clay films on faces of peds; calcareous with visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.0); clear smooth boundary. (3 to 9 inches thick)

C1ca—32 to 39 inches; light gray (10YR 7/2) loam, brown (10YR 5/3) moist; weak coarse blocky structure; hard, very friable; calcareous with visible secondary calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.2); gradual smooth boundary. (6 to 12 inches thick)

C2—39 to 60 inches; very pale brown (10YR 7/3) very fine sandy loam, brown (10YR 5/3) moist; massive, slightly hard, very friable, calcareous; moderately alkaline (pH 8.2)

Depth to the dark colored buried subsoils ranges from 12 to 20 inches Thickness of the solum ranges from 24 to 40 inches.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is loam or silt loam. The B2t and B2tb horizons have a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3 Texture of these horizons is silt loam, loam, or silty clay loam with less than 15 percent fine sand or coarser.

Kutch Series

The Kutch series consists of moderately deep, well drained soils formed in calcareous clayey materials weathered from clay shale. Kutch soils are on upland ridges and valley sideslopes. Slopes are 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is about 49 degrees F.

Kutch soils are similar to the Nunn and Renohill soils. They are near the Nunn and Midway soils. Nunn soils lack bedrock at depths of less than 40 inches. Renohill soils have dark surface layers less than 7 inches thick. Midway soils have bedrock at depths of less than 20 inches and lack B2t horizons.

A typical pedon of Kutch clay loam is located 60 feet north and 162 feet west of the east quarter corner of section 8, T.9N., R.54W.

A1—0 to 3 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist, moderate fine granular structure; slightly hard, friable; neutral (pH 7.0); clear smooth boundary. (3 to 6 inches thick)

B21t—3 to 7 inches; dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic breaking to moderate medium subangular blocky structure; very hard, firm; moderately thick nearly continuous clay films on faces of peds; neutral (pH 7.2); clear wavy boundary. (4 to 6 inches thick)

B22t—7 to 14 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; moderate medium prismatic breaking to moderate coarse angular blocky structure, very hard, firm; thin patchy clay films on faces of peds; mildly alkaline (pH 7.4); clear smooth boundary (6 to 10 inches thick)

B3ca—14 to 20 inches; light brownish gray (2.5Y 6/2) clay loam, dry and moist; weak medium prismatic structure; very hard, firm; thin patchy clay films on faces of peds, moderately alkaline (pH 8.0); gradual smooth boundary. (3 to 8 inches thick)

C1ca—20 to 37 inches, light gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist, weak coarse prismatic structure, very hard, firm; 5 percent small shale fragments; calcareous with visible calcium carbonate occurring as concretions and as thin seams and streaks; moderately alkaline (pH 8 4); gradual smooth boundary. (14 to 20 inches thick)

C2r—37 to 60 inches; light gray (2.5Y 7/2) clay shale, light brownish gray (2.5Y 6/2) moist; moderately alkaline (pH 8.4).

Depth to calcareous material ranges from 6 to 20 inches. Depth to bedrock ranges from 20 to 40 inches. Shale fragments range from 0 to 5 percent in the C horizon.

The A horizon has a hue of 10YR or 2.5Y, value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a loam or clay loam. The B2t horizon is a clay loam or clay.

Lebsack Series

The Lebsack series consists of deep, moderately well drained soils formed in calcareous alluvium deposited by the South Platte River and tributary streams. Lebsack soils are on terraces and have slopes of 0 to 1 percent. Average annual precipitation ranges from 13 to 19 inches, and mean annual temperature is about 47 degrees F.

The Lebsack soils are similar to the Hayford soils. They are near the Hayford and Nunn soils. Hayford soils have sand and gravel at a depth of 20 to 40 inches. Nunn soils have dark surface layers less than 20 inches thick and have B2t horizons with strong grades of structure.

A typical pedon of Lebsack silty clay loam is located 450 feet south and 120 feet east of the north quarter corner of section 10, T.6N., R.53W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky parting to moderate fine granular structure; slightly hard, very friable; calcareous; moderately alkaline (pH 7.9); abrupt smooth boundary. (5 to 10 inches thick)

B2—6 to 34 inches; grayish brown (10YR 5/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure, friable; few thin patchy clay films on vertical faces of peds; calcareous, moderately alkaline (pH 8.0); gradual wavy boundary. (12 to 30 inches thick)

Cca—34 to 60 inches; light gray (2.5Y 6/0) heavy silty clay loam, gray (2.5Y 5/0) moist; massive, hard, friable; few gypsum crystals; calcareous with visible secondary calcium carbonate occurring as nodules and in thin seams and streaks, moderately alkaline (pH 8.2).

The mollic epipedon ranges from 20 to 40 inches thick. These soils can have distinct mottles below depths of 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3. It is commonly a silty clay loam but ranges to clay or clay loam. Texture of the B2 horizon is heavy silty clay loam or clay.

Loveland Series

The Loveland series consists of deep, somewhat poorly drained soils formed in calcareous alluvium underlain by mottled sand and gravel. Loveland soils are on low terraces and bottom lands with slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 49 degrees F.

Loveland soils are similar to the Alda soils. They are near the Alda and Hayford soils. Alda soils have sandy loam or loam underlying layers. Hayford soils have clay loam or clay B2t horizons.

A typical pedon of Loveland clay loam is located 145 feet east and 985 feet north of the southwest corner of section 16, T.9N., R.51W.

Ap—0 to 10 inches; grayish brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) moist; weak medium granular structure; hard, friable, calcareous; mildly alkaline (pH 7.8); abrupt smooth boundary. (8 to 12 inches thick)

A12—10 to 13 inches; grayish brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) moist, weak medium subangular blocky structure, hard, friable, calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (3 to 7 inches thick)

AC—13 to 19 inches; gray (10YR 6/1) clay loam, dark gray (10YR 4/1) moist; weak medium prismatic structure; very hard, friable; calcareous with visible calcium carbonate occurring in thin seams and streaks and as small concretions; moderately alkaline (pH 8.3); clear smooth boundary. (4 to 9 inches thick)

C1cag—19 to 25 inches, light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist with few fine distinct mottles of light olive brown (2.5Y 5/6) moist, and yellowish brown (10YR 5/8) moist; weak prismatic structure; very hard, friable; calcareous with visible secondary calcium carbonate occurring in thin seams and streaks and as small concretions; moderately alkaline (pH 8.3); gradual smooth boundary. (5 to 10 inches thick)

IIC2g—25 to 34 inches; light brownish gray (2.5Y 6/2) sandy clay loam, grayish brown (2.5Y 5/2) moist, with many fine distinct olive yellow (2.5Y 6/8) mottles, massive; very hard, firm; calcareous; mildly alkaline (pH 7.6); gradual wavy boundary (0 to 10 inches thick)

IIC3g—34 to 60 inches; pale yellow (2.5Y 7/4) coarse sand and gravel, light olive brown (2.5Y 5/4) moist, with common coarse prominent yellow (2.5Y 6/8) moist and yellowish brown (10YR 5/8) mottles, massive; very hard, very friable, neutral (pH 7.3).

Thickness of the mollic epipedon ranges from 8 to 20 inches. Depth to the underlying sand and gravel ranges from 20 to 40 inches.

The Ap horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 or 2. It is a loam or clay loam. Texture of the C horizon is commonly a clay loam but ranges to loam or sandy clay loam.

Manter Series

The Manter series consists of deep, well drained soils that formed in calcareous, eolian or alluvial materials. Manter soils are on terraces, upland ridges and flats with slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and mean annual temperature is 49 degrees F.

Manter soils are similar to the Julesburg soils. They are near the Julesburg, Ascalon, Chappell and Vona soils. Julesburg soils are noncalcareous. Ascalon soils have sandy clay loam B2t horizons. Chappell soils have B2 horizons. Vona soils have light colored A horizons.

A typical pedon of Manter sandy loam is located 1,050 feet east of the southwest corner of section 29, T.7N., R.54W.

A1—0 to 6 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; neutral (pH 7.0); clear smooth boundary. (4 to 7 inches thick)

B1—6 to 10 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist, weak coarse prismatic structure; very hard, friable; very thin patchy clay films on faces of peds; neutral (pH 7.0); clear smooth boundary. (3 to 5 inches thick)

B2t—10 to 18 inches; brown (10YR 5/3) sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure; very hard, friable, thin patchy clay films on faces of peds; neutral (pH 7.2); clear smooth boundary. (6 to 14 inches thick)

B3ca—18 to 24 inches, light brownish gray (10YR 6/2) sandy loam, grayish brown (10YR 5/2) moist; weak coarse prismatic structure; hard, friable; very thin patchy clay films on faces of peds, calcareous; mildly alkaline (pH 7.8); gradual smooth boundary. (4 to 10 inches thick)

C1ca—24 to 32 inches, light gray (10YR 7/2) sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, calcareous with visible secondary calcium carbonate occurring as concretions, and in

thin seams and streaks; moderately alkaline (pH 8.2); gradual smooth boundary. (6 to 12 inches thick)

C2ca—32 to 60 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; massive; slightly hard, very friable, calcareous with visible secondary calcium carbonate occurring as concretions, and in thin seams and streaks; moderately alkaline (pH 8.2)

Depth to calcareous material ranges from 12 to 20 inches. Depth of solum ranges from 15 to 24 inches. Coarse fragments range from 0 to 10 percent by volume and are mainly 1/4 to 1 inch in diameter. Depth to contrasting sand and gravel layers exceeds 40 inches.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a loamy sand, fine sandy loam or sandy loam Texture of the B2t horizon is commonly a sandy loam but ranges to fine sandy loam

Manzanola Series

The Manzanola series consists of deep, well drained soils that formed in calcareous, loamy alluvium derived mainly from soft shale. Manzanola soils are on alluvial fans, flood plains and stream terraces and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 15 inches and the mean annual temperature is about 49 degrees F.

Manzanola soils are similar to the Heldt soils. They are near the Heldt, Haverson and Nunn soils. Heldt soils have B2 horizons. Haverson soils lack B horizons. Nunn soils have dark colored surface soils extending to depths of 7 to 20 inches.

A typical pedon of Manzanola clay loam is located 155 feet east and 110 feet north of the southwest corner of section 11, T.10N., R.54W.

A1—0 to 3 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure, slightly hard, friable; mildly alkaline (pH 7.4); clear smooth boundary. (3 to 6 inches thick)

B21t—3 to 6 inches; grayish brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium and fine prismatic parting to moderate fine angular blocky structure; hard, friable; moderate, continuous clay films on faces of peds and in root channels and pores, mildly alkaline (pH 7.4); clear smooth boundary. (3 to 6 inches thick)

B22tca—6 to 11 inches; light brownish gray (2.5Y 6/2) heavy clay loam, light olive brown (2.5Y 5/4) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, firm; moderate, thin continuous clay films on faces of peds and in root channels and pores; calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (5 to 8 inches thick)

C1ca—11 to 22 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist, weak coarse prismatic structure; hard, firm, calcareous with visible secondary calcium carbonate occurring as concretions, and in thin seams or streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (8 to 20 inches thick)

C2—22 to 30 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic parting to weak coarse subangular blocky structure; hard, firm; calcareous with visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary.

C3—30 to 60 inches; light gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist, massive; hard, firm; calcareous with visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.4).

Depth to calcareous material ranges from 0 to 8 inches Thickness of the solum ranges from 12 to 20 inches.

The A horizon has hue of 10YR or 2 5Y, value of 5 or 6 dry, 3 or 4 moist, and chroma of 2 or 3 moist and dry Value of 3 moist extends to depths of less than 6 inches. Texture of the A horizon is commonly a clay loam ranging to a clay. The B2t horizon is heavy clay loam or clay. The C horizon is clay loam or loam It is commonly moderately alkaline ranging to strongly alkaline

Midway Series

The Midway series consists of shallow, well drained soils that formed in calcareous, clayey materials weathered from shale. Midway soils are on upland ridges and hills and have slopes of 0 to 18 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual temperature is about 48 degrees F.

Midway soils are similar to the Shingle soils. They are near the Shingle, Renohill and Cushman soils. Shingle soils have less than 35 percent clay in all parts. Renohill and Cushman soils have B2t horizons and have shale bedrock below 20 inches.

A typical pedon of Midway clay loam is located 180 feet east and 800 feet south of the center of section 14, T.9N., R.53W.

A1—0 to 2 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak granular structure; slightly hard, firm, mildly alkaline (pH 7.6); clear smooth boundary (2 to 5 inches thick)

AC—2 to 7 inches; light yellowish brown (2.5Y 6/4) heavy clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (3 to 6 inches thick)

C1ca—7 to 10 inches; light yellowish brown (2 5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (3 to 10 inches thick)

C2r—10 to 60 inches; light yellowish brown (2.5Y 6/4) calcareous clay shale, light olive brown (2.5Y 5/4) moist.

Depth to soft shale ranges from 6 to 20 inches. These soils may be calcareous throughout, but are commonly leached of lime for 2 or 3 inches

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry, 3 or 4 moist and chroma of 2 or 3 moist and dry. Moist value of 3 extends to depths of 5 inches or less. The A horizon is commonly a clay loam but ranges to a silty clay loam.

Mitchell Series

The Mitchell series consists of deep, well drained soils that formed in calcareous, loamy alluvial and eolian materials derived from weathered Brule siltstone. Mitchell soils are on broad upland flats, ridges and fans and have slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual temperature is about 48 degrees F.

Mitchell soils are similar to the Keota and Epping soils. They are near the Keota, Epping and Norka soils. Keota soils have siltstone between 20 and 40 inches. Epping soils are shallow and have siltstone between 10 and 20 inches. Norka soils have dark surface layers extending to 7 inches or more and B2t horizons.

A typical pedon of Mitchell loam is located 520 feet west and 970 feet north of the southeast corner of section 9, T.11N., R.54W.

A11—0 to 2 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; mildly alkaline (pH 7 8); clear smooth boundary. (2 to 3 inches thick)

A12—2 to 5 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable; moderately alkaline (pH 8.0); clear smooth boundary. (2 to 5 inches thick)

AC—5 to 10 inches; light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure, slightly hard, friable; calcareous, moderately alkaline (pH 8.2); clear smooth boundary. (4 to 10 inches thick)

C1ca—10 to 18 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive, slightly hard, friable; calcareous; moderately alkaline (pH 8 4); gradual smooth boundary. (7 to 14 inches thick)

C2—18 to 60 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist, massive; slightly hard, very friable; few small Brule siltstone fragments; calcareous; moderately alkaline (pH 8 4); gradual smooth boundary.

Depth to Brule siltstone commonly is more than 60 inches, but in places it is 40 to 60 inches.

The A horizon has a color value of 4 or 5 dry, 3 or 4 moist and chroma of 2 or 3. Value of 3 moist extends to depths of 4 inches or less. This horizon is commonly a loam but ranges to silt loam The C horizon is a silt loam or loam with less than 15 percent fine sand or coarser. Fragments of Brule siltstone range from 0 to 10 percent in the C horizon.

Mosher Series

The Mosher series consists of deep, somewhat poorly drained soils that formed in calcareous, stratified clayey alluvium deposited by the South Platte River. Mosher soils are on terraces having slopes of 0 to 1 percent. Average annual precipitation ranges from 15 to 19 inches and the mean annual temperature is about 48 degrees F.

Mosher soils are similar to the Lebsack soils. They are near the Lebsack and Hayford soils. Lebsack soils have dark surface layers extending below 20 inches. Hayford soils have mottled sand and gravel at depths of 20 to 40 inches and lack strongly alkaline subsoil layers.

A typical pedon of Mosher loam is located 40 feet south and 1,085 feet west of the east quarter corner of section 6, T.10N., R.48W.

A1—0 to 2 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; neutral (pH 7.0); clear smooth boundary. (2 to 5 inches thick)

A2—2 to 5 inches, gray (10YR 6/1) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; neutral (pH 7.2); abrupt smooth boundary. (2 to 4 inches thick)

B2t—5 to 10 inches; dark gray (10YR 4/1) heavy clay loam, very dark brown (10YR 2/2) moist; strong medium and fine prismatic parting to strong medium and fine subangular blocky structure, hard, firm; moderate continuous clay films on faces of peds; moderately alkaline (pH 8.4); clear smooth boundary. (4 to 8 inches thick)

B31casa—10 to 17 inches, grayish brown (10YR 5/2) heavy clay loam, dark grayish brown (10YR 4/2) moist; moderate coarse prismatic parting to moderate coarse subangular blocky structure; hard, firm; thin continuous clay films on faces of peds; visible salts occurring in thin seams and streaks; calcareous; strongly alkaline (pH 9.0); clear smooth boundary. (5 to 8 inches thick)

B32casa—17 to 21 inches; pale brown (10YR 6/3) fine sandy clay loam, brown (10YR 5/3) moist; weak coarse prismatic structure; slightly hard, friable; few thin patchy clay films on faces of peds, visible salt occurring in thin seams and streaks; calcareous, very strongly alkaline (pH 9 2); clear smooth boundary. (4 to 8 inches thick)

C1ca—21 to 28 inches; light gray (2 5Y 7/2) sandy clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; calcareous with visible calcium carbonate in thin seams and streaks; strongly alkaline (pH 9.0); clear smooth boundary (6 to 12 inches thick)

C2—28 to 50 inches; light gray (2.5Y 7/2) clay loam, stratified with thin strata of very fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, some Chadron shale fragments at 32 inches, calcareous, strongly alkaline (pH 9.0); clear smooth boundary (12 to 30 inches thick)

C3g—50 to 55 inches; gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist, with few common distinct mottles, light olive brown (2.5Y 5/6), massive; hard, firm; calcareous; moderately alkaline (pH 8.2); clear smooth boundary.

IIC4g—55 to 60 inches; light gray (2 5Y 7/2) loam, grayish brown (2.5Y 5/2) moist, with few common distinct mottles, light olive brown (2 5Y 5/6); massive, slightly hard, firm; few fragments and concretions of Chadron shale; calcareous; moderately alkaline (pH 8.2).

Mottles are common below depths of 40 inches. Reaction of the lower part of the solum is strongly alkaline or very strongly alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 dry, 2 to 3 moist and chroma of 1 or 2 It is a loam or very fine sandy loam Texture of the B2t horizon is commonly heavy clay loam ranging to silty clay loam or clay. Texture of the stratified C horizon ranges from clay loam, silt loam, or sandy loam.

Norka Series

The Norka series consists of deep, well drained soils that formed in calcareous, eolian materials. Norka soils are on upland tablelands, hills and valley sideslopes. Slopes are 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is 48 degrees F.

Norka soils are similar to the Keith soils. They are near the Colby, Keith, Mitchell and Wages soils. Keith soils have sola thicker than 15 inches. Colby and Mitchell soils lack B horizons or dark surface layers. Wages soils have more than 15 percent fine sand or coarser.

A typical pedon of Norka loam is located 35 feet north and 380 feet east of the southwest corner of section 14, T.10N., R.51W.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, weak very fine granular structure; slightly hard, very friable, neutral (pH 7.0); clear smooth boundary. (3 to 6 inches thick)

B2t—4 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin continuous clay films on faces of peds and in pores; neutral (pH 7.2); clear smooth boundary. (5 to 12 inches thick)

B3ca—12 to 15 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist, weak medium prismatic structure; hard, friable; thin patchy clay films on faces of peds and in pores, calcareous; moderately alkaline (pH 8 0); clear smooth boundary. (2 to 4 inches thick)

C1ca—15 to 25 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; hard, very friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.2); gradual smooth boundary. (9 to 20 inches thick)

C2—25 to 60 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; hard, very friable; calcareous; moderately alkaline (pH 8.2).

Thickness of solum ranges from 8 to 15 inches. Coarser textured substratum materials are common below 40 inches

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. This horizon is commonly a loam but ranges to silt loam. The B horizon is a silt loam, silty clay loam, loam or clay loam, with less than 15 percent sand coarser than fine sand. The C horizon is a loam, silt loam or fine sandy loam.

Nunn Series

The Nunn series consists of deep, well drained and moderately well drained soils that formed in calcareous alluvium and eolian materials. Nunn soils are on terraces, alluvial fans, upland flood plains and ridges and have slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 48 degrees F.

Nunn soils are similar to the Satanta and Manzanola soils. They are near the Satanta, Platner and Kutch soils. Satanta soils have less than 35 percent clay in the B2t horizon. Manzanola soils lack dark colored surface layers extending more than 7 inches. Platner soils have an abrupt textural boundary between the A and B horizons. Kutch soils have bedrock at depths of 20 to 40 inches.

A typical pedon of Nunn loam is located 140 feet east and 1,700 feet south of the northwest corner of section 31, T.10N., R.54W.

A1—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure with weak thin platy in the lower part of the horizon; slightly hard, friable; neutral (pH 7.0); clear smooth boundary (4 to 8 inches thick)

B1—6 to 10 inches, grayish brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) moist, moderate medium prismatic parting to moderate medium subangular blocky structure, hard, friable, few thin patchy clay films on faces of peds; neutral (pH 7.2); clear smooth boundary. (3 to 6 inches thick)

B21t—10 to 15 inches; grayish brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; strong medium prismatic parting to strong medium and fine angular blocky structure; hard, firm; nearly continuous, moderately thick clay films on faces of peds; mildly alkaline (pH 7.6), clear smooth boundary. (4 to 7 inches thick)

B22t—15 to 26 inches; grayish brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; strong moderate to fine prismatic parting to strong medium subangular blocky structure; hard, firm; moderate continuous clay films on faces of peds; mildly alkaline (pH 7.8); clear smooth boundary. (4 to 12 inches thick)

B3ca—26 to 31 inches; grayish brown (2.5Y 5/2) light clay loam, dark grayish brown (2.5Y 4/2) moist, weak coarse prismatic structure, hard, firm; thin patchy clay films on faces of peds; calcareous with visible calcium carbonate occurring as small concretions, in thin seams and streaks, moderately alkaline (pH 8.0); clear smooth boundary. (3 to 10 inches thick)

C1ca—31 to 47 inches, light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure, hard, friable; calcareous with visible calcium carbonate occurring as small concretions, in thin seams and streaks, moderately alkaline (pH 8.2), clear smooth boundary. (10 to 20 inches thick)

C2—47 to 60 inches; light brownish gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; calcareous with few visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8 0).

Depth of solum ranges from 16 to 40 inches thick. Depth to calcareous materials ranges from 10 to 20 inches.

The A horizon has 10YR or 2.5Y hue, value of 4 or 5 dry, 2 or 3 moist and chroma of 1 through 3 It is a loam or clay loam ranging to clay. Texture of the B2t horizon is commonly a heavy clay loam or clay. Texture of the C horizon is commonly clay loam or loam.

Olney Series

The Olney series consists of deep, well drained soils that formed in calcareous, eolian and alluvial materials. Olney soils are on upland ridges and hills and have slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 15 inches and mean annual temperature is about 48 degrees F.

Olney soils are similar to the Stoneham, Ascalon, and Cushman soils. They are near the Stoneham, Ascalon, Cushman and Vona soils. Stoneham soils have sola less than 15 inches thick. Ascalon soils have dark surface layers with moist values of 3 extending to 7 inches or more. Cushman soils have bedrock at depths of 20 to 40 inches. Vona soils have sandy loam subsoils.

A typical pedon of Olney sandy loam is located 115 feet south and 2,800 feet east of the northwest corner of section 6, T.9N., R.54W.

A11—0 to 2 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, soft, very friable; neutral (pH 6.8), abrupt smooth boundary. (2 to 3 inches thick)

A12—2 to 3 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable; neutral (pH 7 0); clear smooth boundary. (1 to 4 inches thick)

B2t—3 to 11 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; very hard, firm; thin continuous clay films on faces of peds; mildly alkaline (pH 7.6); clear smooth boundary (6 to 12 inches thick)

B3ca—11 to 15 inches, pale brown (10YR 6/3) heavy sandy loam, brown (10YR 5/3) moist, weak medium prismatic structure, hard, friable; thin patchy clay films on faces of peds; calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (3 to 8 inches thick)

C1ca—15 to 26 inches; pale yellow (2.5Y 7/4) sandy loam, light brownish gray (2.5Y 6/2) moist; weak coarse prismatic structure; slightly hard, friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (9 to 16 inches thick)

C2—26 to 48 inches; light brownish gray (2.5Y 6/2) sandy loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4), gradual smooth boundary. (20 to 34 inches thick)

C3—48 to 60 inches; light yellowish brown (2.5Y 6/4) fine sandy loam, light olive brown (2.5Y 5/4) moist, massive; soft, very friable, few shale fragments; calcareous; moderately alkaline (pH 8.4).

Thickness of solum ranges from 15 to 24 inches. Depth to calcareous material ranges from 10 to 20 inches.

The A horizon has color value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 or 3. Value of 3 moist extends to depths of 6 inches or less This horizon is commonly a sandy loam but ranges to fine sandy loam The C horizon ranges from sandy loam to sandy clay loam and is stratified in some pedons.

Peetz Series

The Peetz series consists of deep, well drained soils that formed in calcareous, gravelly alluvial materials of the Ogallala Formation. Peetz soils are on upland ridges and knobs and have slopes of 5 to 25 percent. Average annual precipitation ranges from 15 to 19 inches and mean annual temperature is about 49 degrees F.

Peetz soils are similar to the Dix soils. They are near the Dix, Kim and Wages soils. Dix soils have noncalcareous B2 horizons. Kim soils lack dark surface layers extending to 7 inches or more. Wages soils have loam or clay loam B2t horizons.

A typical pedon of Peetz gravelly sandy loam is located 1,640 feet north of the southeast corner of section 18, T.11N., R.50W.

A1—0 to 3 inches, gray (10YR 5/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; 20 percent gravel; calcareous; mildly alkaline (pH 7.4), clear smooth boundary. (2 to 4 inches thick)

AC—3 to 9 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; hard, friable; 30 percent gravel; calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (4 to 8 inches thick)

C1ca—9 to 15 inches; light gray (10YR 7/2) gravelly coarse sandy loam, grayish brown (10YR 5/2) moist; massive; hard, friable; 40 percent gravel; calcareous with lime coated rounded fragments of sandstone and Brule siltstone; moderately alkaline (pH 8.2); gradual wavy boundary. (4 to 9 inches thick)

C2ca—15 to 28 inches; white (10YR 8/2) very gravelly coarse sandy loam, light brownish gray (2.5Y 6/2) moist; massive; hard, friable; 55 percent gravel; calcareous with lime coating on gravel and fragments of sandstone and rounded Brule siltstone; calcareous; moderately alkaline (pH 8.2); gradual wavy boundary. (4 to 9 inches thick)

C3—28 to 60 inches; pale brown (10YR 6/3) very gravelly coarse sand, brown (10YR 5/3) moist; massive; slightly hard, friable; 55 percent gravel; few cobbles up to 4 inches diameter; Brule siltstone and sandstone cobbles common; calcareous; mildly alkaline (pH 7.8).

This soil is commonly calcareous throughout but some pedons have noncalcareous A1 horizons. Rock fragments range from about 15 percent in the upper part of the profile to 60 percent in the lower part. Rounded cobble-sized fragments of sandstone and Brule siltstone are common.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3.

Platner Series

The Platner series consists of deep, well drained soils formed in calcareous, alluvial and eolian deposits. Platner soils are on upland tablelands, ridges, and hills and have slopes of 0 to 5 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 49 degrees F.

Platner soils are similar to the Weld soils. They are near the Weld, Satanta, Rago and Dacono soils. Weld soils contain less than 15 percent fine sand or coarser in the B2t horizon. Satanta soils have loam and clay loam subsoils. Rago soils have B2tb horizons and dark surface layers more than 20 inches thick. Dacono soils have sand and gravel at depths of 20 to 40 inches.

A typical pedon of Platner loam is located 95 feet north and 950 feet west of the southeast corner of section 20, T.7N., R.49W.

Ap—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; 5 percent fine gravel; neutral (pH 7.0); abrupt smooth boundary. (4 to 7 inches thick)

A1—5 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium platy structure; hard, friable; very thin patchy clay films on faces of peds; bleached sand grains on soil peds; neutral (pH 7.0); abrupt smooth boundary. (0 to 3 inches thick)

B21t—7 to 15 inches; grayish brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; strong medium and fine prismatic parting to strong fine angular blocky structure; extremely hard, firm, sticky and plastic; moderately thick continuous clay films on faces of peds; 5 percent fine gravel; neutral (pH 7.2); clear smooth boundary. (5 to 9 inches thick)

B22t—15 to 18 inches; light brownish gray (10YR 6/2) heavy clay loam, brown (10YR 4/3) moist; moderate medium prismatic parting to moderate medium angular blocky structure; hard, firm, sticky, plastic; moderately thick continuous clay films on faces of peds; mildly alkaline (pH 7.3); clear smooth boundary. (3 to 8 inches thick)

B3ca—18 to 21 inches; light gray (10YR 7/2) loam, brown (10YR 5/3) moist; weak medium prismatic structure; hard, friable; thin patchy clay films on faces of peds; calcareous with calcium carbonate occurring as concretions and in seams and streaks; moderately alkaline (pH 7.9); clear smooth boundary. (2 to 7 inches thick)

C1ca—21 to 26 inches; white (10YR 8/2) loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; hard, very friable; 5 percent gravel; calcareous with visible calcium carbonate occurring as concretions, and in seams and streaks; moderately alkaline (pH 8.2); gradual wavy boundary. (5 to 12 inches thick)

C2—26 to 34 inches; very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable; 5 percent fine gravel; calcareous with some visible calcium carbonate occurring in seams and streaks; moderately alkaline (pH 8.2); gradual wavy boundary. (8 to 20 inches thick)

C3—34 to 60 inches; brown (7.5YR 5/4) moist, gravelly sandy clay loam; massive; very hard, firm; calcareous with visible calcium carbonate occurring in seams up to 1/4 inch in thickness; moderately alkaline (pH 8.2).

Depth to calcareous material ranges from 8 to 24 inches. Solum ranges from 15 to 30 inches thick. Coarse fragments range from 0 to 15 percent by volume. These soils may have thin A2 horizons. Below 40 inches coarser textured or more gravelly materials commonly occur.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. Texture is loam or fine sandy loam. Texture of the B2t horizon is clay loam or clay. The C horizon is a loam, sandy loam or sandy clay loam and may be gravelly.

Rago Series

The Rago series consists of moderately deep, well drained soils that formed in eolian and alluvial materials of two ages. Rago soils are in upland swales, depressions and drainageways and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 48 degrees F.

Rago soils are similar to the Kuma soils. They are near the Kuma, Platner and Weld soils. Kuma soils have subsoils with less than 35 percent clay. Platner and Weld soils lack dark colored buried subsoil layers.

A typical pedon of Rago loam is located 1,530 feet north and 95 feet west of the southeast corner of section 25, T.8N., R.49W.

Ap—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; neutral (pH 7.0); abrupt smooth boundary. (4 to 8 inches thick)

B1—4 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; fine thin patchy clay films on faces of peds; neutral (pH 7.0); clear smooth boundary. (4 to 8 inches thick)

B2t—8 to 14 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin continuous clay films on faces of peds, in root channels and pores; neutral (pH 7.2); clear smooth boundary. (6 to 10 inches thick)

B2tb—14 to 22 inches; dark gray (10YR 4/1) heavy clay loam, very dark brown (10YR 2/2) moist, strong medium and fine prismatic parting to strong medium and fine angular blocky structure; very hard, firm, thin continuous clay films on faces of peds, neutral (pH 7.2); clear smooth boundary.

B3b—22 to 26 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist with very dark brown (10YR 2/2) streaks moist, on some faces of peds; weak medium prismatic structure; hard, friable, thin patchy clay films on faces of peds, mildly alkaline (pH 7.6); clear smooth boundary. (3 to 8 inches thick)

C1cab—26 to 34 inches; light gray (10YR 7/2) loam, pale brown (10YR 6/3) moist, massive; hard, friable; calcareous with visible secondary calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.0); clear wavy boundary. (6 to 14 inches thick)

C2b—34 to 49 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist, massive; hard, very friable; calcareous with visible secondary calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.0); clear wavy boundary. (12 to 26 inches thick)

C3b—49 to 60 inches, pale brown (10YR 6/3) coarse sandy loam, brown (10YR 5/3) moist; massive; hard, very friable; 10 percent fine gravel; calcareous, mildly alkaline (pH 7.8).

Thickness of the mollic epipedon ranges from 20 to 40 inches. Depth to the dark colored buried soil ranges from 12 to 24 inches. Contrasting IIC horizons consisting of sand and gravel can occur at depths below 40 inches in some areas.

The A horizon has color value of 4 or 5 dry, 2 or 3 moist, and chroma of 1 through 3. It is a loam or fine sandy loam. Texture of the B2t horizon is a clay loam averaging 27 to 40 percent clay. The B2tb horizon has color value of 3 or 4 dry, 2 or 3 moist and chroma of 1 through 3. It is a clay loam, silty clay loam or clay. The C horizon is silt loam, loam, fine sandy loam, sandy loam or coarse sandy loam.

Renohill Series

The Renohill series consists of moderately deep, well drained soils that formed in materials weathered from interbedded soft shale and sandstone. Renohill soils are on upland ridges and hills and have slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is about 49 degrees F.

Renohill soils are similar to the Manzanola, Cushman and Kutch soils. They are near the Cushman, Shingle, Midway and Stoneham soils. The Manzanola and Stoneham soils lack bedrock above 40 inches. Cushman soils have B2t horizons with less than 35 percent clay. Shingle and Midway soils have bedrock at depths above 20 inches.

A typical pedon of Renohill loam is located 60 feet north and 155 feet east of the southwest corner of section 31, T.11N., R.55W.

A1—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, moderate fine granular structure; slightly hard, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 5 inches thick)

B1—3 to 5 inches; grayish brown (10YR 5/2) heavy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable; very thin patchy clay films on faces of peds, neutral (pH 7.2); clear smooth boundary. (2 to 4 inches thick)

B2t—5 to 11 inches, light olive brown (2.5Y 5/4) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; strong medium prismatic parting to strong medium and fine subangular blocky structure; very hard, firm; thin continuous clay films on faces of peds, mildly alkaline (pH 7.4); clear smooth boundary. (5 to 10 inches thick)

B3ca—11 to 20 inches; light yellowish brown (2 5Y 6/4) heavy clay loam, light olive brown (2.5Y 5/4) moist; moderate medium prismatic structure; very hard, firm, thin patchy clay films on faces of peds; few partially weathered shale fragments; calcareous with visible calcium carbonate occurring as small concretions and in thin seams and streaks, moderately alkaline (pH 8 0); gradual smooth boundary. (4 to 9 inches thick)

C1ca—20 to 27 inches; light yellowish brown (2 5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; few partially weathered shale fragments; calcareous with visible calcium carbonate occurring as small concretions and in thin seams and streaks; moderately alkaline (pH 8.2); gradual smooth boundary. (5 to 12 inches thick)

C2r—27 to 60 inches; light yellowish brown (2.5Y 6/4) partially weathered clay shale, light olive brown (2.5Y 5/4) moist.

Depth to bedrock ranges from 20 to 40 inches. Thickness of solum ranges from 15 to 30 inches. Content of shale fragments and fine gravel is commonly less than 5 percent but ranges from 0 to 15 percent.

The A horizon has 10YR or 2 5Y hue, value of 5 or 6 dry, 3 or 4 moist, and chroma of 2 to 3. Moist values of 3 extend to depths of 6 inches or less. The A horizon is a loam. The B2t horizon has 10YR or 2 5Y hue, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. It is commonly a heavy clay loam or clay The C horizon is commonly a clay loam or loam and is stratified in some pedons

Rosebud Series

The Rosebud series consists of moderately deep, well drained soils that formed in calcareous, alluvial and eolian materials underlain by calcareous sandstone. Rosebud soils are on upland ridges and flats and have slopes of 3 to 9 percent. Average annual precipitation ranges from 17 to 19 inches and mean annual temperature is about 48 degrees F.

Rosebud soils are similar to the Wages and Satanta soils. They are near the Wages, Escabosa and Canyon soils. Wages and Satanta soils lack bedrock above 40 inches. Escabosa soils lack B2t horizons. Canyon soils have bedrock at less than 20 inches.

A typical pedon of Rosebud loam is located 50 feet east and 255 feet north of the west quarter corner of section 12, T.7N., R.50W.

Ap—0 to 5 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral (pH 7.0), abrupt smooth boundary. (4 to 7 inches thick)

B2t—5 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 3/2) moist; moderate coarse prismatic structure; hard, friable; thin patchy clay films on faces of peds, neutral (pH 7.2), clear smooth boundary (5 to 10 inches thick)

B3ca—12 to 18 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist, weak coarse prismatic structure; hard, friable; very thin patchy clay films on faces of peds; calcareous; moderately alkaline (pH 8.0), gradual smooth boundary. (3 to 6 inches thick)

C1ca—18 to 24 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive, very hard, friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams; moderately alkaline (pH 8.2), gradual wavy boundary. (5 to 12 inches thick)

C2—24 to 33 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; massive; hard, very friable; calcareous with visi-

ble calcium carbonate occurring as concretions and thin seams and streaks; moderately alkaline (pH 8.2); clear smooth boundary. (0 to 12 inches thick)

C3r—33 to 60 inches; white (10YR 8/2) weakly consolidated calcareous sandstone of the Ogallala Formation, light gray (10YR 7/2) moist.

The thickness of the solum ranges from 12 to 24 inches Up to 10 percent fragments of sandstone and fine gravel are scattered throughout the profile. Depth to the calcareous sandstone or siltstone ranges from 20 to 40 inches.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3 It is a loam or fine sandy loam. The B2t horizon is a loam or clay loam The C horizon is commonly a loam ranging to sandy loam.

Satanta Series

The Satanta series consists of deep, well drained soils that formed in calcareous, alluvial and eolian materials. Satanta soils are on terraces and upland flats, ridges and hills with slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and mean annual temperature is about 49 degrees F.

Satanta soils are similar to the Wages, Rosebud and Ascalon soils. They are near the Wages, Nunn and Keith soils. The Wages soils have sola less than 15 inches thick. Rosebud soils have bedrock at depths of 20 to 40 inches. Ascalon soils have B2t horizons with more than 35 percent fine or coarser sand. Nunn soils have heavy clay loam and clay B2t horizons. Keith soils have B2t horizons containing less than 15 percent fine sand or coarser.

A typical pedon of Satanta loam is located 415 feet east and 225 feet south of the west quarter corner of section 6, T.9N., R.53W.

A1—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist, weak fine granular structure; slightly hard, friable, neutral (pH 7.0); clear smooth boundary (5 to 8 inches thick)

B1—5 to 7 inches, dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, friable; very thin patchy clay films on faces of peds; neutral (pH 7.0), clear smooth boundary (2 to 4 inches thick)

B21t—7 to 11 inches, dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin continuous clay films on faces of peds; neutral (pH 7 2), clear smooth boundary (3 to 5 inches thick)

B22t—11 to 17 inches, grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist, moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable, thin continuous clay films on faces of peds; mildly alkaline (pH 7.4); clear smooth boundary (4 to 8 inches thick)

B3ca—17 to 20 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; weak medium prismatic structure; slightly hard, friable; very thin patchy clay films on faces of peds, calcareous with visible calcium carbonate occurring in thin seams and streaks; moderately alkaline (pH 8.0); clear smooth boundary. (3 to 8 inches thick)

C1ca—20 to 26 inches; light gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; massive, slightly hard, friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.2); gradual smooth boundary. (5 to 12 inches thick)

C2—26 to 60 inches; very pale brown (10YR 7/3) loam, grayish brown (2 5Y 5/2) moist; massive, slightly hard, very friable, moderately alkaline (pH 8 0).

Thickness of solum ranges from 15 to 30 inches The mollic epipedon ranges from 8 to 20 inches in thickness Content of coarse fragments ranges from 0 to 10 percent Some pedons have IIC horizons at depths below 40 inches

The A horizon has 10YR or 2.5Y hue, value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is a loam or fine sandy loam. Texture of the B2t horizon is a loam, clay loam or sandy clay loam.

Shingle Series

The Shingle series consists of shallow, well drained soils that formed in calcareous materials weathered from interbedded soft shale and sandstone. Shingle soils are on upland ridges and hills and have slopes of 1 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual temperature is about 48 degrees F.

Shingle soils are similar to the Epping and Canyon soils. They are near the Thedalund and Kim soils. Epping soils formed in materials weathered from Brule siltstone. Canyon soils have 15 to 35 percent coarse fragments in underlying layers and are over calcareous sandstone. Thedalund soils have bedrock below 20 inches. Kim soils lack bedrock above 40 inches.

A typical pedon of Shingle loam is located 1,010 feet west and 110 feet north of the center of section 34, T.11N., R.54W.

A1—0 to 2 inches, grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist, weak fine granular structure; slightly hard, friable, calcareous; mildly alkaline (pH 7.6), clear smooth boundary (2 to 5 inches thick)

AC—2 to 4 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2 5Y 4/4) moist; weak fine granular structure; slightly hard, friable; calcareous, mildly alkaline (pH 7 8); clear smooth boundary (2 to 5 inches thick)

C1ca—4 to 10 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, calcareous, moderately alkaline (pH 8.0); clear smooth boundary. (4 to 12 inches thick)

C2r—10 to 60 inches; pale yellow (2.5Y 7/4) partially weathered calcareous shale, light olive brown (2.5Y 5/6) moist.

These soils are commonly calcareous throughout but are noncalcareous in the upper 2 to 4 inches in some pedons Depth to bedrock ranges from 10 to 20 inches Up to 5 percent fragments of shale are scattered throughout the soil.

The A horizon has hue of 2.5Y or 10YR, value of 5 through 7 dry, 3 through 5 moist and chroma of 2 or 3. Moist values of 3 extend to depths of 4 inches or less. The A horizon is a loam or clay loam. The C horizon is commonly a loam or clay loam.

Stoneham Series

The Stoneham series consists of deep, well drained soils that formed in calcareous, stratified alluvial and eolian materials. Stoneham soils are on upland convex ridges and have slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 17 inches and mean annual temperature is 49 degrees F.

The Stoneham soils are similar to the Cushman, Olney and Wages soils. They are near the Cushman and Olney soils. Cushman soils have bedrock at depths of 20 to 40 inches. Olney soils have sola more than 15 inches thick. Wages soils have surface soils with moist values of 3 extending to depths of 7 inches or more.

A typical pedon of Stoneham loam is located 30 feet north and 195 feet east of the south quarter corner of section 22, T.10N., R.54W.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 4 inches thick)

B2t—4 to 9 inches, grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic parting to moderate medium and fine subangular blocky structure, very hard, friable; thin continuous clay films on faces of peds, neutral (pH 7.2); clear smooth boundary. (4 to 7 inches thick)

B3ca—9 to 13 inches, light brownish gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2) moist; weak medium prismatic structure; hard, friable; very thin patchy clay films on faces of peds; calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (2 to 4 inches thick)

C1ca—13 to 18 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; weak coarse subangular blocky structure; hard, friable; calcareous with visible calcium carbonate occurring as concretions, in thin seams and streaks, moderately alkaline (pH 8 4), gradual smooth boundary. (6 to 18 inches thick)

C2ca—18 to 34 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist, massive; slightly hard, very friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4); gradual smooth boundary. (16 to 24 inches thick)

C3—34 to 60 inches; very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable; calcareous; strongly alkaline (pH 8.6).

Thickness of the solum ranges from 10 to 15 inches. Depth to calcareous material ranges from 6 to 10 inches.

The A horizon has a color value of 5 or 6 dry, 3 or 4 moist and chroma of 2 or 3. Moist value of 3 extends to depths of 6 inches or less. The A horizon is a fine sandy loam or loam The B2t horizon is a loam or clay loam.

Thedalund Series

The Thedalund series consists of moderately deep, well drained soils formed in calcareous alluvium derived from interbedded soft shale and sandstone. Thedalund soils are on upland ridges and hills and have slopes of 3 to 25 percent. Mean annual precipitation is 15 inches and mean annual temperature is 49 degrees F.

Thedalund soils are similar to the Kim and Keota soils. They are near the Kim and Shingle soils. Kim soils lack bedrock at depths less than 40 inches. Keota soils formed in materials derived from Brule siltstone. Shingle soils have bedrock at depths of 20 inches or less.

A typical pedon of Thedalund loam is located about 1,320 feet east and 495 feet north of the center of section 31, T.10N., R.54W.

A1—0 to 4 inches, grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist, weak fine granular structure; slightly hard, friable; calcareous; moderately alkaline (pH 8.2); clear smooth boundary. (2 to 6 inches thick)

AC—4 to 14 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; hard, friable; few shale fragments; dark staining on ped faces; calcareous; moderately alkaline (pH 8.4); gradual smooth boundary. (5 to 10 inches thick)

C1ca—14 to 31 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; few shale fragments in lower part of horizon; calcareous; moderately alkaline (pH 8.4); abrupt smooth boundary. (12 to 24 inches thick)

C2r—31 inches; pale yellow (5Y 7/3) interbedded soft calcareous shale and soft sandstone; pale olive (5Y 6/3) moist.

Commonly, these soils are calcareous throughout but are leached 1 to 4 inches in some pedons. Depth to bedrock ranges from 20 to 40 inches

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry, 3 through 5 moist and chroma of 2 or 3. Moist value of 3 extends to depths less than 5 inches. This horizon is very fine sandy loam or loam The C horizon is a loam or clay loam.

Ulysses Series

The Ulysses series consists of deep, well drained soils that formed in calcareous, loamy eolian materials. Ulysses soils are on upland flats, ridges and hills and have slopes of 0 to 12 percent. Average annual precipitation ranges from 17 to 19 inches and the mean annual air temperature is about 49 degrees F.

Ulysses soils are similar to the Colby soils. They are near the Colby, Keith and Norka soils. Colby soils lack dark surface layers and B2 horizons. Keith and Norka soils have B2t horizons.

A typical pedon of Ulysses loam is located about 95 feet north and 1,465 feet west of the southeast corner of section 17, T.6N., R.51W.

A1—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure, soft, very friable; neutral (pH 7 0); clear smooth boundary. (5 to 9 inches thick)

B2—5 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; very thin patchy clay films on faces of peds; mildly alkaline (pH 7 6); clear smooth boundary. (4 to 10 inches thick)

B3ca—10 to 14 inches; pale brown (10YR 6/2) loam, brown (10YR 5/3) moist; weak medium prismatic structure; very hard, very friable; very thin patchy clay films on faces of peds; calcareous, mildly alkaline (pH 7.8); clear smooth boundary. (2 to 5 inches thick)

C1ca—14 to 24 inches; light gray (2.5Y 7/2) very fine sandy loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; hard, very friable, calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.0); gradual smooth boundary. (9 to 14 inches thick)

C2—24 to 60 inches; light yellowish brown (2.5Y 6/4) very fine sandy loam, light olive brown (2.5Y 5/4) moist; massive; soft, very friable; calcareous; moderately alkaline (pH 8.2).

The thickness of the solum ranges from 10 to 24 inches. The mollic epipedon ranges from 7 to 20 inches thick.

The A horizon has a color value of 4 or 5 dry, 2 to 3 moist, and chroma of 2 or 3. It is commonly a loam ranging to silt loam or very fine sandy loam. The control section is commonly a silt loam or very fine sandy loam ranging to loam. It contains less than 15 percent fine sand or coarser.

Valent Series

The Valent series consists of deep, excessively drained soils formed in noncalcareous, sandy eolian deposits. Valent soils are on upland sandhills and have slopes of 3 to 20 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual air temperature is 48 degrees F.

Valent soils are similar to the Dailey soils. They are near the Dailey and Julesburg soils. Dailey soils have dark surface layers extending to 10 inches or more. Ju-

lesburg soils have dark surface layers and sandy loam B2t horizons.

A typical pedon of Valent loamy sand is located 50 feet west and 310 feet south of the northwest corner of section 2, T.7N., R.52W.

A1—0 to 3 inches, grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 6.8); clear smoooth boundary. (3 to 10 inches thick)

AC—3 to 12 inches; brown (10YR 5/3) loamy sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure, soft, very friable; neutral (pH 6.8); clear smooth boundary. (6 to 10 inches thick)

C1—12 to 27 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grained, loose, dry and moist; neutral (pH 7.0), gradual smooth boundary. (12 to 20 inches thick)

C2—27 to 60 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist, single grained, loose, dry and moist; neutral (pH 7 0)

These soils are commonly noncalcareous throughout but some pedons are calcareous below 40 inches

The A horizon has a color value of 5 or 6 dry, 3 through 5 moist, and chroma of 2 or 3. Moist values of 3 extend to depths of 6 inches or less The A horizon is a loamy sand, loamy fine sand or fine sand. The C horizon is neutral to mildly alkaline.

Vona Series

The Vona series consists of deep, well drained soils that formed in calcareous, eolian materials. Vona soils are on upland ridges and hills and have slopes of 3 to 9 percent. Average annual precipitation ranges from 13 to 15 inches and mean annual temperature is about 49 degrees F.

Vona soils are similar to the Manter and Olney soils. They are near the Olney, Ascalon and Manter soils. Manter soils have dark colored surface layers. Olney soils have sandy clay loam B2t horizons. Ascalon soils have dark colored surface layers and sandy clay loam B2t horizons.

A typical pedon of Vona fine sandy loam is located 85 feet south and 175 feet east of the north quarter corner of section 13, T.7N., R.54W.

A1—0 to 3 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure, soft, very friable; neutral (pH 7.0); clear smooth boundary. (3 to 6 inches thick)

B1—3 to 5 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, very thin patchy clay skins on faces of peds; neutral (pH 7 0); clear smooth boundary. (2 to 3 inches thick)

B2t—5 to 11 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist, weak coarse prismatic structure, slightly hard, very friable; thin patchy clay skins on faces of peds and in root channels; neutral (pH 7.2); clear smooth boundary (4 to 12 inches thick)

B3ca—11 to 16 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist, weak coarse prismatic structure; soft, very friable; thin patchy clay skins on faces of peds; calcareous, mildly alkaline (pH 7.4); clear smooth boundary. (3 to 6 inches thick)

C1ca—16 to 28 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure, slightly hard, very friable; calcareous with visible secondary calcium carbonate accumulation occurring as small concretions and in thin seams and streaks, moderately alkaline (pH 8.0), gradual smooth boundary (5 to 12 inches thick)

C2—28 to 60 inches, pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist, massive; soft, very friable; calcareous; moderately alkaline (pH 8 2).

Depth to calcareous material ranges from 8 to 24 inches Thickness of the solum ranges from 15 to 24 inches

The A horizon has a color value of 5 or 6 dry, 3 or 4 moist and chroma of 2 or 3. Moist values of 3 extend to a depth of 6 inches or less. The A horizon is a loamy sand or sandy loam. The B2t horizon is a sandy loam or fine sandy loam. Texture of the C horizon is commonly sandy loam or fine sandy loam but ranges to loamy sand with depth.

Wages Series

The Wages series consists of deep, well drained soils that formed in calcareous, loamy alluvial and eolian materials. Wages soils are on upland flats, ridges and hills and have slopes of 0 to 9 percent. Average annual precipitation ranges from 13 to 19 inches and the mean annual temperature is about 48 degrees F.

Wages soils are similar to the Satanta, Ascalon, Rosebud and Stoneham soils. They are near the Satanta, Rosebud, Ascalon, Norka and Manter soils. Satanta, Ascalon and Manter soils have sola more than 15 inches thick. Rosebud soils have bedrock at depths of 20 to 40 inches. Stoneham soils have light colored surface layers. Norka soils have less than 15 percent fine sand or coarser.

A typical pedon of Wages loam is located 30 feet north and 1,025 feet west of the south quarter corner of section 15, T.10N., R.53W.

A1—0 to 4 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary. (4 to 6 inches thick)

B2t—4 to 11 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; common thin clay films on faces of peds, neutral (pH 7.2), clear smooth boundary. (5 to 10 inches thick)

B3ca—11 to 14 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; weak medium prismatic structure; hard, friable, few thin clay films on faces of peds; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks, moderately alkaline (pH 8.0); clear smooth boundary. (2 to 5 inches thick)

C1ca—14 to 30 inches; light gray (10YR 7/2) loam, brown (10YR 5/3) moist, massive, hard, friable; calcareous with visible calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8 2), gradual smooth boundary. (12 to 24 inches thick)

C2—30 to 60 inches, light gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable; calcareous; moderately alkaline (pH 8.0).

The solum is commonly 8 to 15 inches thick Depth to calcareous material is 6 to 13 inches Layers of gravelly sandy loam materials are common below 40 inches

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist and chroma of 2 or 3. It is a loam ranging to sandy loam and gravelly loam. Texture of the B2t horizon is clay loam or loam ranging to sandy loam or sandy clay loam.

Weld Series

The Weld series consists of deep, well drained soils that formed in calcareous, eolian loamy materials. Weld soils are on upland tablelands and have slopes of 0 to 3 percent. Average annual precipitation ranges from 13 to 17 inches and the mean annual temperature is about 47 degrees F.

Weld soils are similar to the Platner and Iliff soils. They are near the Rago and Platner soils. Platner soils have B2t horizons with more than 15 percent fine sand or coarser. Rago soils have dark colored surface layers extending below 20 inches and buried subsoils. Iliff soils have bedrock at depths of less than 40 inches.

A typical pedon of Weld loam is located 60 feet west and 130 feet south of the east quarter corner of section 7, T.8N., R.53W.

A11—0 to 4 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral (pH 7.0); clear smooth boundary (3 to 6 inches thick)

A12—4 to 7 inches, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; hard, friable; neutral (pH 7.0); clear smooth boundary. (2 to 3 inches thick)

B21t—7 to 10 inches; grayish brown (10YR 52) heavy silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure, hard, firm; common thin clay films on faces of peds, and in root channels and pores, mildly alkaline (pH 7.2); clear smooth boundary. (3 to 8 inches thick)

B22t—10 to 16 inches; brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 3/3) moist; strong medium and fine prismatic parting to strong fine angular blocky structure; very hard, firm; continuous thin clay films on faces of peds, in root channels and pores; mildly alkaline (pH 7.4); clear smooth boundary. (4 to 8 inches thick)

B3ca—16 to 18 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; hard, friable; thin patchy clay films on faces of peds, in root channels and pores; calcareous; moderately alkaline (pH 8.0), clear smooth boundary. (2 to 6 inches thick)

C1ca—18 to 32 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; massive, slightly hard, very friable; calcareous visible secondary calcium carbonate occurring as concretions and in thin seams and streaks; moderately alkaline (pH 8.4); clear smooth boundary (8 to 24 inches thick)

C2—32 to 41 inches; light gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable; calcareous; moderately alkaline (pH 8.4); gradual smooth boundary (8 to 20 inches)

C3—41 to 60 inches; very pale brown (10YR 8/3) sandy loam, pale brown (10YR 6/3) moist; massive; soft, very friable; calcareous; moderately alkaline (pH 8.4).

Contrasting IIC horizons consisting of gravelly coarse sand can occur below depths of 40 inches.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is commonly loam or very fine sandy loam. Texture of the B2t horizon includes clay loam, silty clay loam or clay. Texture of the C horizon is silt loam, loam, fine sandy loam or sandy loam.

Westplain Series

The Westplain series consists of deep, somewhat poorly drained soils that formed in calcareous, clayey alluvium underlain by mottled sand and gravel and deposited by the South Platte River. Westplain soils are on bottomlands and concave parts of low terraces. Slopes are 0 to 3 percent. Average annual precipitation ranges from 13 to 19 inches, and the mean annual temperature is about 47 degrees F.

Westplain soils are near the Alda and Hayford soils. The Alda soils have mottled sand and gravel at depths of 20 to 40 inches. The Hayford soils have B2t horizons and mottled sand and gravel at depths of 20 to 40 inches.

A typical pedon of Westplain silty clay loam is located 70 feet north and 1,495 feet east of the west quarter corner of section 7, T.10N., R.48W.

A11—0 to 8 inches, dark gray (10YR 4/1) heavy silty clay loam, black (10YR 2/1) moist; moderate medium granular structure, slightly hard, friable, sticky, plastic; calcareous, moderately alkaline (pH 8.0); gradual wavy boundary. (6 to 10 inches thick)

A12—8 to 14 inches; dark gray (10YR 4/1) heavy clay loam, black (10YR 2/1) moist; weak medium subangular blocky structure, hard, firm, sticky and plastic; calcareous; moderately alkaline (pH 8.0), clear wavy boundary. (6 to 10 inches thick)

AC—14 to 17 inches; brown (10YR 5/3) very gravelly clay loam, dark brown (10YR 3/3) moist, with common medium distinct strong brown (7.5YR 5/6) mottles, massive, hard, friable; 50 percent gravel; calcareous; moderately alkaline (pH 7.9); abrupt wavy boundary (0 to 6 inches thick)

IICg—17 to 60 inches, light gray (10YR 7/2) very gravelly sand, light brownish gray (10YR 6/2) moist, with many large prominent strong brown (7.5YR 5/6) mottles; single grained; loose dry and moist, 50 percent gravel; mildly alkaline (pH 7.6).

The mollic epipedon ranges from 7 to 20 inches thick. Depth to the sand and gravel substratum ranges from 14 to 20 inches These soils are calcareous in the upper part, but the substratum materials are commonly noncalcareous.

The A horizon has a color value of 4 or 5 dry, 2 or 3 moist and chroma of 1 or 2. Texture of the A horizon is commonly a clay loam ranging to silty clay loam or clay.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*5*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 16, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each

order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquents (*Hapl*, meaning simple horizons, plus *aquent*, the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies for the subgroup that is thought to typify the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, nonacid, mesic, Typic Haplaquents.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the Soils

This section discusses the factors of soil formation, relates them to the formation of soils in the area, and explains the processes of soil formation.

Soil is formed by the action of soil-forming processes on parent material that was deposited or accumulated by geologic forces. The characteristics of the soil are determined by the interaction of five factors of soil formation. Each of these factors modifies the effect of the others. The five interacting factors are: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the parent material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time these forces have acted on the parent material. All five of these factors are important, but, in different locations and under different conditions, some are more effective than others. In places where any one factor varies widely, different soils are formed. The five main factors of soil formation are discussed below.

Parent Materials

The soil of Logan County formed from many kinds of parent materials. Differences in physical, chemical and mineralogical properties of these materials have influenced soil formation. These parent materials also determine the texture, color, consistence and other soil profile characteristics to a large extent.

The parent materials within the area vary widely and are discussed in the following paragraphs.

Alluvium.—Alluvium is present as recent flood plain and bottomland deposits and as Pleistocene terrace deposits.

The recent flood plain deposits occur on low terraces and bottomlands adjacent to the channels of the South Platte River and its tributaries. These are highly stratified deposits ranging from sandy loams to clay and are underlain by sand and gravel at depths of 10 to 40 inches. Profile development on soils of these deposits is usually weak, and the soils are usually calcareous throughout. Fluctuating water tables are common in the deposits and result in mottling and gleyed conditions. Developing on these low terraces and bottomlands are the Alda, Loveland, and Hayford soils and Fluvaquents and Fluvaquentic Haplaquolls.

Alluvial deposits of the Pleistocene uplands are a result of past runoff erosion. With ages ranging from Pleistocene to Holocene, these deposits are characteristically better sorted and less stratified than those of the low flood plains. Textures are sandy loams, loam, and clay loam. Profile formation shows distinct horizonation, evidence of B horizons, and the development of weak lime accumulation in soils of these deposits. Boundaries between the higher terraces and low flood plains may be obscured by land leveling, cultivation, or roads and are best distinguished by the character of the alluvial deposits and the nature of the soils. Common on these terraces are the Nunn, Satanta, Manter, Haverson and Lebsack soils.

Eolian Sand Deposits.—There are extensive eolian sand deposits occupying an area that parallels the South Platte River on the south.

The deposits have accumulated chiefly during Pleistocene to Holocene time and commonly consist of noncalcareous well sorted pale brown sands and loamy sands derived from the flood plains of the South Platte River (*3*). They were transported and deposited by the prevailing northwesterly and southwesterly winds. The topography of the areas in which this parent material occurs is rolling sandhills. The deposits range from a few feet to nearly 100 feet thick.

Developing on these deposits are the Valent and Dailey soils.

Moderately Coarse Textured Eolian Deposits.—These deposits consist of calcareous and noncalcareous sandy loams deposited by wind. The calcareous deposits are most common to the north of the South Platte River and were derived from calcareous sandstone. The noncalcareous materials are most common on the south side of the river and were derived from materials blown out of flood plains of the South Platte River and larger tributaries.

The deposits vary in thickness from a thin mantle to several feet thick and occupy ridges, which are usually northwest trending, with undulating to rolling relief.

Manter, Vona and Ascalon soils are the dominant soils formed on the calcareous deposits north of the river. Julesburg and Haxtun soils dominate the noncalcareous deposits transitional between the eolian sand deposits and the hardlands south of the river.

Loess.—Loess deposits occur in the hardland areas of the county. They are chiefly of eolian origin and were deposited during the Late Pleistocene. The materials vary in thickness and generally overlie Tertiary outwash deposits or sandstone members of the Ogallala Formation. The origin of the deposits is the flood plains of large streams and rivers to the north or local alluvium from the silty Brule Formation.

The loess deposits are calcareous silt loam and loam grading into fine sandy loam with depth. In some areas, scattered fine gravel on the surface of these deposits gives evidence that the loess has been reworked by water to some degree.

Forming in the loess parent materials are Rago, Weld, Iliff, Norka, Keith, Ulysses, Kuma and Colby soils.

Calcareous Alluvial Materials of the Uplands.—The upland alluvial deposits are located in hardland areas throughout the county. They are generally of Tertiary and Pleistocene origin. These parent materials are calcareous and stratified. They have a range in texture from sandy loam to loam. Many show evidence of having been reworked by wind and water. In some deposits, scattered fine gravel occurs in the surface layers. Loess may also have formed a thin mantle on these deposits, or it may be mixed into the surface layers.

The thinner deposits of these parent materials commonly mantle the reddish colored gravel and calcareous sandstone of the Ogallala Formation.

Developing in the old alluvial deposits are the Platner, Stoneham, Wages, Ascalon, Manter, Rosebud and Altvan soils.

Gravel Deposits of Early Pleistocene and Late Tertiary Ages.—This group of materials includes reddish colored gravelly deposits of the Ogallala Formation, which are both calcareous and noncalcareous. The deposits occur as ridges that represent remnants of old high terraces or late Tertiary outwash deposits.

Commonly developing in these deposits are the Dix and Peetz soils.

Brule Siltstone and Chadron Sandy Clay Shale.—This parent material includes both residuum and transported material derived from siltstone, loamstone, and clay shale. The textures are commonly silt loam, loam, and clay loam. This material occurs in the northwestern part of the county and often gives rise to the badland topography occurring there.

The Brule siltstone is buff colored, soft, calcareous, and easily weathered. Soils developing from it are light colored and calcareous, most commonly silt loam and very fine sandy loam.

The Chadron shale is olive-gray, calcareous, laminated clay shale containing water soluble salts. Alkali salts also occur in some localities.

Developing in these parent materials are Epping, Keota, Mitchell and Midway soils.

Calcareous Sedimentary Rocks of the Late Cretaceous Age.—These parent materials include both transported material and residuum derived from clay shale and fine-grained sandstone. The textures are commonly calcareous loam and clay loam. These parent materials are common in the northwest and west central parts of Logan County, particularly in the watersheds of Pawnee, Cedar, Two Mile and Horsetail Creeks.

These parent materials contain some water soluble salts, and in some localities, alkali salts.

Developing in these parent materials are Renohill, Cushman, Midway, Shingle, and Stoneham soils.

Climate

Through its influence on the vegetation, the rate of biological activity, and the physical and chemical weathering of parent material, climate has been important in the development of the soils in Logan County. Soil temperature and moisture are the main factors. Such factors as wind velocity and humidity also have a significant influence.

The county has a semiarid continental climate. The average annual precipitation is 13 to 19 inches. The county has wide seasonal variations in temperature. The summer is usually warm and winter cold, but the average annual air temperature ranges from 46 to 48 degrees. The length of the growing season averages 145 days.

The amount of precipitation and variations in temperature are factors that contribute to the accumulation of organic matter in the soil, to the physical movement of substances in suspension or solution, and to controlling the rate of chemical processes.

The uplands in the northern and eastern parts of the county receive 17 to 19 inches of rainfall, and the western uplands and South Platte Valley receive from 13 to 17 inches. The limited amount of rainfall in the survey area has controlled the depth of calcium carbonate leaching. The depths to carbonates tend to be shallower in the western part of the county.

Because of relatively low rainfall, infrequent high temperatures, cool nights, and shallow frost penetration, the chemical and biological processes of soil formation proceed slowly. The amount of organic matter is lower in areas of low precipitation. As a result, the soils have thin surface layers and light colors.

Where the soils are dryfarmed or used for grazing, they are seldom wet below the depth of live roots except in very wet years. The low humidity causes a high loss of water through evaporation. This loss has influenced soil formation because it reduces the amount of water that percolates through the soil; hence, the depth of live roots and calcium carbonate leaching is relatively shallow.

Strong winds have influenced the formation of the soils generally and have caused local changes in individual farms and fields. In some areas, winds have removed much of the original surface soil from silty and sandy soils and have exposed the subsoil material and substrata.

Plant and Animal Life

Plants, micro-organisms, earthworms and other forms of plant and animal life on or in the soil influence soil formation. The kinds of plant cover and micro-organisms growing at any location are controlled mainly by soil temperature, soil moisture supply, and the physical and chemical character of the soil.

The native vegetation in Logan County consists primarily of tall, mid, and short grasses and scattered trees. The grasses have been more important than trees in soil formation. Roots penetrate the soil material and increase its permeability to air and water. As organic matter and roots decay, needed nutrients are released for plant use and soil organisms. Plants help to counteract leaching by bringing minerals upward from lower horizons.

The number and kinds of living micro-organisms are significant to the development of soils. The undecomposed organic matter in the soil provides food for micro-organisms and is changed by them into humus. Prairie dogs, gophers, badgers, and other burrowing animals are common in the county. They aid in mixing the soil materials by bringing up deeper material to the surface layer. Earthworms feed on organic matter and help to mix the soil materials. Worm casts increase the fertility of soils.

Man has affected the development of soils, mainly through farming practices, although soil manipulation for other purposes has also affected soil development.

Relief

In many areas relief is the most important factor in determining the kinds of soils that formed in a particular landscape. Relief affects the formation of soils through its influence on drainage, runoff, and erosion. Internal drainage and moisture content differ in areas of different relief. If the plant cover and the amount of rainfall are about the same in two areas, runoff is more rapid where slopes are steep than it is where they are nearly level. On the steeper slopes, there are greater runoff and movement of materials downslope through creep and erosion. Ridges and hilltops are more exposed to air currents than lower areas, and therefore are more susceptible to loss of moisture by evaporation.

The soils on steep slopes generally have thinner surface layers and less development in the subsoil than soils in nearly level areas. Unless a good vegetative cover is maintained, soil erosion may remove soil material faster than it forms. Also, where other factors are equal, the zone of calcium carbonate accumulation is nearer the surface in steep soils.

Soils with slight relief often retain more water to affect soil development because runoff is slower, and because they receive water from higher lying areas or from flooding. This additional moisture allows more rapid weathering and soil development.

Depressional areas tend to concentrate runoff waters. Soils in these positions receive more water than is normally supplied by precipitation, tend to have thicker, darker surface layers and sola, and are leached to greater depths.

Time

The formation of soil requires time, the length of time depending, to a large extent, on the kind of parent materials. In soils formed in residuum, the process of rock weathering and the formation of soil horizons in the weathered parent material generally occur simultaneously. In the transported, unconsolidated materials, such as loess or alluvium, soil formation can begin as soon as the materials are stabilized. A soil profile may be formed in some fresh materials within a few years; in other materials it may be centuries before a B horizon is formed. A long interval may pass even before parent materials can accumulate and horizon development can begin.

Frequently, the degree of development, or maturity, of a soil can best be evaluated by specific soil characteristics rather than by the length of time the soil has been developing. Soil characteristics commonly used to determine the comparative maturity of soils are thickness and color of the surface layer, degree of structure in the subsoil, evidence of the movement of clay downward in the soil, and the thickness of the solum.

Older soils normally have more distinct genetic horizons than younger soils. For example, in Logan County, older

soils, such as Iliff, Platner, and Weld, have a clay enrichment and horizons of calcium accumulation. Dailey, Haverson, Keota, and Mitchell lack distinct subsoil horizons.

References

(1) American Association of State Highway (and Transportation) Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Condra, G. E., E. C. Reed, and E. D. Gordon. 1950. Correlation of the pleistocene deposits of Nebraska. Nebr. Geol. Surv. Bull. 15A, 74 pp., illus.

(4) United States Department of Agriculture. 1951, Soil survey manual. U. S. Dept. Agric. Handb. 18, 503 pp., illus. (Supplements replacing pp. 173-188 issued May 1962)

(5) United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. Soil Conserv. Serv., 265 pp., illus. (Supplements issued March 1967, September 1968, April 1969.)

(6) United States Department of Agriculture. 1961. Land capability classification. U.S. Dept. Agric. Handb. 210, 21 pp.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess alkali. Excess exchangeable sodium. The resulting poor physical properties restrict the growth of plants.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime. Excess carbonates. Excessive carbonates, or lime, restrict the growth of some plants.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free,

water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gypsum. Hydrous calcium sulphate.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Landslide. The rapid downhill movement of a mass of soil and loose rock generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-alumina ratio. The molecular ratio of silica to alumina in soil, clay, or any alumino-silicate mineral.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.005 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitaion is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt*, *silt loam*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).