United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with University of Nebraska, Conservation and Survey Division

Soil Survey of Knox County, Nebraska

How To Use This Soil Survey

General Soil Map

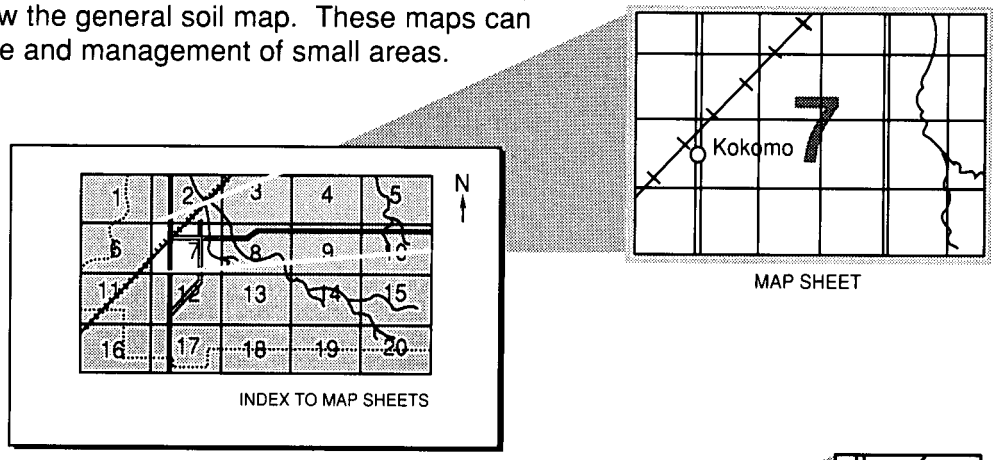
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

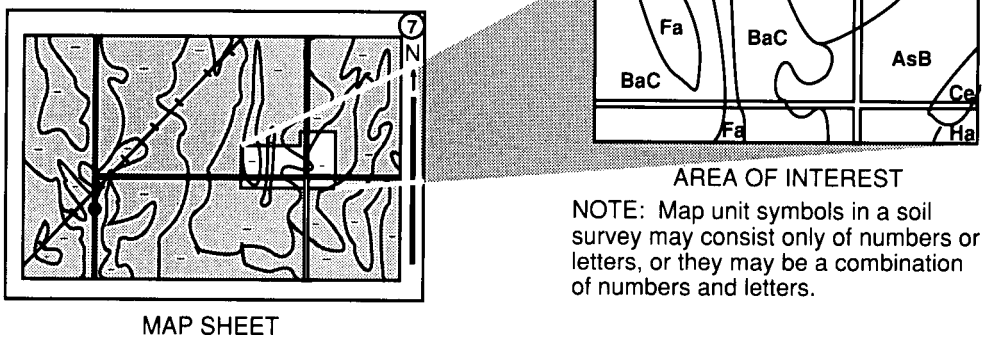
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1987. Soil names and descriptions were approved in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1989. This survey was made cooperatively by the Natural Resources Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Lower Niobrara, Lewis and Clark, and Lower Elkhorn Natural Resources Districts.

Cover: Aerial view of the Niobrara State Park at the junction of the Niobrara and Missouri Rivers.

Contents

Index to map units iv
Summary of tables vii
Foreword ix
General nature of the county 1
How this survey was made 4
Map unit composition 5
General soil map units 7
Soil descriptions 7
Detailed soil map units 21
Soil descriptions 21
Prime farmland 140
Use and management of the soils 143
Crops and pasture 143
Rangeland 147
Windbreaks and environmental plantings 154
Native woodland 157
Recreation 157
Wildlife habitat 159
Engineering 162
Soil properties 167
Engineering index properties 167
Physical and chemical properties 168
Soil and water features 170
Engineering index test data 171
Classification of the soils 173
Soil series and their morphology 173
Albaton series 173
Alcester series 174
Aowa series 175
Barney series 175
Bazile series 176
Betts series 177
Blendon series 177
Blyburg series 178
Boel series 178
Boelus series 179
Bristow series 179
Brunswick series 180
Butler series 181
Coleridge series 181
Crofton series 182
Elsmere series 182
Eltree series 183
Fillmore series 184
Gavins series 184
Gibbon series 185
Hobbs series 186
Hord series 186
Inavale series 186
Kezan series 187
Labu series 188
Longford series 189
Loretto series 189
Lynch series 190
Mariaville series 190
Meadin series 191
Moody series 192
Nora series 193
Obert series 193
Onawa series 194
O'Neill series 194
Ord series 195
Ortello series 196
Orwet series 196
Paka series 197
Percival series 198
Redstoe series 198
Sansarc series 199
Scott series 200
Shell series 200
Simeon series 201
Solomon series 201
Thurman series 202
Trent series 202
Valentine series 203
Verdel series 204
Verdigre series 204
Factors of soil formation 207
References 211
Glossary 213
Tables 221

Index to Map Units

Aa—Albaton silty clay, 0 to 2 percent slopes..... 21
Ab—Albaton silty clay, ponded, 0 to 1 percent slopes..... 22
AcC—Alcester silt loam, 2 to 6 percent slopes..... 23
AcD—Alcester silt loam, 6 to 11 percent slopes..... 24
Ao—Aowa silt loam, 0 to 2 percent slopes..... 25
Ar—Aowa silt loam, channeled, 0 to 2 percent slopes..... 26
Ba—Barney loam, 0 to 2 percent slopes..... 27
Bd—Bazile loamy fine sand, 0 to 2 percent slopes..... 28
BdC—Bazile loamy fine sand, 2 to 6 percent slopes..... 30
BdD—Bazile loamy fine sand, 6 to 11 percent slopes..... 31
Bn—Bazile loam, 0 to 2 percent slopes..... 32
BnC—Bazile loam, 2 to 6 percent slopes..... 33
BnD—Bazile loam, 6 to 11 percent slopes..... 34
BoD2—Betts clay loam, 6 to 11 percent slopes, eroded..... 35
BoE2—Betts clay loam, 11 to 15 percent slopes, eroded..... 36
BoF—Betts clay loam, 15 to 30 percent slopes..... 37
BoG—Betts clay loam, 30 to 60 percent slopes..... 38
Bp—Blendon fine sandy loam, 0 to 2 percent slopes..... 38
Br—Blyburg silt loam, 0 to 2 percent slopes..... 39
Bs—Boel loamy fine sand, 0 to 2 percent slopes..... 40
Bt—Boelus loamy sand, 0 to 2 percent slopes..... 41
BtC—Boelus loamy sand, 2 to 6 percent slopes..... 42
BtD—Boelus loamy sand, 6 to 11 percent slopes..... 43
BvG—Bristow silty clay, 30 to 60 percent slopes..... 45
BwD—Brunswick fine sandy loam, 6 to 11 percent slopes..... 45
BxE—Brunswick-Paka complex, 6 to 15 percent slopes..... 46
BxF—Brunswick-Paka complex, 15 to 30 percent slopes..... 48
By—Butler silt loam, 0 to 2 percent slopes..... 49
Co—Coleridge silt loam, 0 to 2 percent slopes..... 50
CrC2—Crofton silt loam, 2 to 6 percent slopes, eroded..... 51
CrD2—Crofton silt loam, 6 to 11 percent slopes, eroded..... 52
CrE2—Crofton silt loam, 11 to 15 percent slopes, eroded..... 54
CrF—Crofton silt loam, 15 to 30 percent slopes..... 55
CrG—Crofton silt loam, 30 to 60 percent slopes..... 56
CsC2—Crofton-Nora complex, 2 to 6 percent slopes, eroded..... 56
CsD2—Crofton-Nora complex, 6 to 11 percent slopes, eroded..... 58
CsE2—Crofton-Nora complex, 11 to 15 percent slopes, eroded..... 59
CtD2—Crofton-Thurman complex, 6 to 11 percent slopes, eroded..... 60
CtE2—Crofton-Thurman complex, 11 to 15 percent slopes, eroded..... 62
CtF—Crofton-Thurman complex, 15 to 30 percent slopes..... 63
Ef—Elsmere loamy fine sand, 0 to 2 percent slopes..... 64
Eh—Elsmere fine sandy loam, 0 to 2 percent slopes..... 65
Et—Eltree silt loam, 0 to 2 percent slopes..... 66
EtC—Eltree silt loam, 2 to 6 percent slopes..... 67
Fm—Fillmore silt loam, 0 to 1 percent slopes..... 68
Fu—Fluvaquents, silty, 0 to 2 percent slopes..... 69
GaG—Gavins silt loam, 30 to 60 percent slopes..... 70
Gf—Gibbon silt loam, 0 to 2 percent slopes..... 70
Hd—Hobbs silt loam, 0 to 2 percent slopes..... 71
Ho—Hord silt loam, 0 to 2 percent slopes..... 72
If—Inavale fine sand, 0 to 2 percent slopes..... 73
Ig—Inavale fine sand, channeled, 0 to 2 percent slopes..... 74
Ih—Inavale loamy fine sand, 0 to 2 percent slopes..... 75
Im—Inavale fine sandy loam, 0 to 2 percent slopes..... 76
Ke—Kezan silt loam, 0 to 2 percent slopes..... 77

KzB—Kezan silt loam, channeled, 0 to 2 percent slopes ... 78
LbD—Labu silty clay, 6 to 11 percent slopes ... 79
LcF—Labu-Sansarc complex, 11 to 30 percent slopes ... 80
LhC2—Longford silty clay loam, 2 to 6 percent slopes, eroded ... 81
LhD2—Longford silty clay loam, 6 to 11 percent slopes, eroded ... 82
Lk—Loretto fine sandy loam, 0 to 2 percent slopes ... 83
LkC—Loretto fine sandy loam, 2 to 6 percent slopes ... 84
LyF—Lynch-Bristow complex, 11 to 30 percent slopes ... 84
LzD—Lynch-Verdel complex, 6 to 11 percent slopes ... 85
MbF—Mariaville very fine sandy loam, 3 to 30 percent slopes ... 87
MeB—Meadin sandy loam, 0 to 3 percent slopes ... 87
MgF—Meadin-O'Neill complex, 3 to 30 percent slopes ... 88
Mm—Moody loam, 0 to 2 percent slopes ... 90
MmC—Moody loam, 2 to 6 percent slopes ... 91
Mo—Moody silty clay loam, 0 to 2 percent slopes ... 92
MoC—Moody silty clay loam, 2 to 6 percent slopes ... 92
NoC—Nora silty clay loam, 2 to 6 percent slopes ... 93
NoD—Nora silty clay loam, 6 to 11 percent slopes ... 94
NoE—Nora silty clay loam, 11 to 15 percent slopes ... 95
Ob—Obert silt loam, wet, 0 to 2 percent slopes ... 96
Od—Onawa silty clay, 0 to 2 percent slopes ... 97
Oe—O'Neill sandy loam, 0 to 2 percent slopes ... 98
OeC—O'Neill sandy loam, 2 to 6 percent slopes ... 99
Og—Ord fine sandy loam, 0 to 2 percent slopes ... 100
Oh—Ord loam, 0 to 2 percent slopes ... 101
Or—Ortello fine sandy loam, 0 to 2 percent slopes ... 102
OrC—Ortello fine sandy loam, 2 to 6 percent slopes ... 103
Ou—Orwet loam, 0 to 2 percent slopes ... 104
Ph—Paka loam, 0 to 2 percent slopes ... 105
PhC—Paka loam, 2 to 6 percent slopes ... 106
PhD—Paka loam, 6 to 11 percent slopes ... 107
PhE—Paka loam, 11 to 15 percent slopes ... 108
Pt—Percival silty clay, 0 to 2 percent slopes ... 108
RdD—Redstoe silt loam, 6 to 11 percent slopes ... 109
RgF—Redstoe-Gavins complex, 11 to 30 percent slopes ... 110
SaG—Sansarc silty clay, 30 to 60 percent slopes ... 112
Sc—Scott silt loam, 0 to 1 percent slopes ... 112
Sh—Shell silt loam, 0 to 2 percent slopes ... 113
SsF2—Simeon sand, 6 to 30 percent slopes, eroded ... 114
StC—Simeon loamy sand, 0 to 6 percent slopes ... 115
SuC—Simeon sandy loam, 0 to 6 percent slopes ... 116
SvF—Simeon-Thurman complex, 6 to 30 percent slopes ... 117
Sw—Solomon silty clay, 0 to 2 percent slopes ... 118
TfB—Thurman fine sand, 0 to 3 percent slopes ... 119
TfC—Thurman fine sand, 3 to 6 percent slopes ... 120
ThB—Thurman loamy fine sand, 0 to 3 percent slopes ... 122
ThC—Thurman loamy fine sand, 3 to 6 percent slopes ... 123
ToB—Thurman fine sandy loam, 0 to 3 percent slopes ... 125
ToD—Thurman fine sandy loam, 3 to 11 percent slopes ... 126
ToF—Thurman fine sandy loam, 11 to 30 percent slopes ... 127
Tr—Trent silt loam, 0 to 2 percent slopes ... 128
Tx—Trent silt loam, moderately wet, 0 to 2 percent slopes ... 129
UbF—Urban land, 3 to 30 percent slopes ... 130
VaD—Valentine fine sand, 3 to 9 percent slopes ... 130
VaE—Valentine fine sand, 9 to 24 percent slopes ... 131
Ve—Verdel silty clay, 0 to 2 percent slopes ... 132
VeC—Verdel silty clay, 2 to 6 percent slopes ... 133
VeD—Verdel silty clay, 6 to 11 percent slopes ... 134
VfC—Verdigre fine sandy loam, 2 to 6 percent slopes ... 135

VfD—Verdigre fine sandy loam, 6 to 11 percent slopes 136
VfF—Verdigre fine sandy loam, 11 to 30 percent slopes 137
VgC—Verdigre loam, 2 to 6 percent slopes..... 137
VgD—Verdigre loam, 6 to 11 percent slopes..... 138
VgF—Verdigre loam, 11 to 30 percent slopes..... 139

Summary of Tables

Temperature and precipitation (table 1) 222

Freeze dates in spring and fall (table 2) 223

Growing season (table 3) 223

Acreage and proportionate extent of the soils (table 4) 224

Prime farmland (table 5) 226

Land capability and yields per acre of crops and pasture (table 6) 227

Capability classes and subclasses (table 7) 233

Rangeland productivity and characteristic plant communities (table 8) 234

Windbreaks and environmental plantings (table 9) 246

Recreational development (table 10) 253

Wildlife habitat (table 11) 260

Building site development (table 12) 266

Sanitary facilities (table 13) 275

Construction materials (table 14) 283

Water management (table 15) 290

Engineering index properties (table 16) 298

Physical and chemical properties of the soils (table 17) 307

Soil and water features (table 18) 313

Engineering index test data (table 19) 318

Classification of the soils (table 20) 320

Foreword

This soil survey contains information that can be used in land-planning programs in Knox County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as 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 soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

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Soil Survey of Knox County, Nebraska

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United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with
the University of Nebraska, Conservation and Survey Division

KNOX COUNTY is in northeastern Nebraska (fig. 1). The total area of the county is 728,679 acres, or about 1,138 square miles. The county is bordered on the north by South Dakota, on the west by Boyd and Holt Counties, Nebraska, on the south by Antelope and Pierce Counties, Nebraska, and on the east by Cedar County, Nebraska. The Missouri River forms the northern boundary of the county.

Farming is the main occupation in the county. Feed grain, forage crops, and cash-grain crops are grown. The major livestock are cattle and swine. The county also has a few herds of dairy cattle. Most residents of the county are employed in agriculture or agriculturally related occupations.

This soil survey updates the survey of Knox County published in 1930 *(3)*. It provides more detail because of aerial photography and has more interpretive information.

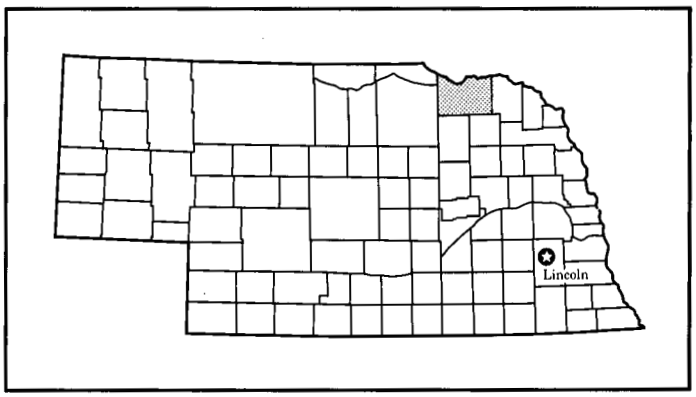

Figure 1.—Location of Knox County in Nebraska.

General Nature of the County

This section provides general information about Knox County. It describes history and development; climate; geology and ground water; and physiography, relief, and drainage.

History and Development

The first permanent settlement in the area now known as Knox County was made in 1856 near the present site of Niobrara. The county was established as L'Eau Qui Court County by the territorial legislature in 1857 and was organized the same year. The name was changed to Knox County in 1873. In 1883, the area north of the Niobrara River, formerly part of the Dakota Territory, was added. Early settlers came mainly from the central and eastern states. Most of these settlers were born in America.

According to records, the Lewis and Clark Expedition made the first authentic government survey of the land in 1804. In 1846, the Mormons traveled through the Niobrara area. They dug the Mormon Canal near the mouth of the Niobrara River. Newell Knight and a band of followers from Nauvoo, Illinois, spent the winter in the Niobrara area. The winter was hard, and many settlers died even though the Indians provided them with food.

An important location for crossing the Missouri River

during cattle drives was in an area near the town of Niobrara. Later, a ferry crossing was operated with a series of ropes. A ferry at Santee was powered by a horse treadmill. The ferries were forced to cease operation because of water fluctuations in the river resulting from dams opening and closing.

The location for the town of Niobrara changed twice. The first change was in 1881 because of flooding caused by the Missouri River. The second change occurred in 1977 because the Gavins Point Dam, which was built in 1955, raised water levels in the town. The courthouse was also moved because of the flooding. The town of Center was established when people voted on a geographic midpoint in the county.

In 1866, a reservation for the Santee Sioux Indians was established from 115,000 acres of the Nebraska Territory.

The large rugged area of bluffs and wooded draws in the northeastern part of the county known as "Devil's Nest" is believed to have developed from rapid erosion. This area may have served as a hideout for Jesse and Frank James after they robbed a bank in Northfield, Minnesota.

The population of Knox County was 9,534 in 1990. It had been 19,110 in 1930. Bloomfield has a population of 1,181. Creighton, the largest city, has a population of 1,223. Crofton, Wausa, Verdigre, Niobrara, Santee, Center, Winnetoon, Verdel, and Bazile Mills each have fewer than 1,000 residents. Center is the county seat.

Climate

Knox County is cold in winter. Summers are quite hot but have occasional cool spells. Precipitation during the winter frequently occurs as snowstorms. During the warm months precipitation mainly consists of showers, often heavy, that occur when warm, moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Niobrara, Nebraska, in the period 1951 to 1987. 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 23 degrees F and the average daily minimum temperature is 12 degrees. The lowest temperature on record, which occurred at Niobrara on January 29, 1966, is -31 degrees. In summer, the average temperature is 74 degrees and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred on July 27, 1952, is 109 degrees.

Growing degree days are shown in table 1. They 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 (50 degrees F). 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.

The total annual precipitation is about 23 inches. Of this, more than 17 inches, or nearly 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 14 inches. The heaviest 1-day rainfall during the period of record was 7.2 inches on June 7, 1967. Thunderstorms occur on about 49 days each year.

The average seasonal snowfall is about 29 inches. The greatest snow depth at any one time during the period of record was 27 inches. On the average, 27 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 14 miles per hour, in spring.

Tornadoes and severe thunderstorms occasionally occur. These storms are local in extent and of short duration. They can result in sparse damage in narrow areas. Hailstorms occur at times during the warmer part of the year. They occur in irregular patterns and in relatively small areas.

Geology and Ground Water

The bedrock in Knox County consists of layers of sandstone, chalk, and shale of Cretaceous age. Two rock units of Late Cretaceous age are exposed within the county. The Niobrara Formation is the lower of these units. It is composed of chalk, calcareous shale, and shaly limestone. It is overlain by the Pierre Shale, a formation consisting of bentonitic shale, calcareous shale, shaly chalk, and claystone.

In the topographically higher parts of the county, remnants of the Ogallala Group of Miocene (Tertiary) age overlie the bedrock. This rock unit is composed of beds of sand, lime-cemented sandstone, and sandy silt that has areas of lime.

Continental ice sheets advanced over the eastern part of Knox County at least twice during the Pleistocene (Quaternary) age. When these ice sheets melted, they left deposits of clayey and silty till

throughout most of the area east of a line between the present sites of the towns of Niobrara and Creighton. Glacial meltwater deposited sand and clayey sand west of this line. Layers of wind-deposited limy silt (loess) mantle these ice-age deposits. The lower part of these wind-deposited sediments is pale pink. It is known as Loveland loess. The upper part is grayish yellow. It is called Peorian loess. Most of the upland soils formed in these loess deposits.

The Missouri River, which forms the northern boundary of Knox County, has cut a valley through the Pierre Shale and into the Niobrara Formation. The lower areas of Ponca Creek and the Niobrara River also are incised into the Niobrara Formation. Verdigris Creek, which flows into the Niobrara River, and Bazile, Lost, and Weigand Creeks, which flow into the Missouri River, are the principal tributary streams draining the upland part of the county. Stream terraces and flood plains in the valleys of the Missouri and Niobrara Rivers and Ponca Creek and other creeks are underlain by stream-deposited sediments (alluvium) of Quaternary age.

Ground-water supplies that are sufficient for irrigation are mostly limited to those parts of the county that are underlain by the Ogallala Group and by coarse textured Quaternary deposits. In other areas ground-water supplies that are sufficient for domestic and livestock use are in sand lenses of till and alluvial deposits.

In fractured areas the Niobrara Formation is a potential source of water. This water, however, is likely to be very alkaline. Another potential source of water is the Dakota Sandstone of Early Cretaceous age. Wells must be drilled to a depth of 500 feet or more to tap this water.

Many springs occur along valley sides. They provide natural outlets for water in the Ogallala Group and Quaternary deposits.

Physiography, Relief, and Drainage

The county includes a wide variety of exposed geologic materials. The surface features are the result of wind and water acting on these materials. The general character of the surface relief in a particular area is related to the severity of geologic erosion to which the soil in that area has been subjected, to the erosive resistance of the formations that were exposed, and to the surface features of the formations at the time they were covered by the later deposits.

Geologic erosion has been most severe in the western and northern parts of the county. It has resulted in the development of three major physiographic areas—the loess hills, the Holt Table, and the Pierre shale plains and hills. About 60 percent of the county, in the southeastern part, is covered by the loess hills area. The northern boundary of this area extends diagonally across the central part of the county from southwest to northeast. Throughout most of this area, the mantle of loess is intact. In places the surface relief is nearly level or gently undulating. The nearly level areas make up 10 percent or less of the loess hills area. Gently rolling to steep areas make up the rest of the loess hills area. The eastern part of the county is characterized by round-topped hills and divides. The drainage pattern is fairly intricate. Only a comparatively small percentage of the surface is rough and gullied. The relief in the areas that have a mantle of loess probably is not so much the result of erosion but is caused by the nature of the surface layer beneath the loess.

In the central and western parts of the county, the mantle of loess has been severely eroded by the headwater of Bazile and Verdigris Creeks. These creeks are entrenched at a depth of 150 to 200 feet below the general level of the uplands. A few small, tablelike remnants of loess remain, but most of the loess material has been carved into a succession of sharp divides and narrow, steep-sided valleys. The loess has been eroded in large areas, exposing the underlying formation. In areas where the exposed material is sand, drainage channels are poorly developed and the land surface is gently rolling or hummocky. In areas where erosion has cut through the loose sand into the underlying sandstone formation of Tertiary age, such as areas adjacent to the headwater of Merriman and Verdigris Creeks, the relief is pronounced. Most of the lower valley slopes are gradual, but they become steeper as elevation increases. Although the tops of most of the divides are narrow, few of them are sharp. In areas where the divides are covered by loess, they have surfaces that are nearly level to extremely rough and broken, depending on the severity of erosion to which they have been subjected. In areas where the divides are covered by sandy material, they are rolling or hummocky.

The physiographic area known as the Holt Table makes up about 12 percent of the county. This area extends into the county from the west. It is in all of the upland areas south of the Niobrara River, west of Verdigris Creek, and north of the loess hills.

The surface features in the area of the Holt Table in Knox County were largely formed by wind. The loess mantle has been removed from all but about 15 percent of the Holt Table, and the underlying sand deposits have been exposed. These sand deposits, although fairly stable because of the large admixture of loess, have been reworked and shifted by the winds, resulting in a strongly undulating or gently rolling appearance.

The surface is modified in places by hummocky sands that have been deposited into low mounds and ridges, by nearly level areas of the loess mantle, and by strongly rolling or hilly areas where stream erosion has gullied the surface of the loess remnants or has cut through both the loess and sand into the underlying Pierre shale. In places, drifting sand has modified the irregularities formed by water, and in most areas the surface features are well rounded.

The area of Pierre shale plains and hills makes up about 18 percent of the county. It is fairly continuous across the northern edge of the county. It includes the uplands between the Niobrara and Missouri Rivers in the northwestern part of the county, the upland areas in the Verdigris Creek drainage basin south of Verdigre in the west-central part of the county, and upland areas between the loess hills and the Missouri River that range from 1 to 7 miles in width. The Pierre shale plains and hills have been more severely eroded than either the loess hills or the Holt Table. Areas of the Pierre shale plains and hills include some of the roughest surfaces in the county but also include rather large areas where the surface is undulating or rolling. The more gentle relief is in areas of loess between the Niobrara and Missouri Rivers. In these areas, a thin covering of loess covers about 40 percent of the surface, including the higher divides. Throughout the remainder of the area, erosion has removed the loess mantle and the underlying glacial deposits and exposed the Pierre shale. The relief in areas of the shale ranges from strongly sloping to extremely rough and broken. In many of the deeper valleys, the shale has been eroded and the streams have carved vertical channel walls in the underlying chalk rock. Vertical exposures of chalk rock also are numerous on the lower slopes of the high, blufflike escarpment that borders the Missouri River.

The stream terraces and flood plains occur along the streams. The stream terraces occur at several distinct levels, depending on the depth to which the streams had cut prior to deposition of the alluvial material. The highest and most extensive development of stream terraces is between the flood plains and uplands on the south side of the Niobrara River. In these areas several of the stream terraces are more than a mile wide and are 75 to 90 feet above the stream channel. Lower and smaller stream terraces border the flood plains along the Missouri River. Low stream terraces occur along the Niobrara River, Bazile Creek, and Verdigris Creek and some of their tributaries. The stream terraces are nearly level or gently undulating, except in areas where the surface is slightly hummocky and sandy.

The flood plains make up the lowest parts of the landscape. The surface of the flood plains is only a few feet above the streams. The broadest flood plains are along the Missouri River. They are discontinuous and, in places, are as much as 2 miles wide. Continuous strips, ranging from one-eighth mile to about one-half mile in width, are along most of the creeks and their larger tributaries. The flood plain is nearly level but is modified in places by stream channels and remnant stream terraces.

Knox County has an average elevation of about 1,600 feet above sea level. The lowest elevation, approximately 1,220 feet above sea level, is in an area where the Missouri River crosses the northeast corner of the county. The highest elevation, about 2,000 feet above sea level, is in the uplands in the southeastern part of the county. Niobrara has an elevation of 1,248 feet above sea level; Verdigre, 1,345; Creighton, 1,600; Winnetoon, 1,645; Bloomfield, 1,703; and Wausa, 1,780.

Drainage is northward to the Missouri River through Beaver, Weigand, Bazile, and Verdigris Creeks and their tributaries. A small area in the northwestern part of the county drains eastward to the Missouri River through the Niobrara River and Ponca Creek. Areas in a few townships in the southeast corner of the county drain southward to the Elkhorn River.

The rivers, creeks, and tributaries provide ample drainage throughout practically all parts of the county. In large areas, surface runoff is rapid and erosion is severe. Areas that are poorly drained are in small, scattered, basinlike depressions on the more nearly level parts of the uplands *(3)*. Poorly drained soils are along most of the creeks in the county, especially at the upper end of drainage systems where there is seepage and the stream channel is not deep.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of

soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so

complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map 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 soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Moody-Bazile-Trent Association

Very deep, nearly level to gently sloping, well drained and moderately well drained, loamy and silty soils; on uplands and stream terraces

This association consists of soils on ridgetops and side slopes along upland drainageways. These soils formed in silty and sandy sediments and loess. Slopes range from 0 to 6 percent.

This association has a total area of about 118,100 acres, or about 17 percent of the county. It is about 39 percent Moody soils, 29 percent Bazile soils, 17 percent Trent soils, and 15 percent minor soils.

The Moody soils are on flat ridgetops and smooth side slopes in the uplands. These well drained soils are nearly level to gently sloping. Typically, the surface layer is dark grayish brown, firm silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 41 inches thick. The upper part is grayish brown, and the lower part is pale brown and very pale brown. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

The Bazile soils are on ridgetops and side slopes in the uplands and on stream terraces along drainageways. These well drained soils are nearly level to gently sloping. Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is dark grayish brown, friable clay loam about 10 inches thick. The subsoil is about 14 inches thick. The upper part is grayish brown, firm silty clay loam, and the lower part is pale brown, friable clay loam. The underlying material to a depth of more than 60 inches is very pale brown sand.

The Trent soils are in swales on uplands. These well drained and moderately well drained soils are nearly level. Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 12 inches thick. The subsoil is firm silty clay loam about 34 inches thick. The upper part is dark grayish brown, and the lower part is brown. The underlying material to a depth of more than 60 inches is pale brown, calcareous silty clay loam.

Of minor extent in this association are the Crofton, Kezan, Nora, Paka, and Thurman soils. Crofton soils are calcareous at or near the surface. They are on gently sloping to strongly sloping ridgetops and side slopes. Kezan soils are poorly drained. They are on bottom land along narrow drainageways below the major soils. Nora and Paka soils are shallower to carbonates than the Moody soils. They are on gently sloping to strongly sloping side slopes. Paka soils have weakly cemented siltstone bedrock below a depth of 40 inches. Thurman soils are sandy. They are on gently sloping side slopes.

The major soils in this association are used for diversified farming. Most farms combine grain and livestock enterprises. More than half of the area is dry-farmed. Corn, soybeans, oats, and alfalfa are the main crops. Some areas are irrigated with sprinkler systems. Water for irrigation is supplied by deep wells (fig. 2). A few small areas support introduced grasses or native grasses used for grazing or hay. Some farms have

Figure 2.—Center-pivot irrigation in an area of the Moody-Bazile-Trent association.

dairy herds. Some livestock is fattened in feedlots and then marketed. The forage crops generally are used as winter feed for cattle.

The main management concerns in cultivated areas are reducing the rate of runoff, controlling water erosion, conserving soil moisture, and maintaining soil fertility and tilth. The efficient use of irrigation water is a management concern in irrigated areas. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and conserves moisture. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed

each year help to maintain or improve the range condition.

2. Crofton-Nora-Alcester Association

Very deep, gently sloping to very steep, well drained, silty soils; on uplands and foot slopes

This association consists of soils on ridgetops and side slopes along intermittent drainageways. These soils formed in loess and silty colluvial and alluvial sediments. Slopes range from 2 to 60 percent (fig. 3).

This association has a total area of about 231,900 acres, or about 33 percent of the county. It is about 50 percent Crofton soils, 16 percent Nora soils, 14 percent Alcester soils, and 20 percent minor soils.

The Crofton soils are on ridgetops, side slopes, and short breaks along drainageways. These well drained soils are gently sloping to very steep. Typically, the surface layer is grayish brown, friable, calcareous silt loam about 6 inches thick. Below this is a transitional layer of brown, friable, calcareous silt loam about 5 inches thick. The underlying material to a depth of more than 60 inches is pale brown and very pale brown, calcareous silt loam.

The Nora soils are on smooth divides and long smooth side slopes along intermittent drainageways. These well drained soils are gently sloping to moderately steep. Typically, the surface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer also is dark grayish brown, friable silty clay loam. It is about 5 inches thick. The subsoil is about 27 inches thick. The upper part is brown, friable silty clay loam, and the lower part is pale brown, friable, calcareous silt loam. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

The Alcester soils are on short, smooth, slightly concave foot slopes below areas of the Crofton and Nora soils and along narrow, intermittent drainageways. These well drained soils are gently sloping and strongly sloping. Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 16 inches thick. The subsoil is about 37 inches thick. The upper part is brown, friable silt loam, and the lower part is pale brown, firm, calcareous silty clay loam.

Of minor extent in this association are the Aowa, Bazile, Betts, Moody, and Thurman soils. Aowa soils are silty. They are on bottom land along narrow drainageways below the Alcester soils. Bazile soils formed in loamy material over sandy sediments. They are on smooth ridgetops and side slopes. Betts soils formed in glacial till. They are on side slopes below the Crofton soils. Moody soils are silty. They are commonly on smooth, gentle slopes above the Crofton and Nora soils. Thurman soils are somewhat excessively drained and sandy. They are on ridgetops and gently sloping to steep side slopes.

The major soils in this association are used for diversified farming. Most farms combine grain and livestock enterprises. Most of the gently sloping to moderately steep areas are dry-farmed. Corn, soybeans, oats, and alfalfa are the main crops. Some areas are irrigated with sprinkler systems. Water for irrigation is supplied by deep wells. Corn and soybeans are the main irrigated crops. Most areas of the steep and very steep Crofton soils support native grasses used for grazing. A few steep areas support bromegrass or alfalfa and are used for grazing or hayland. Some farms have dairy herds. Some livestock is fattened in feedlots and then marketed.

The main management concerns in cultivated areas are reducing the rate of runoff, controlling water erosion, conserving soil moisture, and maintaining fertility and tilth. The efficient use of irrigation water is a management concern in irrigated areas. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and conserves moisture. Proper grazing use, timely deferment of grazing and haying, and a system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

3. Betts-Crofton-Alcester Association

Very deep, gently sloping to very steep, well drained, loamy and silty soils; on uplands and foot slopes

This association consists of soils on ridgetops and side slopes along intermittent drainageways. These soils formed in glacial till, loess, and colluvial and alluvial sediments. Slopes range from 2 to 60 percent.

This association has a total area of about 18,700 acres, or about 3 percent of the county. It is about 64 percent Betts soils, 18 percent Crofton soils, 5 percent Alcester soils, and 13 percent minor soils.

The Betts soils are on short to long side slopes and breaks along drainageways. These well drained soils are strongly sloping to very steep. Typically, the surface layer is very dark grayish brown, friable clay loam about 5 inches thick. The subsoil is light brownish gray, friable clay loam about 21 inches thick. The underlying material to a depth of more than 60 inches is light gray clay loam. The soils are calcareous throughout. A few pebbles and stones are on the surface and throughout the profile.

The Crofton soils are on narrow ridgetops and short

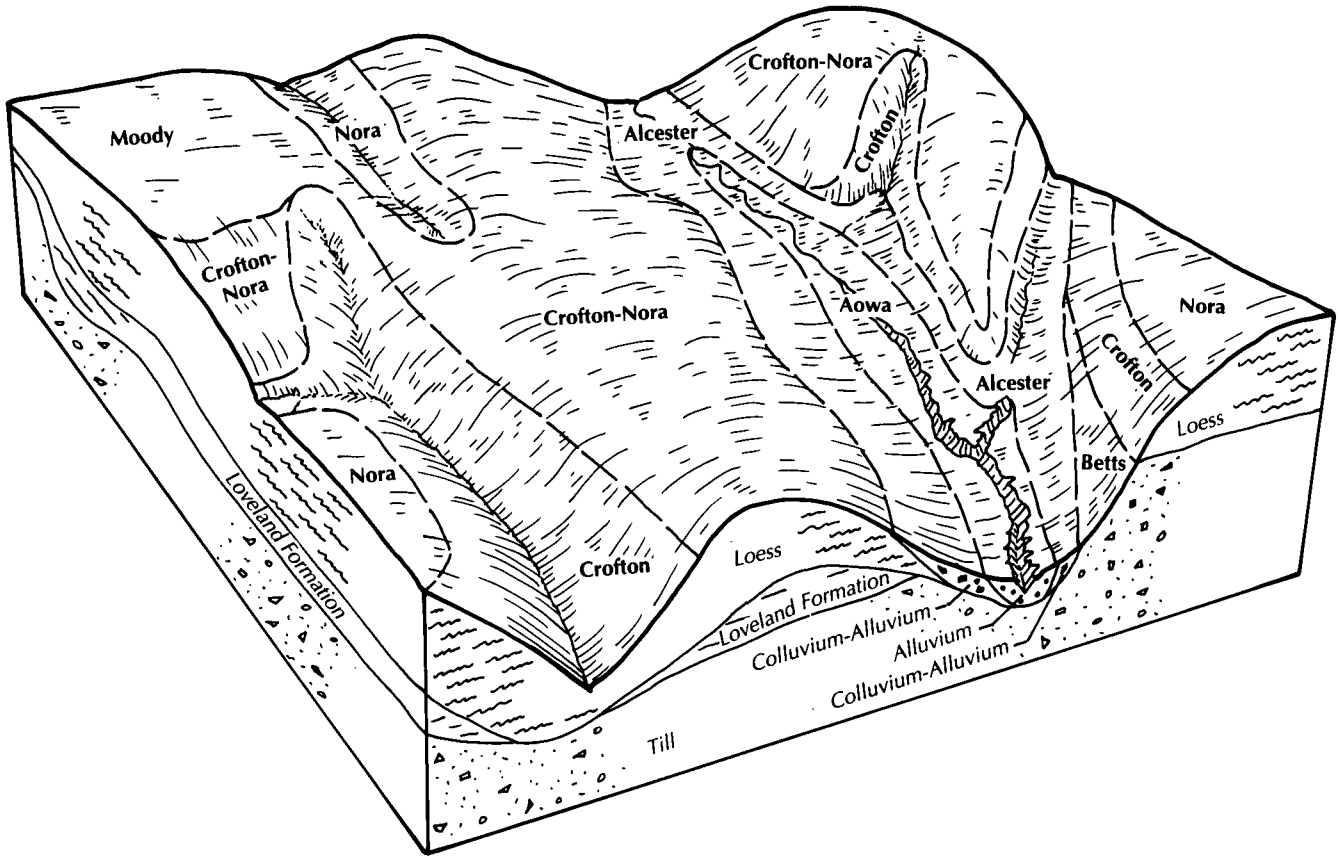

Figure 3.—Typical pattern of soils and parent material in the Crofton-Nora-Alcester association.

to long side slopes. These well drained soils are gently sloping to very steep. Typically, the surface layer is grayish brown, friable silt loam about 6 inches thick. Below this is a transitional layer of brown, friable silt loam about 5 inches thick. The underlying material to a depth of more than 60 inches is friable silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soils are calcareous throughout.

The Alcester soils are on smooth, slightly concave foot slopes below the Betts and Crofton soils and along narrow, intermittent drainageways. These well drained soils are gently sloping and strongly sloping. Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 16 inches thick. The subsoil is about 37 inches thick. The upper part is brown, friable silt loam, and the lower part is pale brown, firm, calcareous silty clay loam.

Of minor extent in this association are the Brunswick, Meadin, Paka, Simeon, and Thurman soils. Brunswick soils are moderately deep over weakly cemented sandstone bedrock. They are commonly on side slopes below the Betts and Crofton soils. Meadin soils are excessively drained and are shallow over gravelly coarse sand. They are on ridgetops and the upper side slopes between areas of the Betts and Crofton soils. Paka soils are loamy. They have weakly cemented siltstone bedrock below a depth of 40 inches. They are commonly on the lower side slopes. Simeon soils are excessively drained and sandy. They are on ridgetops and the upper side slopes. Thurman soils are somewhat excessively drained and sandy. They are on side slopes.

The major soils in this association are used for diversified farming. Most farms combine livestock and grain enterprises. The most common livestock enterprises are cow-calf herds and dairy operations. About half of this association supports native grasses and is used for range. The steep and very steep areas are too erosive to be used as cropland. Some of the strongly sloping to steep areas are used as hayland. The other areas of this association are used for cultivated crops or support introduced grasses used for grazing. Corn, alfalfa, and oats are the main crops.

Water erosion is a hazard. Constructing dams can help to control erosion. The main management concerns in cultivated areas are reducing the rate of runoff, controlling water erosion, conserving soil moisture, and maintaining fertility and tilth. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and conserves moisture. Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

4. Thurman-Bazile-Ortello Association

Very deep, nearly level to steep, somewhat excessively drained and well drained, sandy and loamy soils; on uplands and stream terraces

This association consists of soils on uplands and in valleys. These soils formed in loamy and sandy sediments, loess, and sandy eolian material. Slopes range from 0 to 30 percent (fig. 4).

This association has a total area of about 91,000 acres, or about 13 percent of the county. It is about 44 percent Thurman soils, 10 percent Bazile soils, 8 percent Ortello soils, and 38 percent minor soils.

The Thurman soils are on undulating or smooth slopes on uplands or stream terraces. These somewhat excessively drained soils are nearly level to steep. Typically, the surface soil is very friable loamy fine sand about 14 inches thick. It is grayish brown in the upper part and dark grayish brown in the lower part. The next layer is grayish brown, loose fine sand about 4 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown fine sand in the upper part and very pale brown sand in the lower part.

The Bazile soils are on ridgetops and side slopes in the uplands and on stream terraces. These well drained soils are nearly level to strongly sloping. Typically, the surface layer is grayish brown, very friable loamy fine sand or friable loam about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand or friable clay loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is pale brown, very friable loamy fine sand or firm silty clay loam, and the lower part is pale brown, friable silt loam. The underlying material to a depth of more than 60 inches is very pale brown sand.

The Ortello soils are on ridgetops and side slopes in the uplands and on stream terraces. These well drained soils are nearly level to gently sloping. Typically, the surface layer is grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsoil is friable fine sandy loam about 26 inches thick. It is grayish brown in the upper part and pale brown in the lower part. The underlying material to a depth of more than 60 inches is very pale brown loamy sand.

Of minor extent in this association are the Blendon, Boelus, Crofton, Loretto, and Simeon soils. Blendon soils have a thick, dark solum. They are in upland swales. Boelus soils have a sandy surface soil and loamy underlying material. They are on side slopes in the uplands and on stream terraces. Crofton soils are silty and calcareous. They are on ridgetops, side slopes, and short, steep breaks along upland drainageways. Loretto soils are loamy. They are on upland ridgetops and side slopes. Simeon soils are excessively drained and sandy. They are on the upper side slopes in the uplands.

The major soils in this association are used for diversified farming. Most farms combine grain and livestock enterprises. More than half of the nearly level to strongly sloping areas are used for dryland farming or as irrigated cropland. Corn, soybeans, oats, rye, and alfalfa are the main dryland crops. Irrigation is mainly by center-pivot systems. Water for irrigation is supplied by deep wells. Corn, soybeans, and alfalfa are the main irrigated crops. The areas of pasture or native grasses are used for grazing or hayland. A few farms have dairy herds. Some livestock is fattened in feedlots and then marketed. The forage crops generally are used as winter feed for cattle.

The main hazard in cultivated areas is soil blowing. Water erosion also is a hazard on the long, smooth side slopes. In some years, insufficient rainfall is a limitation affecting the production of dryland crops. Management concerns include maintaining fertility and organic matter content. A conservation tillage system that leaves crop residue on the surface helps to control soil blowing. Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

5. Valentine-Simeon-Thurman Association

Very deep, nearly level to steep, excessively drained and somewhat excessively drained, sandy soils; on uplands

This association consists of soils on nearly level to steep uplands. These soils formed in sandy eolian material and sandy alluvium or outwash material. Slopes range from 0 to 30 percent.

This association has a total area of about 19,300 acres, or about 3 percent of the county. It is about 34 percent Valentine soils, 22 percent Simeon soils, 21

Figure 4.—Typical landscape in an area of the Thurman-Bazile-Ortello association.

percent Thurman soils, and 23 percent minor soils.

The Valentine soils are on uplands and occur mostly as areas of sandhills. These excessively drained soils are mainly gently sloping to steep. Typically, the surface layer is grayish brown, loose fine sand about 6 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sand.

The Simeon soils are on upland divides and on side slopes along entrenched drainageways. These excessively drained soils are nearly level to steep. Typically, the surface layer is grayish brown, loose sand about 5 inches thick. Below this is a transitional layer that is also grayish brown, loose sand. It is about 8 inches thick. The underlying material to a depth of more than 60 inches is sand. It is very pale brown in the upper part and white in the lower part.

The Thurman soils are on upland ridgetops and side slopes and in swales. These somewhat excessively drained soils are nearly level to strongly sloping. Typically, the surface layer is grayish brown, loose fine sand about 6 inches thick. The subsurface layer is dark grayish brown, loose fine sand about 7 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 5 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sand.

Of minor extent in this association are the Inavale, Ortello, and Verdigre soils. Inavale soils are sandy. They are in narrow areas of bottom land along drainageways. Ortello and Verdigre soils are loamy. Ortello soils are in upland swales. They are lower on the landscape than the major soils. Verdigre soils

formed in shale. They are on side slopes below the major soils.

Farms and ranches in this association are mainly cow-calf livestock enterprises. Most of the acreage supports native grasses used for range. Some of these areas are mowed for hay, which is used as winter livestock feed. A few areas are used for dryland farming or as irrigated cropland. Irrigation is by sprinkler systems. Water for irrigation is supplied by deep wells. Corn, oats, and alfalfa are the main crops.

Soil blowing is a severe hazard in cultivated areas. Using a system of conservation tillage, stripcropping, and seeding cover crops in the fall can help to control soil blowing. In some years, insufficient rainfall is a limitation affecting the production of dryland crops. The main management concern in areas of range is the production of grasses. Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

6. Simeon-Meadin-O'Neill Association

Very deep, nearly level to steep, excessively drained and well drained, sandy and loamy soils that are shallow and moderately deep over gravelly coarse sand; on uplands and stream terraces

This association consists of soils on uplands and stream terraces. These soils formed in sandy alluvium or outwash material and sandy or loamy material deposited over gravelly coarse sand. Slopes range from 0 to 30 percent.

This association has a total area of about 11,200 acres, or about 1 percent of the county. It is about 37 percent Simeon soils, 20 percent Meadin soils, 15 percent O'Neill soils, and 28 percent minor soils.

The Simeon soils are on narrow ridgetops and side slopes in the uplands and on stream terraces. These excessively drained soils are nearly level to steep. Typically, the surface layer is grayish brown, loose sand about 5 inches thick. Below this is a transitional layer that is also grayish brown, loose sand. It is about 8 inches thick. The underlying material to a depth of more than 60 inches is sand. It is very pale brown in the upper part and white in the lower part. A few pebbles are throughout the profile.

The Meadin soils are on ridgetops and broad side slopes in the uplands and on stream terraces. These excessively drained soils are gently sloping to steep. Typically, the surface layer is dark grayish brown, friable sandy loam about 7 inches thick. Below this is a transitional layer of dark grayish brown, friable gravelly sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is gravelly coarse sand. It is light yellowish brown in the upper part and very pale brown in the lower part.

The O'Neill soils are on convex ridgetops and side slopes in the uplands and on stream terraces. These well drained soils are gently sloping to steep. Typically, the surface layer is grayish brown, friable sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, friable sandy loam about 3 inches thick. The subsoil is brown, friable sandy loam about 14 inches thick. The underlying material to a depth of more than 60 inches is very pale brown gravelly coarse sand.

Of minor extent in this association are the Brunswick, Inavale, Paka, Thurman, and Valentine soils. Brunswick and Paka soils are lower on the landscape than the major soils. Brunswick soils formed in material weathered from weakly cemented sandstone bedrock. Paka soils are loamy. They are on upland side slopes. Inavale soils are in narrow areas of sandy bottom land along drainageways. Thurman and Valentine soils have less medium and coarse textured sand than the major soils. They commonly are higher on the landscape than the major soils. They are hummocky.

Farms and ranches in this association are mainly a combination of grain and livestock enterprises. Some farms have dairy herds. Most of this association supports native grasses used for range. The soils are commonly too steep, too sandy, or too droughty to be farmed. Alfalfa, oats, and rye are the main dryland crops. In most areas the water supply is sufficient for livestock and domestic use but not for irrigation. Some gravel is mined from open pits.

Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Soil blowing is a hazard in cultivated areas. Water erosion is a hazard. The low available water capacity is a limitation affecting crop production in most years. Keeping crop residue on the surface, stripcropping, and minimizing tillage help to control erosion and conserve soil moisture.

7. Brunswick-Paka-Simeon Association

Moderately deep, deep, and very deep, nearly level to steep, well drained and excessively drained, loamy and sandy soils; on uplands and stream terraces

This association is in an area of dissected uplands. The narrow ridges are gently sloping to strongly sloping, and the side slopes are moderately steep to steep. The drainageways are mainly intermittent or are spring-fed tributaries of Verdigris Creek. The soils in this

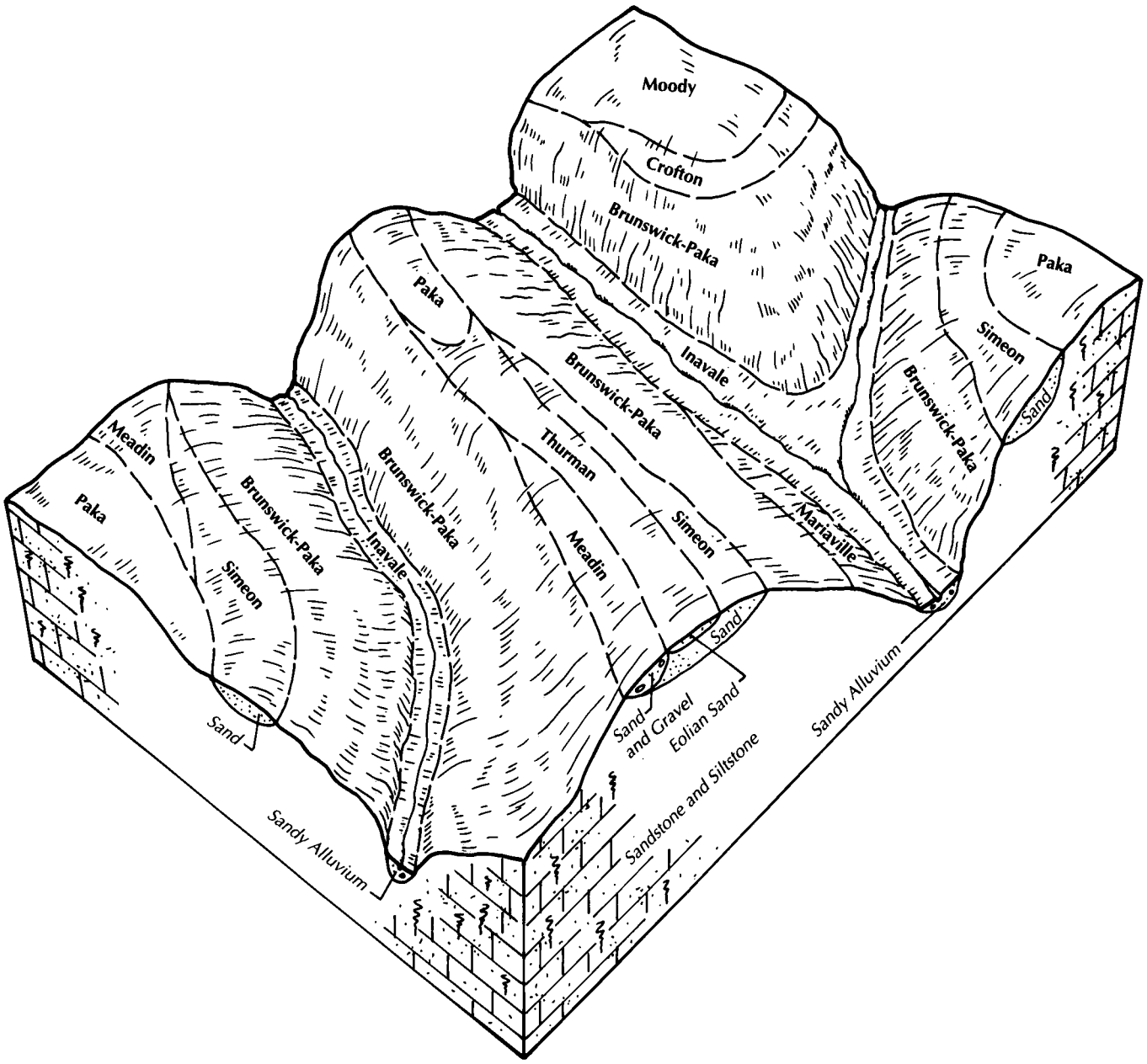

Figure 5.—Typical pattern of soils and parent material in the Brunswick-Paka-Simeon association.

association formed in material weathered from sandstone bedrock or siltstone bedrock and sandy alluvium or outwash material. Slopes range from 0 to 30 percent (fig. 5).

This association has a total area of about 53,700 acres, or about 8 percent of the county. It is about 34 percent Brunswick soils, 29 percent Paka soils, 9 percent Simeon soils, and 28 percent minor soils.

The Brunswick soils are on upland side slopes. These well drained soils are strongly sloping to steep. Typically, the surface layer is dark grayish brown, friable fine sandy loam about 5 inches thick. The subsoil is friable, fine sandy loam about 11 inches thick. The upper part is grayish brown, and the lower part is light gray. The underlying material is light gray fine sandy loam about 20 inches thick. White, weakly cemented sandstone bedrock is at a depth of about 36 inches.

The Paka soils are on ridgetops and side slopes along drainageways. These well drained soils are gently sloping to steep. Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 3 inches thick. The subsoil is about 22 inches thick. The upper part is light brownish gray, firm silty clay loam, and the lower part is light gray, firm, calcareous silty clay loam. The underlying material is light gray and white, calcareous silty clay loam about 22 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 54 inches.

The Simeon soils are on ridgetops and side slopes in the uplands and on some stream terraces along drainageways. These excessively drained soils are nearly level to steep. Typically, the surface layer is grayish brown, loose sand about 5 inches thick. Below this is a transitional layer that is also grayish brown, loose sand. It is about 8 inches thick. The underlying material to a depth of more than 60 inches is sand. It is very pale brown in the upper part and white in the lower part.

Of minor extent in this association are the Crofton, Inavale, Mariaville, Meadin, Moody, and Thurman soils. Crofton and Mariaville soils are in landscape positions similar to those of the major soils. Crofton soils are silty and calcareous throughout. Mariaville soils have weakly cemented siltstone bedrock at a depth of 10 to 20 inches. Inavale and Thurman soils are sandy. Inavale soils are on bottom land along drainageways below the major soils. Thurman and Meadin soils are higher on the landscape than the major soils. Thurman soils are slightly hummocky. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Moody soils are silty. They formed in loess on the ridges and broad divides.

Farms and ranches in this association are mainly a combination of grain and cow-calf livestock enterprises. Some farms have dairy herds. Most of this association supports native grasses used for range. The steep areas are too erosive for farming. Some areas are mowed for hay. Cultivated areas are nearly level to moderately steep. Alfalfa, oats, and rye are the main dryland crops. In the few areas that are irrigated, alfalfa and corn are the main crops. Irrigation wells can be drilled in only a few areas of this association. The water from wells generally is sufficient for livestock and domestic use, except in the northern part of the county.

Water erosion and soil blowing are hazards in cultivated areas. Keeping an adequate cover of crop residue on the surface helps to control erosion and conserves soil moisture. Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

8. Labu-Lynch-Sansarc Association

Moderately deep and shallow, strongly sloping to very steep, well drained, clayey soils; on uplands

This association consists of soils on ridgetops and side slopes in the uplands. These soils formed in material weathered from shale. Slopes range from 6 to 60 percent (fig. 6).

This association has a total area of about 105,100 acres, or about 15 percent of the county. It is about 40 percent Labu soils, 14 percent Lynch soils, 11 percent Sansarc soils, and 35 percent minor soils.

The Labu soils are on long side slopes and smooth, rounded knolls. They are moderately deep and formed in dark shale bedrock. These well drained soils are strongly sloping to steep. Typically, the surface layer is dark grayish brown, firm, calcareous silty clay about 4 inches thick. The subsoil is about 21 inches thick. The upper part is grayish brown, very firm, calcareous silty clay, and the lower part is light olive gray, very firm, calcareous clay. The underlying material is light olive gray, calcareous clay about 9 inches thick. Light gray, calcareous shale bedrock is at a depth of about 34 inches. In some areas the soils are noncalcareous.

The Lynch soils are on long side slopes and smooth, rounded knolls. They are moderately deep and formed in light colored shale bedrock. These well drained soils are strongly sloping to steep. Typically, the surface layer is light brownish gray, firm, calcareous silty clay about 5 inches thick. The subsoil is firm, calcareous silty clay about 15 inches thick. It is light brownish gray in the upper part and mixed light gray and light yellowish brown in the lower part. The underlying material is mixed light olive gray and olive yellow, calcareous clay about 15 inches thick. Mixed pale yellow and light gray, calcareous shale bedrock is at a depth of about 35 inches. The soils have a high content of gypsum in seams below a depth of 12 inches.

The Sansarc soils are on very steep side slopes, steep shoulders, and narrow ridgetops. They are shallow and formed in dark shale bedrock. Catsteps are common. Typically, the surface layer is dark grayish brown, very firm, calcareous clay about 4 inches thick. Below this is a transitional layer of olive gray, very firm, calcareous clay about 5 inches thick. The underlying material is light olive gray, calcareous clay about 9 inches thick. Light gray, calcareous shale bedrock is at a depth of about 18 inches.

Of minor extent in this association are the Bristow, Eltree, Gavins, Redstoe, Verdel, and Verdigre soils. Bristow soils are on very steep side slopes, steep

Figure 6.—Typical landscape in an area of the Labu-Lynch-Sansarc association.

knolls, and narrow ridgetops. They are shallow over light colored shale bedrock and contain a high percentage of gypsum. Eltree soils are very deep and loamy. They are on stream terraces below the major soils. Gavins soils are on the steep and very steep lower side slopes. They are shallow over siltstone bedrock. Redstoe soils are on the lower, strongly sloping to steep side slopes. They are moderately deep and loamy over siltstone bedrock. Verdel soils are on foot slopes or nearly level stream terraces. They have a thick, dark surface layer and a very deep, clayey profile. Verdigre soils are on side slopes and ridgetops. They are deep. They have a loamy surface layer and clayey underlying material.

Large farms and ranches in this association are mainly cow-calf livestock enterprises. Some combine livestock and grain enterprises. Some farms have dairy herds. About 75 percent of this association supports native grasses and is used for range. Most of the areas that support native grasses are too steep and erosive for use as cropland. Some of the moderately steep and steep areas are used as hayland. The rest of this

association is used for dry-farming. Alfalfa, grain sorghum, oats, and wheat are the main crops. A few areas support introduced grasses. These grasses are cut for hay or are used for grazing. In most areas runoff that collects in farm ponds provides water for livestock. In some areas springs and artesian wells provide water for livestock. Wells in this area are very deep and generally yield water of poor quality. In many places pipelines that originate in areas outside the association provide a source of water for domestic and livestock use.

Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Water erosion and droughtiness are management concerns in areas that are cultivated or used as range. Gully erosion is a hazard. It can be overcome by constructing dams. Landslides are a severe hazard along roads.

9. Aowa-Shell-Kezan Association

Very deep, nearly level, well drained and poorly drained, silty soils; on bottom land

This association consists of soils on bottom land along the North Fork of the Elkhorn River and along other major creeks and their tributaries. These soils formed in silty alluvium. They are subject to occasional and frequent flooding. Slopes range from 0 to 2 percent.

This association has a total area of about 32,800 acres, or about 4 percent of the county. It is about 33 percent Aowa soils, 23 percent Shell soils, 15 percent Kezan soils, and 29 percent minor soils.

The Aowa soils are on bottom land along narrow drainageways. They are well drained and subject to occasional and frequent flooding. Typically, the surface layer is grayish brown, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 30 inches is stratified grayish brown and pale brown, calcareous silt loam. Below this, to a depth of 54 inches, is a buried soil that is very dark grayish brown silt loam. The next layer to a depth of more than 60 inches is stratified grayish brown and dark grayish brown silt loam.

The Shell soils are in wide areas of bottom land characterized by deeply entrenched stream channels. The soils are well drained and subject to occasional flooding. Typically, the surface layer is dark grayish brown, friable silt loam about 5 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 19 inches thick. The underlying material, to a depth of about 33 inches, is grayish brown silt loam. Below this, to a depth of 50 inches, is a buried soil that is dark grayish brown silty clay loam. The next layer to a depth of more than 60 inches is grayish brown silty clay loam.

The Kezan soils are along narrow drainageways. They are poorly drained and subject to occasional and frequent flooding. Depth to an apparent seasonal high water table ranges from about 1 foot in wet years to about 3 feet in dry years. Typically, the surface layer is stratified grayish brown and brown, mottled, friable, calcareous silt loam about 10 inches thick. The underlying material extends to a depth of more than 60 inches. It is stratified grayish brown and light brownish gray, mottled, calcareous silt loam in the upper part; dark gray silt loam in the next part; and dark gray, mottled silty clay loam in the lower part.

Of minor extent in this association are the Coleridge, Hobbs, Hord, and Obert soils. Coleridge, Hobbs, and Obert soils are on bottom land that is occasionally flooded. Coleridge soils are silty and somewhat poorly drained. The well drained Hobbs soils are noncalcareous and silty. Obert soils are very poorly drained and have a thick, dark surface layer. The well drained Hord soils are silty. They are on nearly level stream terraces.

Farms in this association are a combination of grain and livestock enterprises. Most of the acreage is used for cultivated crops. Corn, soybeans, and alfalfa are the main crops. Most areas are dry-farmed. Some areas are irrigated. Both gravity and center-pivot irrigation systems can be used. The wetter areas along narrow drainageways and stream channels are mainly used for pastures of introduced or native grasses. Some farms have dairy herds. Some livestock is fattened in feedlots.

The hazard of flooding and small areas of poorly drained and very poorly drained soils are the main management concerns. In some years the wetness delays fieldwork in the spring. Maintaining fertility is an additional management concern in cultivated areas. A few areas are suitable only for wildlife habitat.

10. Fluvaquents-Albaton-Solomon Association

Very deep, nearly level, poorly drained and very poorly drained, silty and clayey soils; on bottom land

This association consists of soils on bottom land along the Missouri River. These soils formed in silty and clayey alluvium. They are subject to occasional and frequent flooding. Slopes range from 0 to 2 percent.

This association has a total area of about 11,500 acres, or about 1 percent of the county. It is about 46 percent Fluvaquents, 13 percent Albaton soils, 7 percent Solomon soils, and 34 percent minor soils.

The Fluvaquents are on bottom land along the Missouri River. They are very poorly drained and are

under water most of the year because of frequent flooding, a very high water table, or a combination of both. The seasonal high water table is about 2 feet above the surface in wet years to about 1 foot below the surface in dry years. The soils are stratified silty material to a depth of more than 60 inches. Typically, the surface layer is black, mottled silt loam mixed with partially decayed organic matter. It is about 10 inches thick. The underlying material extends to a depth of more than 60 inches. It is dark gray, mottled silt loam in the upper part and light gray or white, stratified silt loam in the lower part.

The Albaton soils are commonly in wide areas of bottom land. They are poorly drained and very poorly drained and are subject to occasional and frequent flooding. A seasonal high water table is about 6 inches above the surface in wet years to about 3 feet below the surface in dry years. Typically, the surface layer is dark grayish brown, very firm, calcareous silty clay about 6 inches thick. The underlying material extends to a depth of more than 60 inches. It is stratified grayish brown and light brownish gray, mottled, calcareous silty clay in the upper part; gray, mottled, calcareous clay in the next part; and light gray and light olive gray, mottled, calcareous silty clay in the lower part.

The Solomon soils are in the slightly higher areas of bottom land. They are poorly drained and subject to occasional flooding. A seasonal high water table is at the surface in wet years or is at a depth of about 2 feet in dry years. Typically, the surface layer is dark grayish brown, very firm, calcareous silty clay loam about 6 inches thick. The subsurface layer is dark gray, mottled, very firm, calcareous silty clay about 14 inches thick. The subsoil is grayish brown, mottled, very firm, calcareous silty clay about 20 inches thick. The underlying material to a depth of more than 60 inches is grayish brown, mottled, calcareous silty clay.

Of minor extent in this association are the Barney, Blyburg, Gibbon, Inavale, and Onawa soils. Barney soils are in low areas and in old stream channels that are frequently flooded. They are poorly drained and have a calcareous, loamy surface layer and sandy underlying material. Blyburg and Inavale soils are in the higher areas of bottom land that are rarely flooded. Blyburg soils are well drained and are calcareous and loamy. Inavale soils are excessively drained and sandy. Gibbon soils are in the slightly higher areas of bottom land that are occasionally flooded. They are somewhat poorly drained and are calcareous and loamy. Onawa soils are in the slightly higher areas of bottom land that are rarely flooded. They are somewhat poorly drained. They formed in calcareous, clayey alluvium over loamy underlying material.

Farms and ranches in this association generally have their headquarters in adjoining associations. They are mainly a combination of cow-calf herds and grain enterprises. Corn, soybeans, alfalfa, and some small grain are the main crops. Nearly all of the very poorly drained soils are covered by trees, brush, and hydrophytic vegetation. Areas close to the rivers are used mostly for recreational activities. The areas of Fluvaquents also provide excellent habitat for wetland wildlife. The very poorly drained areas along the rivers are used for range.

The main management concerns are the hazard of flooding and the wetness. Tilling in the spring is generally delayed because of the seasonal high water table. Maintaining fertility is an additional management concern in cultivated areas. In areas of poorly drained and very poorly drained soils that support native grasses, timely deferment of grazing during the spring helps to maintain or improve the range condition and prevents the development of bogs.

11. Inavale-Barney-Orwet Association

Very deep, nearly level, excessively drained and poorly drained, sandy and loamy soils; on bottom land

This association consists of soils on bottom land along the Niobrara River and Verdigris Creek. These soils formed in sandy and loamy alluvium. They are subject to flooding. Slopes range from 0 to 2 percent.

This association has a total area of about 14,195 acres, or about 2 percent of the county. It is about 54 percent Inavale soils, 12 percent Barney soils, 10 percent Orwet soils, and 24 percent minor soils.

The Inavale soils are in areas of high bottom land that are rarely flooded and in dissected stream channels that are frequently flooded. These soils are excessively drained. Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 9 inches thick. The underlying material to a depth of more than 60 inches is light gray fine sand that has thin strata of fine sandy loam.

The Barney soils are in the lower areas of bottom land that are frequently flooded. These soils are poorly drained. A seasonal high water table is at the surface in wet years or at a depth of about 2 feet in dry years. Typically, the surface layer is gray, mottled, friable, calcareous loam about 7 inches thick. Below this is a transitional layer that is also gray, mottled, friable, calcareous loam. It is about 3 inches thick. The underlying material extends to a depth of about 60 inches. It is light gray, mottled fine sand in the upper part and light gray sand in the lower part. In some places the lower layers have strata of gravelly coarse sand.

The Orwet soils are in areas of bottom land that are rarely flooded. They are poorly drained. Depth to an apparent seasonal high water table ranges from about 1 foot in wet years to about 3 feet in dry years. Typically, the surface layer is dark gray, friable, calcareous loam about 10 inches thick. The subsurface layer also is dark gray, friable, calcareous loam. It is about 9 inches thick. Below this is a transitional layer of light brownish gray, mottled, very friable loamy sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light gray, mottled sand.

Of minor extent in this association are the Boel, Elsmere, Hord, and Ord soils. Boel and Ord soils are in areas of low bottom land that are occasionally flooded. Boel and Elsmere soils are somewhat poorly drained and sandy. Ord soils are also somewhat poorly drained. They have a calcareous, loamy surface layer and sandy underlying material. Elsmere soils are in areas of high bottom land that are rarely flooded. Ord soils are nearly level, well drained, and silty. They are on stream terraces.

Farms in this association are livestock and grain enterprises. More than half the acreage supports native grasses used as range. Trees and shrubs are scattered throughout some of the areas used for grazing and provide excellent habitat for wildlife. The Barney soils are typically too wet for use as cropland, but some areas are mowed for hay. Some of the larger areas of Inavale soils are used as cropland. Alfalfa, corn, grain sorghum, and oats are the main crops. Wells on the bottom land along the Niobrara River are used to irrigate a few areas, but most of the water used for irrigation is pumped from streams. Cow-calf herds or dairy cows are the main livestock enterprises.

The main management concerns are the wetness and the hazard of flooding. Maintaining fertility also is a management concern. The high water table is a limitation in areas of the Barney and Orwet soils. Dikes may be needed in some areas to control streambank erosion and reduce the damage caused by flooding. Soil blowing is a hazard in cultivated areas of the Inavale soils. Keeping most of the crop residue on the surface helps to control soil blowing. Proper grazing use, timely deferment of grazing, restricted grazing during wet periods, and timely haying can improve the range condition.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Crofton silt loam, 15 to 30 percent slopes, is a phase of the Crofton series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Labu-Sansarc complex, 11 to 30 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land, 3 to 30 percent slopes, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

Aa—Albaton silty clay, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is in areas of bottom land along the Missouri and Niobrara Rivers and Verdigris Creek. It formed in calcareous, clayey alluvium. It is subject to occasional flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very firm silty clay about 6 inches thick. The underlying material to a depth of more than 60 inches is dominantly stratified, mottled silty clay and clay. It is grayish brown and light brownish gray in the upper part and gray, light gray, and light olive gray in the lower part. In some places shell fragments are in the underlying material. The soil is calcareous throughout. In a few areas the surface layer is silty clay loam. In a few places the lower part of the underlying material is silty clay loam, silt loam, or fine sand.

Included with this soil in mapping are small areas of Fluvaquents and Gibbon, Kezan, and Onawa soils. Fluvaquents are in the lower landscape positions. They are covered by shallow water most of the year. Gibbon, Kezan, and Onawa soils are higher on the landscape than the Albaton soil. Gibbon and Onawa soils are

somewhat poorly drained. Gibbon and Kezan soils have more silt and less clay than the Albaton soil. Onawa soils are loamy in the lower part. Included soils make up 5 to 15 percent of the unit.

Permeability is very slow in the Albaton soil. The available water capacity is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is low. Tilth is poor. The soil can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential is high. The water intake rate is very low. The seasonal high water table ranges from a depth of about 1 foot during wet years to about 3 feet during dry years. It is at a lower depth during the growing season. In areas of the Missouri River valley in Knox County, the soil is flooded for extended periods during some years because of excess water released from the Fort Randall Dam.

About half of the acreage of this soil is cultivated. Most of the remaining acreage supports introduced grasses or legumes and is used for grazing or hay. A small acreage supports native grasses and a few scattered trees and is used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. The excessive wetness and poor tilth are the main limitations. They sometimes delay tillage in the spring. Because of the wetness in the spring, many areas are tilled in the fall. Tilth can be maintained by tilling only when the soil is at the proper moisture content. Cracking can occur during droughty periods. These cracks can contribute to crop stress, injure the roots of plants, and accelerate drying. Cultivation can minimize the cracking. A system of conservation tillage that leaves part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil and including grasses and legumes in the cropping sequence can improve or maintain organic matter content and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Because of the seasonal high water table, wetness is the main limitation. The soil is suited to gravity irrigation systems but is not suited to sprinkler irrigation systems. Applying a system of conservation tillage that leaves part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. The rate of water application should be low because of the very low intake rate of the soil.

This soil is suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. Reed canarygrass and Garrison foxtail are suitable species. Overgrazing or grazing when the soil is wet can result in surface compaction and poor tilth. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range and hay. Continuous heavy grazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to keep the native plants in good condition.

This soil is suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. The species selected for planting should be those that are tolerant of a high water table. In some years, planting may not be possible until the water table has dropped below the surface. The cracking that occurs in summer because of the high shrink-swell potential and the weeds and grasses that compete with the trees for moisture are hazards. Light cultivation and irrigation can minimize the cracking. Weeds and grasses can be controlled by proper site preparation; by cultivation between the tree rows when the water table is at its lowest level; by cultivation practices, such as hand hoeing or rototilling; or through application of appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the wetness, the flooding, and the very slow permeability. A suitable alternative site should be selected. Sewage lagoons are not suitable in areas of this soil unless they are protected from flooding. The soil is not suited to building site development because of the flooding, the wetness, and the high shrink-swell potential. Constructing roads on suitable, well compacted fill material and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding and wetness. The low strength and the high shrink-swell potential should be considered when roads and streets are designed. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is IIIw-1, dryland and irrigated. The range site is Clayey Overflow, and the windbreak suitability group is 2W.

Ab—Albaton silty clay, ponded, 0 to 1 percent slopes. This very deep, nearly level, very poorly drained soil is in low areas of bottom land that were once channels of the Missouri and Niobrara Rivers and Verdigris Creek. It formed in calcareous, clayey

alluvium. It is frequently flooded. Areas range from 5 to 200 acres in size.

Typically, the surface layer is gray, very firm silty clay about 9 inches thick. The underlying material to a depth of more than 60 inches is silty clay. The upper part is grayish brown, and the lower part is light brownish gray. The soil is calcareous throughout. The underlying material is mottled. Some small, higher lying areas near the boundary of the map unit are better drained. Subhorizons of silty clay loam, silt loam, or fine sand are in some areas.

Included with this soil in mapping are small areas of Fluvaquents and Gibbon and Kezan soils. Fluvaquents are in the lower landscape positions. They are covered by shallow water most of the year. Gibbon and Kezan soils are higher on the landscape than the Albaton soil. Also, they have a lower seasonal high water table. Included soils make up 5 to 15 percent of the unit.

Permeability is very slow in the Albaton soil. The available water capacity is moderate. Runoff is slow to ponded. Organic matter content is moderate. Natural fertility is low. Tilth is poor. The shrink-swell potential is high. The seasonal high water table is about 6 inches above the surface during wet years to 2 feet below the surface during dry years. In areas of the Missouri River valley, the soil is flooded for extended periods during some years because of excess water released from the Fort Randall Dam.

Most of the acreage of this soil supports native or introduced grasses and is used for grazing or hay. Small acreages are used for cultivated crops. A few trees and shrubs are in some areas. The soil is not suited to either dryland or irrigated farming because of the high water table, the frequent flooding, and the ponding.

This soil is suited to climatically adapted introduced or domesticated grasses for pasture or hay. Reed canarygrass and Garrison foxtail are suitable species. Because of the wetness, tillage and seeding are generally limited to late summer or early fall. Grazing when the water table is high can damage the grasses and result in a rough surface, which makes mowing for hay difficult. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Weeds are a problem in wet, low areas.

This soil is suited to range and native hay. It produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods can help to maintain or improve the range condition. Grazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of mounds and ruts, which make grazing and harvesting hay difficult.

Because of the high water table, this soil is generally not suited to trees and shrubs grown as windbreaks or to plantings that enhance recreational areas and wildlife habitat. Trees and shrubs that are tolerant of the wetness can be grown in a few areas if they are hand planted or if other special practices are applied.

This soil is not suited to septic tank absorption fields because of the ponding, the flooding, and the very slow permeability. A suitable alternative site should be selected. Sewage lagoons are not suitable in areas of this soil unless they are protected from flooding and ponding. The soil is not suited to building site development because of the flooding, the ponding, and the high shrink-swell potential. Constructing roads on suitable, well compacted fill material and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding and ponding. The low strength and the high shrink-swell potential should be considered when roads and streets are designed. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is Vw-7, dryland. The range site is Wetland, and the windbreak suitability group is 10.

AcC—Alcester silt loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on smooth or concave foot slopes. The foot slopes are generally below uplands that formed in loess. The soil formed in silty colluvial and alluvial material. Areas are long and narrow. They range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 16 inches thick. The upper part of the subsoil is brown, friable silt loam about 27 inches thick. The lower part to a depth of more than 60 inches is pale brown, firm, calcareous silty clay loam. In some areas the soil is silt loam to a depth of more than 60 inches. In a few areas, the surface layer is lighter colored and the upper 12 inches of the soil is slightly calcareous. In other areas the surface layer is very fine sandy loam. Some areas are nearly level.

Included with this soil in mapping are small areas of Aowa, Coleridge, and Kezan soils. Aowa soils are in the lower landscape positions along drainageways. They are commonly flooded. Coleridge soils are in the lower landscape positions. They are somewhat poorly drained. Kezan soils are in the lowest landscape

positions. They are poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Alcester soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is high. The soil is easy to till. Moisture is released readily to plants.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but many areas are irrigated. Some areas are pastured with introduced grasses or are used as native range. A small acreage supports trees planted mainly for farmstead windbreaks.

If dry-farmed, this soil is suited to corn, oats, alfalfa, grain sorghum, and soybeans. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff from soils in the higher landscape positions and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated, this soil is suited to corn, alfalfa, grain sorghum, and soybeans. It is particularly well suited to center-pivot sprinkler systems. It is also suited to contour-furrow systems. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Contour farming, terraces, and grassed waterways help to control runoff from soils on the higher slopes. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

This soil is suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to keep the native plants in good condition.

This soil is well suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. Seedlings generally survive and grow well if competing grasses and weeds are controlled by proper site preparation and if they are cultivated or hoed by hand in a timely manner or if the appropriate herbicides are applied. Irrigation may be necessary during periods of insufficient rainfall.

This soil is suited to septic tank absorption fields. Onsite investigation is needed to determine if sites are suitable for sewage lagoons. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundation of dwellings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-1, dryland, and IIIe-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

AcD—Alcester silt loam, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on upland foot slopes along small drainageways. It formed in silty colluvial and alluvial material. Slopes are short and concave. Areas range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 20 inches thick. The subsoil is friable silt loam about 28 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The underlying material to a depth of more than 60 inches is light brownish gray, calcareous silt loam. In some places, the surface layer is lighter colored and the upper 12 inches of the soil is slightly calcareous.

Included with this soil in mapping are small areas of Aowa, Coleridge, and Crofton soils. Aowa soils are in the lower landscape positions along drainageways. They are commonly flooded. Coleridge soils are in the lower landscape positions. They are somewhat poorly drained. Crofton soils are in the higher landscape positions. They have a calcareous surface layer. Included soils make up 5 to 20 percent of the unit.

Permeability is moderate in the Alcester soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is high. Tilth is good. Moisture is readily released to plants.

About half of the acreage of this soil is farmed. Most areas are dry-farmed, but some areas are irrigated. Many areas are pastured with introduced grasses.

Some areas support trees planted mainly for farmstead windbreaks.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. Water erosion is the main hazard. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Terraces, contour farming, grassed waterways, and crop rotations help to control erosion and conserve moisture.

If irrigated, this soil is suited to corn, soybeans, alfalfa, and grasses. The major hazard is water erosion. The soil is suited to sprinkler systems. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to introduced or domesticated grasses for pasture or hay. Grasses can be rotated with other crops. Pastures consist mostly of cool-season grasses, such as smooth bromegrass. Grasses can be seeded alone or in a mixture with alfalfa. Overgrazing can reduce the vigor of plants and thus can cause the formation of small gullies and rills after periods of heavy rainfall. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses.

This soil is suited to range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to keep the native plants in good condition.

This soil is well suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. Seedlings can survive and grow well if a proper site is prepared by using the appropriate tillage methods or by applying herbicides. Weeds can be controlled by cultivation between the tree rows or by hand hoeing or by careful use of appropriate herbicides within the row. Planting trees on the contour and establishing terraces can help to control erosion. Irrigation may be necessary during periods of insufficient rainfall.

This soil is suited to septic tank absorption fields. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Dwellings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Strengthening the foundation of dwellings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Diversions help to control runoff from the higher landscape positions. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-1, dryland, and IVe-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

Ao—Aowa silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on bottom land. It formed in calcareous, silty alluvium. It is subject to occasional flooding. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, friable, calcareous silt loam about 7 inches thick. The next layer, to a depth of about 30 inches, is stratified grayish brown and pale brown, friable, calcareous silt loam. Below this is a buried layer of very dark grayish brown, friable silt loam about 24 inches thick. The underlying material to a depth of more than 60 inches is stratified grayish brown and dark grayish brown silt loam. In places the soil is calcareous throughout. Some areas have sand within a depth of 30 to 60 inches. A few small areas have a sandy surface layer.

Included with this soil in mapping are small areas of Alcester, Coleridge, Kezan, and Shell soils. Alcester soils are higher on the landscape than the Aowa soil. They are not subject to flooding. Coleridge soils are in the slightly lower landscape positions. They are somewhat poorly drained. Kezan soils are in the lowest landscape positions. They are poorly drained. Shell soils have a very thick, dark surface layer and are

noncalcareous. They are in the slightly higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Aowa soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The soil is easy to work, except during wet periods.

More than half of the acreage of this soil is dry-farmed. A few areas are irrigated. Most of the remaining acreage supports pastures of introduced grasses. A small acreage supports native grasses.

If dry-farmed, this soil is best suited to corn, soybeans, and grain sorghum. Alfalfa and oats are more susceptible to damage from flooding, but they can be grown as part of a crop rotation. The occasional flooding is the main hazard. The damage to crops caused by flooding is seldom severe. Because of the flooding, it may be necessary to reseed the crop or to delay tillage and harvest. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. Some land leveling may be needed in areas where gravity systems are used. Flooding is the main hazard. The damage to crops caused by flooding is seldom severe. Because of the flooding, it may be necessary to reseed the crop or to delay tillage and harvest. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth and increase the rate of water intake.

This soil is suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. The main species are smooth bromegrass and orchardgrass. Sediments deposited by floodwater may partially cover the grasses and reduce their growth and vigor. Overgrazing or improper haying methods can result in low vigor. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applications of nitrogen and phosphate fertilizers are needed for maximum forage production. In areas used as hayland, flooding can be a hazard.

This soil is suited to range and hay. Continuous heavy grazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to keep the native plants in good condition. Although flooding is very brief, it can deposit debris and weed seeds. Grazing when the soil is wet can result in surface compaction.

This soil is suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. Survival rates for adapted species that grow well in calcareous soil are good. The major management concerns are the weeds and grasses that compete with the trees for moisture. The competing vegetation can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through applications of the appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the flooding. A suitable alternative site should be selected. Diking sewage lagoons helps to prevent the damage caused by flooding. The soil is not suited to building site development because of the flooding. A suitable alternative site should be selected. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIw-3, dryland, and IIw-6, irrigated. The range site is Silty Overflow, and the windbreak suitability group is 1L.

Ar—Aowa silt loam, channeled, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on bottom land. It is dissected by meandering, entrenched channels. Conventional farm equipment generally cannot be used to cross these channels. The channels are 2 to 50 feet wide and 3 to 20 feet deep. The soil formed in calcareous, silty alluvium. It is frequently flooded. Areas are long and narrow. They range from 5 to 300 acres in size.

Typically, the surface layer is stratified grayish brown and brown, friable silt loam about 10 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is stratified light brownish gray and light gray in the upper part and grayish brown in the lower

part. The soil is calcareous throughout. Some areas have strata or lenses of contrasting textures. In transitional areas, the content of sand is slightly higher throughout the profile and the soil is not calcareous.

Included with this soil in mapping are small areas of Inavale, Kezan, and Shell soils. Inavale soils are in landscape positions similar to those of the Aowa soil. They are sandy and noncalcareous. Kezan soils are poorly drained. They are in the lower landscape positions. Shell soils are adjacent to the entrenched stream channels in the higher positions on the landscape. They are subject to occasional flooding. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Aowa soil. The available water capacity is high. Runoff is slow. Organic matter content is moderate. Natural fertility is medium.

Most of the acreage of this soil is used for pasture or range. The soil is not suited to cultivated crops because it is dissected by entrenched channels that make the use of most farm equipment unfeasible.

This soil is suited to introduced or domesticated grasses for pasture. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa, or with a warm-season grass, such as switchgrass. Sediments deposited by floodwater may partly cover the grasses and reduce their growth and vigor. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, switchgrass, sideoats grama, and western wheatgrass. These species make up about 65 percent of the total annual forage. Prairie junegrass, green needlegrass, indiangrass, bluegrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, indiangrass, prairie junegrass, and green needlegrass decrease in abundance and are replaced by western wheatgrass, bluegrass, and sedges. If overgrazing continues for many years on adjacent soils, the amount of protective plant cover is reduced and runoff can flow onto the Aowa soil. Although flooding is brief, it can result in channeling and can deposit debris and weed seeds. Grazing when the soil is wet can result in surface compaction.

If the range is in excellent condition, the suggested initial stocking rate is 1 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. Properly located fences and watering and salting facilities can result in a more uniform distribution of grazing.

This soil is generally not suited to trees and shrubs grown as windbreaks. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted or other special practices are applied.

This soil is not suited to septic tank absorption fields or dwellings and buildings because of the flooding. A suitable alternative site should be selected. The soil is not suited to sewage lagoons because of the channels and the flooding. A suitable alternative site should be selected. If areas of this soil are used for roads, bridges or culverts are needed across the channels. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to protect roads from flood damage. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is VIw-7, dryland. The range site is Silty Overflow, and the windbreak suitability group is 10.

Ba—Barney loam, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is in areas of bottom land that are frequently flooded. It formed in loamy alluvium deposited over sand. It is in long, meandering channels of former streams or along narrow drainageways that do not have entrenched channels. Areas range from 5 to 100 acres in size.

Typically, the surface layer is gray, mottled, friable, calcareous loam about 7 inches thick. Below this is a transitional layer of gray, mottled, friable, calcareous loam about 3 inches thick. The underlying material to a depth of more than 60 inches is light gray, stratified fine sand and sand. It is mottled in the upper part. In a few places the underlying material is gray to greenish gray. In other places it has strata of finer and coarser textured material and dark, buried layers.

Included with this soil in mapping are small areas of Boel, Inavale, and Orwet soils. Boel soils are in the higher landscape positions. They are somewhat poorly drained. Inavale soils are in the highest positions on the landscape. They are excessively drained. Orwet soils are in landscape positions similar to those of the

Barney soil. They are poorly drained. Also included are small areas of Fluvaquents and a few small intermittent lakes and narrow stream channels. Fluvaquents are covered by several inches of water most of the year. A few areas are gravelly. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the loamy upper part of the Barney soil and rapid in the sandy lower part. The available water capacity is low. Runoff is very slow. Organic matter content is moderate. Natural fertility is medium or low. The seasonal high water table is at the surface during wet years and at a depth of about 2 feet during dry years.

Most of the acreage of this soil supports native grasses and is used for grazing or hay (fig. 7). The soil is too wet for cultivated crops. A large area is covered with trees and shrubs and provides good wildlife habitat.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and sedges. These species make up 70 percent or more of the total annual forage. Bluegrass, slender wheatgrass, rushes, and forbs make up the rest. If the soil is subjected to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying methods continue for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.1 animal unit months per acre. The soil produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition. Grazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. In wet years some areas cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. The livestock should be removed in the spring before the ground thaws.

This soil is unsuited to windbreaks. Some small areas can be used for plantings that enhance recreational areas and wildlife habitat and for forests if trees and shrubs are hand planted or other special practices are applied.

This soil is not suited to septic tank absorption fields, sewage lagoons, or building site development because of the wetness, the seepage, and the flooding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material and providing adequate roadside ditches and culverts help to protect roads from the damage caused by flooding and wetness.

The capability classification is Vw-7, dryland. The range site is Wetland, and the windbreak suitability group is 10.

Bd—Bazile loamy fine sand, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands and stream terraces. It formed in sandy eolian material and loess or in outwash material over sandy sediments. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 12 inches thick. The subsoil is about 18 inches thick. The upper part is grayish brown, friable clay loam, and the lower part is brown, firm silty clay loam. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is fine sandy loam or fine sand.

Included with this soil in mapping are small areas of Boelus, Loretto, Simeon, and Thurman soils. Boelus, Loretto, and Simeon soils are in landscape positions similar to those of the Bazile soil. Boelus and Loretto soils are silty or loamy in the underlying material. Simeon soils are sandy. They are excessively drained. Thurman soils are in the slightly higher landscape positions and are somewhat excessively drained. They are sandy. Included soils make up 5 to 20 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity is moderate. The water intake rate is high. Runoff is very slow. Organic matter content is moderately low. Natural fertility is medium. The soil is easy to till. It is somewhat droughty.

Most of the acreage of this soil is dry-farmed, but some areas are irrigated. A few areas are pastured with native grasses and are used as range.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. Soil blowing is a hazard if the soil is not adequately protected by crops or crop residue. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated, this soil is suited to corn, grain sorghum,

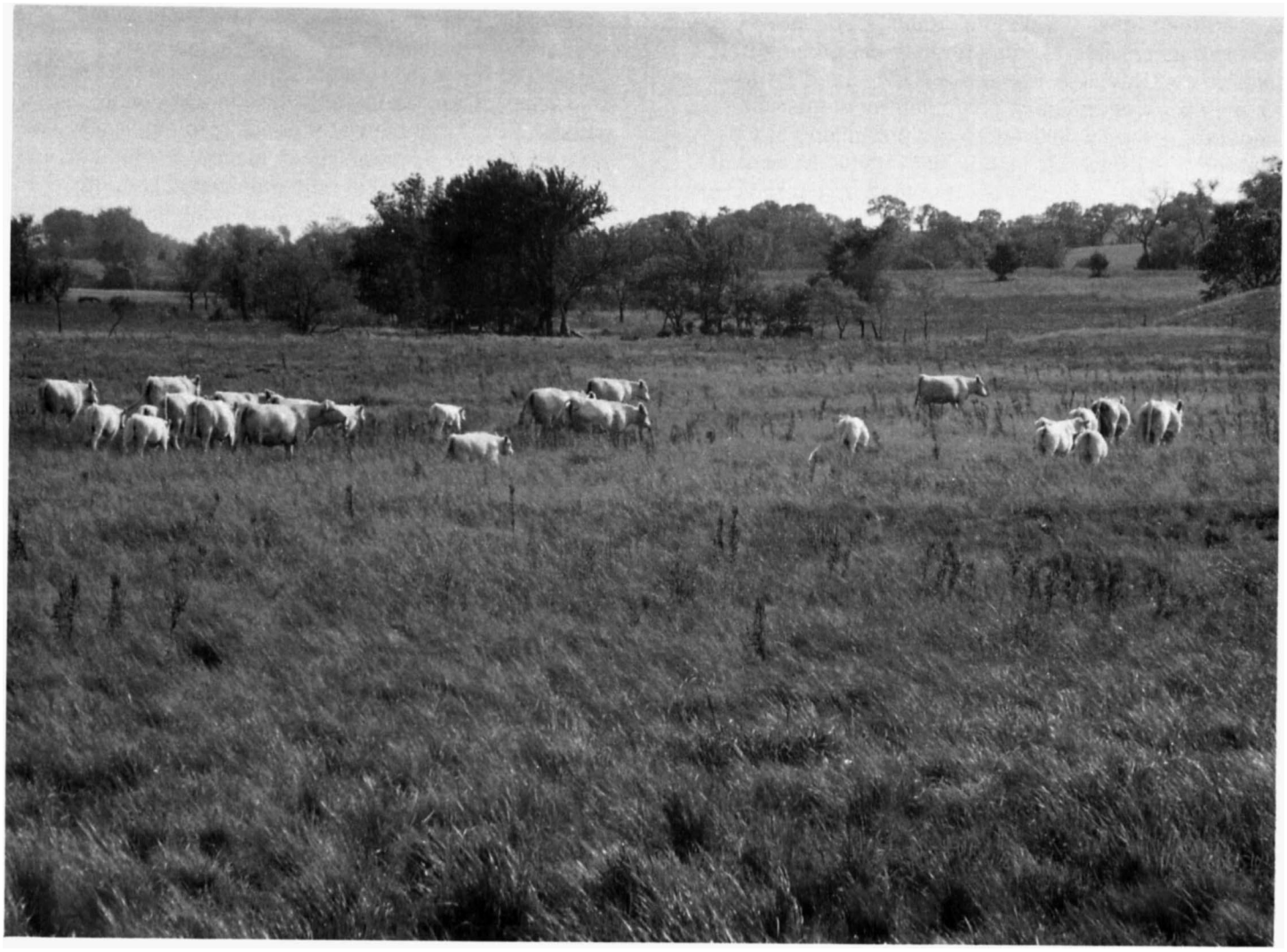

Figure 7.—Cattle grazing in an area of Barney loam, 0 to 2 percent slopes.

soybeans, and alfalfa. Small grain and introduced grasses also are suitable in irrigated areas. The soil is suited to gravity and sprinkler systems. If border or furrow irrigation is used, land leveling can provide the even distribution of water needed for uniform drainage and can help to control erosion. Keeping the length of runs somewhat short can reduce the amount of water lost because of deep percolation into the sandy underlying material. If this soil is irrigated by sprinklers, the rate of water application should be adjusted to the high intake rate of the soil. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Including grasses and legumes in the cropping sequence, returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

This soil is suited to introduced grasses for pasture. Grasses can be rotated with other crops. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help

to keep the grasses in good condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

This soil absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of nearby water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-6, dryland, and IIe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

BdC—Bazile loamy fine sand, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in sandy eolian material and loess or in outwash material over sandy sediments. Areas range from 5 to 200 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The subsoil is about 24 inches thick. The upper part is pale brown, very friable loamy fine sand; the next part is pale brown, firm silty clay loam; and the lower part is pale brown, friable silt loam. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is fine sandy loam or fine sand.

Included with this soil in mapping are small areas of Boelus, Loretto, Simeon, and Thurman soils. Boelus, Loretto, and Simeon soils are in landscape positions similar to those of the Bazile soil. Boelus and Loretto soils are silty or loamy in the underlying material. Simeon and Thurman soils are sandy. Simeon soils are excessively drained. Thurman soils are in the slightly higher landscape positions. They are somewhat excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity is moderate. The water intake rate is high. Runoff is slow or medium. Organic matter content is moderately low. Natural fertility is medium. The soil is easy to till. It is somewhat droughty.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated if adequate water is available. The remaining acreage supports native grasses and is used for range or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Small grain and introduced grasses also are suitable in irrigated areas. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. Adjusting the rate of water application to the high intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion. Most areas are poorly suited to gravity irrigation because of the hazard of erosion.

This soil is suited to introduced grasses or legumes for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of native plants and thus can result in soil blowing. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the

appropriate herbicides are applied.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

This soil absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of nearby water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-6, dryland, and IIIe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

BdD—Bazile loamy fine sand, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on uplands. It formed in sandy eolian material and loess or outwash material over sandy sediments. Areas range from 5 to 50 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer also is grayish brown, very friable loamy fine sand. It is about 4 inches thick. The subsoil is about 19 inches thick. The upper part is brown, friable clay loam, and the lower part is brown, firm silty clay loam. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is fine sandy loam or fine sand.

Included with this soil in mapping are small areas of Boelus, Crofton, and Thurman soils. Boelus and Crofton soils are in landscape positions similar to those of the Bazile soil. Boelus soils are silty or loamy in the underlying material. Crofton soils are silty. Thurman soils are in the slightly higher landscape positions and are somewhat excessively drained. They are sandy. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity is moderate. The water intake rate is high. Runoff is medium. Organic matter content is moderately low. Natural fertility is medium. The soil is easy to till. It is somewhat droughty.

About half of the acreage of this soil is farmed. Most areas are dry-farmed, but some small areas are irrigated. The remaining acreage supports introduced or native grasses and is used for range or hay.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. The hazards of soil blowing and water erosion are moderate or severe. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is poorly suited to oats, wheat, alfalfa, and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a very severe hazard in irrigated areas where these crops are grown. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion. Adjusting the rate of water application to the high intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control water erosion.

This soil is suited to introduced grasses or legumes for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of native plants and thus can result in soil blowing and water erosion. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds

can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

This soil is poorly suited to septic tank absorption fields because of the poor filtering capacity, which can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The sides of shallow excavations can cave in unless they are shored. Strengthening the foundations of buildings and dwellings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Dwellings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IVe-6, dryland, and IVe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

Bn—Bazile loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands and stream terraces. It formed in loess or outwash material over sandy sediments. Areas range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is dark grayish brown, friable clay loam about 10 inches thick. The subsoil is about 14 inches thick. The upper part is grayish brown, firm silty clay loam, and the lower part is pale brown, friable clay loam. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Moody, Paka, Thurman, and Trent soils. Moody and Paka soils are in landscape positions similar to those of the Bazile soil. Moody and Paka soils are silty and loamy in the underlying material. Thurman soils are in the slightly higher landscape positions and are somewhat excessively drained. They are sandy. Trent soils are in the slightly lower landscape positions. They are silty in the underlying material. Included soils make up 5 to 20 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity is moderate. The water intake rate also is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The soil is easy to till. During years when rainfall amounts are below normal, the soil is somewhat droughty during July and August.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some areas are irrigated. The remaining acreage supports native grasses and is used for range.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. The hazard of erosion is slight. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Small grain and introduced grasses also are suitable in irrigated areas. The soil is suited to gravity and sprinkler systems. If border or furrow systems are used, land leveling can provide the even distribution of water needed for uniform drainage and can help to control erosion. Keeping the length of runs somewhat short can reduce the amount of water lost because of deep percolation into the sandy underlying material. If the soil is irrigated by sprinklers, the rate of water application should be adjusted to the moderate intake rate of the soil.

This soil is suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses. Proper grazing use, timely deferment of

grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

This soil absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of nearby water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIs-5, dryland, and I-7, irrigated. The range site is Silty, and the windbreak suitability group is 3.

BnC—Bazile loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in loess or outwash material over sandy sediments. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer also is dark grayish brown, friable loam. It is about 4 inches thick. The subsoil is brown, firm silty clay loam about 19 inches thick. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Moody, Paka, Simeon, and Thurman soils. Moody and Paka soils are in landscape positions similar to those of the Bazile soil. They are silty and loamy in the underlying material. Simeon and Thurman soils are in the slightly higher landscape positions. They are sandy. Simeon soils are excessively drained, and Thurman soils are somewhat excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity, the water intake rate, and the organic matter content are moderate. Runoff and natural fertility are medium. The soil is easy to till. It is somewhat droughty.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but many areas are irrigated. The remaining acreage supports native grasses and is used for range.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. The hazard of water erosion is slight or moderate. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Small grain and introduced grasses also are suitable in irrigated areas. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Most areas are poorly suited to gravity irrigation because of the hazard of erosion. Including grasses and legumes in the cropping sequence, returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

This soil is suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition. If this soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main

limitation if trees are planted. Irrigation may be necessary.

This soil absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of nearby water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-1, dryland, and IIIe-7, irrigated. The range site is Silty, and the windbreak suitability group is 3.

BnD—Bazile loam, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on uplands. It formed in loess or outwash material over sandy sediments. Areas range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 5 inches thick. The subsurface layer is dark grayish brown, friable loam about 6 inches thick. The subsoil is about 19 inches thick. The upper part is brown, firm silty clay loam, and the lower part is pale brown, friable clay loam. The underlying material to a depth of more than 60 inches is very pale brown sand. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Crofton, Paka, Simeon, and Thurman soils. Crofton and Paka soils are in landscape positions similar to those of the Bazile soil. Crofton soils are silty throughout. Paka soils are silty or loamy in the underlying material. Simeon and Thurman soils are in the slightly higher landscape positions. They are sandy throughout. Simeon soils are excessively drained, and Thurman soils are somewhat excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Bazile soil and rapid in the sandy underlying material. The available water capacity, the water intake rate, and the organic matter content are moderate. Runoff and natural fertility are medium. The soil is easy to till. It is somewhat droughty.

About half of the acreage of this soil is dry-farmed. A small acreage is irrigated. The remaining acreage supports native grasses and is used for range.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. The hazard of water erosion is moderate or severe. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is poorly suited to oats, wheat, alfalfa, and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a severe hazard in irrigated areas where these crops are grown. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Including grasses and legumes in the cropping sequence, returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

This soil is suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition. If this soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of the native grasses. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

This soil is poorly suited to septic tank absorption fields because of a poor filtering capacity, which can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The sides of shallow excavations can cave in unless they are temporarily shored. Strengthening the foundations of buildings and dwellings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Dwellings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IVe-1, dryland, and IVe-7, irrigated. The range site is Silty, and the windbreak suitability group is 3.

BoD2—Betts clay loam, 6 to 11 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on smooth to convex side slopes in the uplands. It formed in glacial till. In most cultivated areas, water erosion has removed the original surface layer. Areas range from 5 to 30 acres in size.

Typically, the surface layer is pale brown, firm, calcareous clay loam about 7 inches thick. The subsoil is firm, calcareous clay loam about 17 inches thick. It is pale brown in the upper part and very pale brown in the lower part. The underlying material to a depth of more than 60 inches is pale yellow, calcareous clay loam. A few pebbles and stones are throughout the profile. Small masses of soft lime are in the lower part of the profile. In some areas that support native grasses, the surface layer is dark grayish brown and is leached of lime.

Included with this soil in mapping are small areas of Alcester, Crofton, Nora, Simeon, and Thurman soils. Alcester soils formed in colluvial and alluvial sediments. They are on foot slopes in the lower landscape positions. Crofton soils are commonly slightly higher on the landscape than the Betts soil. Nora soils are in landscape positions similar to those of the Betts soil. Crofton and Nora soils formed in loess. Simeon and Thurman soils are sandy throughout. They are in the higher landscape positions. Also included are a few small gravelly or stony areas. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the solum of the Betts soil and moderately slow in the underlying material. The available water capacity is high. The water intake rate is moderately low. Runoff is medium. Organic matter content is moderately low. Natural fertility is low. The calcium content is high, and the content of available phosphate, sulfur, and zinc is low. The soil is sometimes difficult to work if stones and pebbles are on the surface. It forms clods if tilled when wet.

About half of the acreage of this soil is farmed. Most areas are dry-farmed, but many areas are irrigated. Some areas support native or introduced grasses. A small acreage supports trees planted for windbreaks.

This soil is poorly suited to dryland crops because of the slope and the severe hazard of erosion. In dry-farmed areas, corn, grain sorghum, oats, and alfalfa are generally grown. Water erosion is the main hazard. Management concerns include the loss of moisture because of runoff and the maintenance of fertility. A system of conservation tillage, such as disking, chiseling, or no-till planting, that leaves crop residue on the surface helps to control erosion and runoff. Leaving crop residue on the surface can increase the content of organic matter and conserve moisture. Some smoothly sloping areas can be terraced and cultivated on the contour. Applying phosphate and zinc fertilizers and feedlot manure improves fertility.

If irrigated, this soil is suited only to sprinkler systems. It is poorly suited to row crops because of the slope and the severe hazard of erosion. It is better suited to close-growing crops, such as alfalfa. Row crops, such as corn, can be grown if they are carefully managed. Water erosion is the main hazard. Runoff and low fertility are management concerns. A system of conservation tillage, such as chiseling or disking, that leaves crop residue on the surface helps to control erosion and runoff and conserves moisture. The proper rate of water application is needed. Terraces, contour farming, and grassed waterways help to control erosion and runoff. Applying feedlot manure helps to maintain organic matter content and fertility.

This soil is suited to introduced grasses for pasture. Pastures generally consist of cool-season grasses, such as smooth bromegrass, orchardgrass, or tall fescue, seeded in a mixture with alfalfa. Using areas of this soil for pasture helps to control erosion. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Pasture grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of grasses. Proper grazing use and rotation

grazing help to keep the grasses in good condition. Applying fertilizers and feedlot manure improves the growth and vigor of grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of the native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is fairly suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. The species selected for planting should be those that are tolerant of a high content of calcium in the soil. The main management concerns are water erosion and insufficient moisture. Planting trees on the contour and establishing terraces conserve moisture and help to control erosion. Weeds can be controlled if they are cultivated or hoed by hand or if the appropriate herbicides are applied. Irrigation may be necessary during periods of insufficient rainfall.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. This limitation can generally be overcome by increasing the size of the field. In the steepest areas, land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IVe-8, dryland, and IVe-3, irrigated. The range site is Limy Upland, and the windbreak suitability group is 8.

BoE2—Betts clay loam, 11 to 15 percent slopes, eroded. This very deep, moderately steep, well drained soil is on uplands. It formed in glacial till. In most cultivated areas, water erosion has removed the original surface layer. Areas range from 5 to 60 acres in size.

Typically, the surface layer is light brownish gray, firm, calcareous clay loam about 4 inches thick. The subsoil is firm, calcareous clay loam about 18 inches thick. The upper part is light brownish gray, and the lower part is light gray. The underlying material to a depth of more than 60 inches is calcareous clay loam. It is light gray in the upper part and pale yellow in the lower part. In areas that support native grasses, the surface layer is more than 7 inches thick. In most areas pebbles and small stones are on the surface and throughout the profile. In a few areas that support native grasses, the surface layer is grayish brown and is leached of lime.

Included with this soil in mapping are small areas of Alcester, Crofton, Nora, Simeon, and Thurman soils. Alcester soils formed in silty colluvial and alluvial material. They are in the lower landscape positions on foot slopes. Crofton and Nora soils formed in loess. Crofton soils are slightly higher on the landscape than the Betts soil. Nora soils are in landscape positions similar to those of the Betts soil. Simeon and Thurman soils are sandy. They are in the slightly higher landscape positions. Also included are a few areas where the stones and boulders on the surface are large enough to restrict the use of machinery. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the solum of the Betts soil and moderately slow in the underlying material. The available water capacity is high. Runoff is rapid. Organic matter content is moderately low. Natural fertility is low. The content of calcium is high, and the content of available phosphorus, sulfur, and zinc is low. Tilth can be difficult to maintain if the surface layer has stones and boulders. The soil tends to form clods if tilled when wet.

About half of the acreage of this soil is farmed. Most areas are dry-farmed, but a few areas are irrigated. A small acreage supports trees planted for windbreaks. The remaining acreage is used for pasture or range.

If dry-farmed, this soil is poorly suited to cultivated crops because of the slope and the severe hazard of erosion. It is better suited to close-growing crops, such as alfalfa and oats, than to row crops, such as corn. In areas where row crops are grown, controlling erosion is difficult. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Grasses and legumes are grown during most years, but row crops are grown only infrequently. A system of conservation tillage, such as disking or chiseling, helps to keep crop residue on the surface. Applying nitrogen and phosphorus fertilizers or feedlot manure can improve or maintain fertility.

This soil is not suited to irrigation because of the slope and the severe hazard of erosion.

This soil is suited to introduced or domesticated grasses for pasture. It is subject to water erosion. Using areas of this soil for pastures of introduced or domesticated grasses can help to control water erosion. Grasses can be rotated with other crops. Common species are smooth bromegrass or intermediate

wheatgrass. Overgrazing or improper haying methods reduce productivity and the amount of protective plant cover. Because of the poor vigor of the plants, small gullies and rills can form after periods of heavy rainfall. Management practices, such as rotation grazing and applications of fertilizer, are needed for maximum forage production. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. If the soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is fairly suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. Survival and growth rates of adapted species are fair. The major management concerns are drought and the weeds and grasses that compete with the trees for moisture. Irrigation may be necessary during periods of insufficient rainfall. Competing vegetation can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through applications of the appropriate herbicides.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. This limitation can generally be overcome by increasing the size of the field. Land shaping and installing the septic tank absorption field on the contour help to ensure that the absorption field functions properly. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IVe-8, dryland. The range site is Limy Upland, and the windbreak suitability group is 8.

BoF—Betts clay loam, 15 to 30 percent slopes. This very deep, steep, well drained soil is on uplands. It formed in glacial till. Areas range from 5 to 500 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 5 inches thick. The subsoil is light brownish gray, friable clay loam about 21 inches thick. The underlying material to a depth of more than 60 inches is light gray clay loam. The soil is calcareous throughout. In some areas slopes are less than 15 percent or more than 30 percent. In a few areas the surface layer is loam. In most areas pebbles and small stones are on the surface and throughout the profile.

Included with this soil in mapping are small areas of Alcester, Nora, Simeon, and Thurman soils. Alcester soils are lower on the landscape than the Betts soil. They formed in silty colluvial and alluvial material. Nora soils are in landscape positions similar to those of the Betts soil. They formed in loess. Simeon and Thurman soils are in the slightly higher landscape positions. They are sandy throughout. Also included are a few areas where small stones and boulders on the surface are large enough to restrict the use of farm machinery. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the solum of the Betts soil and moderately slow in the underlying material. The available water capacity is high. Runoff is rapid. Organic matter content is moderately low. Natural fertility is low. The content of calcium is high, and the content of available phosphorus is low.

Nearly all of the acreage of this soil supports pasture or range. A few small areas are farmed. A few areas support trees.

This soil is unsuited to cultivated crops and to pastures of introduced grasses. It is too erodible and steep to be crossed safely with farm machinery. If sloping areas are plowed, water erosion is a hazard.

If this soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Green needlegrass, needleandthread, western wheatgrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, tall dropseed, western wheatgrass, needleandthread, plains muhly, sedges, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive. Woody plants, such as bur oak, eastern redcedar, buckbrush, snowberry, and sumac, may invade the site. Brush management and prescribed burning may be needed to control the growth of woody plants.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

This soil is unsuited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are poor. In some areas trees and shrubs can be planted only if special measures, such as hand planting or specialized site preparation, are applied.

This soil is generally not suited to sanitary facilities because of the slope and the moderately slow permeability. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are generally needed to provide a suitable grade for roads and streets.

The capability classification is VIe-9, dryland. The range site is Limy Upland, and the windbreak suitability group is 10.

BoG—Betts clay loam, 30 to 60 percent slopes. This very deep, very steep, well drained soil is on plane to convex side slopes in the uplands. It formed in glacial till. Catsteps are common on the upper slopes. Areas range from 5 to 300 acres in size.

Typically, the surface soil is dark grayish brown, friable clay loam about 4 inches thick. The subsoil is light brownish gray, firm clay loam about 18 inches thick. The underlying material to a depth of more than 60 inches is light gray clay loam. The soil is calcareous throughout. A few pebbles and small stones are on the surface.

Included with this soil in mapping are small areas of Simeon soils. These soils formed in outwash sand. They are in the slightly higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the solum of the Betts soil and moderately slow in the underlying material. Runoff is rapid. The available water capacity is high. Organic matter content is moderately low. Natural fertility is low. The content of calcium carbonate is high, and the content of available phosphorus is low.

Most of the acreage of this soil is used for range. A large acreage on the north-facing slopes is covered with trees.

This soil is unsuited to cultivated crops, introduced grasses for pasture, and farmstead windbreaks. It is too erodible and steep to be crossed safely with farm machinery.

If this soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Green needlegrass, needleandthread, western wheatgrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, tall dropseed, western wheatgrass, needleandthread, plains muhly, sedges, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive. Woody plants, such as bur oak, eastern redcedar, buckbrush, snowberry, and sumac, may invade the site. Brush management and prescribed burning may be needed to control the growth of woody plants.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

This soil is generally not suited to sanitary facilities because of the slope. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are generally needed to provide a suitable grade for roads and streets.

The capability classification is VIIe-9, dryland. The range site is Limy Upland, and the windbreak suitability group is 10.

Bp—Blendon fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on stream terraces and in upland valleys. It formed in

loamy and sandy glacial or eolian sediments. Areas range from 5 to 25 acres in size.

Typically, the surface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable fine sandy loam about 9 inches thick. The subsoil is dark grayish brown, very friable fine sandy loam about 14 inches thick. The underlying material to a depth of more than 60 inches is loamy sand. It is grayish brown in the upper part and pale brown in the lower part. In some areas loamy material is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Bazile, Ortello, and Trent soils. Bazile and Ortello soils are in the higher landscape positions. They have a dark solum that is less than 20 inches thick. Bazile soils have more clay in the subsoil than the Blendon soil. Trent soils are in the lower landscape positions. They are silty throughout. Also included are areas that have slopes of more than 2 percent and a few small, depressional areas. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the solum of the Blendon soil and rapid in the underlying material. The available water capacity is moderate. The water intake rate is moderately high. Runoff is slow. Most areas receive some runoff from the higher landscape positions. Organic matter content is moderate. Natural fertility is medium. Tilth is good. The soil can be easily tilled throughout a fairly wide range in moisture content.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated, mostly by sprinkler systems. The remaining acreage mainly supports pasture and some range. A few areas support trees planted for windbreaks.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Including grasses and legumes in the cropping sequence, returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. The soil is best suited to sprinkler irrigation systems. Some land leveling may be needed in areas where gravity systems are used. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Including grasses and legumes in the cropping sequence, returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses for pasture. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Rotation grazing and applications of fertilizer are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Timely deferment of grazing and haying and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good, and growth rates are fair. The major management concerns are drought and the weeds and grasses that compete with the trees for moisture. Irrigation can provide supplemental moisture during periods of low rainfall. Competing vegetation can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through applications of the appropriate herbicides.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in pollution of nearby underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. This soil is generally suited to sites for dwellings and small commercial buildings. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the roads by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-3, dryland, and IIe-8, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

Br—Blyburg silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on bottom land along the Missouri River. It formed in calcareous alluvium. It is subject to only rare flooding since large dams were constructed upstream on the Missouri River. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. The subsurface layer also is grayish brown, friable silt loam. It is about 5

inches thick. The underlying material is light gray very fine sandy loam that has strata of silt loam. The soil is calcareous throughout. In some places thin strata of finer or coarser textured material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Inavale, Onawa, and Solomon soils. Inavale soils are in landscape positions similar to those of the Blyburg soil. They are excessively drained. They are sandy throughout. Onawa and Solomon soils are in the lower landscape positions. Onawa soils are somewhat poorly drained. They have more clay in the upper 25 inches than the Blyburg soil. Solomon soils are poorly drained. They are clayey throughout. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Blyburg soil. The available water capacity is high. The water intake rate is low. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The soil is easy to till.

Most areas are dry-farmed. Small areas support irrigated cropland, pastures of introduced grasses, or trees planted mainly for windbreaks.

If dry-farmed, this soil is best suited to corn, soybeans, grain sorghum, alfalfa, oats, and wheat. A water table at a depth of 6 to 10 feet can provide moisture for alfalfa. If the soil is tilled in the fall and the surface remains bare, soil blowing is a moderate hazard. A system of conservation tillage, such as disking or no-till planting, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Applications of phosphate fertilizer are commonly needed.

If irrigated, this soil is best suited to corn, soybeans, grain sorghum, and alfalfa. It is suited to gravity and sprinkler systems. If furrow systems are used, land leveling can provide even distribution of water. A tailwater recovery system conserves moisture. If a sprinkler irrigation system is used, adjusting the rate of water application to the intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. The soil commonly is deficient in phosphorus.

This soil is suited to introduced grasses or legumes for pasture or hay. Grasses are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Proper stocking rates and rotation grazing help to prevent overgrazing. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Overgrazing reduces the quality of the native plants. Proper grazing use, timely deferment of grazing, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to the trees and shrubs commonly grown as windbreaks. The species selected for planting should be those that are tolerant of an excessive amount of calcium carbonate. Seedlings generally survive and grow well if the weeds and grasses that compete with the trees for moisture are controlled. Plant competition can be controlled by proper site preparation, by timely cultivation, or through the application of appropriate herbicides. Lack of rainfall is a limitation in some years, and irrigation may be needed. A water table at a depth of 6 to 10 feet can provide moisture for established trees.

The moderate permeability and the flooding are limitations if this soil is used as a site for septic tank absorption fields. The absorption fields should be protected from floodwater. Increasing the size of the absorption field generally helps to overcome the moderate permeability. Lining or sealing sewage lagoons helps to prevent seepage. Constructing dwellings on raised, well compacted fill material helps to prevent the structural damage caused by flooding. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness. Constructing the roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding.

The capability classification is I-1, dryland, and I-6, irrigated. The range site is Silty Lowland, and the windbreak suitability group is 1L.

Bs—Boel loamy fine sand, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land along the Niobrara and Missouri Rivers and Verdigris Creek. It formed in sandy alluvium. It is subject to occasional flooding, but the duration of the flooding is brief. Areas range from 5 to 150 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 8 inches thick. Below this is a transitional layer of grayish brown, very friable loamy

fine sand about 3 inches thick. The underlying material to a depth of more than 60 inches is fine sand. The upper part is very pale brown, and the lower part is mottled light gray. The lower part of the profile has thin strata of coarser and finer textures. Some places have an overwash of fine sand 6 to 10 inches thick on the surface. In a few places the texture of the surface layer ranges from fine sandy loam to silty clay. In other places the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of Barney, Inavale, Ord, and Orwet soils. Barney and Orwet soils are slightly lower on the landscape than the Boel soil. They are poorly drained or very poorly drained. Inavale soils are slightly higher on the landscape than the Boel soil. They are excessively drained. Ord soils are in landscape positions similar to those of the Boel soil. They have more silt and clay in the upper part of the profile than the Boel soil. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Boel soil. The available water capacity is low. Organic matter content is moderately low. Natural fertility is low. The water intake rate is very high. Runoff is very slow. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to about 3.5 feet below the surface during dry years. It normally recedes to a depth of 4 to 6 feet during the middle of the summer. The soil can be easily tilled throughout a wide range in moisture content.

About half of the acreage of this soil is dry-farmed. The rest supports native grasses and is used for range or hayland. A few small areas are irrigated or seeded to introduced grasses for pasture or hay. Small areas support trees planted for windbreaks. Native trees and shrubs are common in pastures.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, soybeans, small grain, and introduced grasses. Flooding may delay spring planting and limit the production of small grain. Alfalfa yields are high, but the flooding can limit yields. In some years the soil is difficult to work during spring because of the wetness caused by the water table. If alfalfa and other close-growing crops are planted, the soil will not need to be worked in the spring. Planting alfalfa and close-growing crops also helps to control soil blowing when the surface is dry. A system of conservation tillage that leaves crop residue on the surface most of the time can help to control soil blowing. Returning crop residue to the soil and applying barnyard manure improve organic matter content and fertility.

This soil is poorly suited to irrigation. Corn and alfalfa are suitable irrigated crops if flooding is controlled. Sprinkler irrigation is the most suitable method. The applications of water should be light and frequent. Excessive irrigation leaches plant nutrients below the root zone. Tillage is not normally needed, but the water table is a management concern during wet periods. Wetness can be controlled by using open drains or tile drains in areas where suitable outlets are available. Winter cover crops are needed to control soil blowing.

This soil is suited to introduced grasses or legumes for pasture or hay. Grasses are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees planted for windbreaks. The trees and shrubs selected for planting should be those that are tolerant of a moderately high water table. Establishing seedlings and cultivating between the rows may be a problem during some wet years. The abundant and persistent herbaceous vegetation that grows in the tree rows is a management concern because it competes with the trees. Weeds and undesirable grasses can be controlled by cultivating between the rows with conventional equipment or by applying herbicides in a timely manner.

This soil is not suited to septic tank absorption fields or buildings because of the flooding. A suitable alternative site should be selected. Lining or sealing sewage lagoons helps to prevent seepage. Diking the lagoons helps to prevent the damage caused by flooding. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table. Excavating only during dry periods helps to prevent caving and allows for easier operation of machinery. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding.

The capability classification is IVw-5, dryland, and IVw-11, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Bt—Boelus loamy sand, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands

and stream terraces. It formed in sandy eolian material over loamy material. Areas range from 5 to 40 acres in size.

Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. The subsurface layer also is grayish brown, very friable loamy sand. It is about 5 inches thick. The subsoil is about 37 inches thick. It is brown, very friable loamy sand in the upper part and pale brown and light brownish gray, friable silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is light gray, calcareous silty clay loam. In some places the surface layer is sandy loam or sand. In some areas the thickness of sandy material over the loamy material ranges from less than 20 inches to more than 40 inches.

Included with this soil in mapping are small areas of Loretto, Nora, Ortello, Paka, and Thurman soils. Loretto, Nora, Paka, and Ortello soils are in landscape positions similar to those of the Boelus soil. Loretto, Nora, and Paka soils have less sand in the upper part of the profile than the Boelus soil. Ortello soils have more sand and less clay in the lower part of the profile than the Boelus soil. Thurman soils are sandy. They are higher on the landscape than the Boelus soil. Also included are areas where the loamy material is exposed at the surface. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the sandy upper part of the Boelus soil and moderate in the loamy underlying material. The available water capacity and the water intake rate are high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The soil can be easily tilled when moist or dry.

Most of the acreage of this soil is farmed, and the rest supports native or introduced grasses. Some areas are irrigated.

If dry-farmed, this soil is suited to corn, small grain, and alfalfa. Small grain and the first cutting of alfalfa are generally the most suitable crops because they grow and mature in spring when rainfall is plentiful. The soil is highly susceptible to soil blowing. A system of conservation tillage that leaves crop residue on the surface most of the time helps to control soil blowing, conserves moisture, and helps to maintain organic matter content and fertility. Applying barnyard manure improves organic matter content and fertility.

If irrigated, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. A sprinkler irrigation system is the most suitable because light, frequent applications of water are needed. Returning crop residue to the soil improves organic matter content. Leaving crops, grasses, or crop residue on the surface helps to control soil blowing and conserves moisture.

Using areas of this soil for pastures of introduced grasses helps to control erosion. Cool-season grasses, such as smooth bromegrass, orchardgrass, or tall fescue, seeded in a mixture with alfalfa are suitable species. The grazing season can be extended by managing cool-season grasses along with warm-season grasses. Introduced grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer and irrigating can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. The species selected for planting should be those that are tolerant of sandy and somewhat droughty conditions. Insufficient moisture and a severe hazard of soil blowing are the main concerns when trees are established. Irrigation can provide supplemental moisture during dry periods. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Weeds compete with the trees for moisture. Weeds and grasses can be controlled by cultivating or by using appropriate herbicides.

This soil is generally suited to septic tank absorption fields. The moderate permeability is a limitation. It can be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can cave in unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-6, dryland, and IIIe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

BtC—Boelus loamy sand, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in sandy eolian material over loamy material. Areas range from 5 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. The subsurface

layer is dark grayish brown, very friable loamy sand about 5 inches thick. The subsoil is about 29 inches thick. The upper part is grayish brown, very friable loamy sand; the next part is pale brown, firm silty clay loam; and the lower part is light brownish gray, friable silty clay loam. The underlying material to a depth of more than 60 inches is light gray silt loam. In some places the surface layer is sand or sandy loam. In other places the thickness of the sandy material over the loamy material ranges from less than 20 inches to more than 40 inches.

Included with this soil in mapping are small areas of Loretto, Nora, Ortello, Paka, and Thurman soils. Loretto, Nora, Paka, and Ortello soils are in landscape positions similar to those of the Boelus soil. Loretto, Nora, and Paka soils have less sand in the upper part of the profile than the Boelus soil. Ortello soils have more sand and less clay in the lower part of the profile than the Boelus soil. Thurman soils are higher on the landscape than the Boelus soil. They are sandy throughout. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the sandy upper part of the Boelus soil and moderate in the loamy lower part. The available water capacity and the water intake rate are high. Runoff is slow or medium. Organic matter content is moderately low. Natural fertility is medium. The soil can be easily tilled throughout a wide range in moisture content.

Most of the acreage of this soil is farmed. The rest supports native or cool-season grasses. Some areas are irrigated.

If dry-farmed, this soil is suited to corn, soybeans, sorghum, small grain, and alfalfa. Small grain and the first cutting of alfalfa are generally the most suitable crops because they grow and mature in spring when the amount of rainfall is generally highest. The soil is highly susceptible to soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface most of the time helps to control soil blowing and water erosion and conserves moisture. Applying barnyard manure improves organic matter content and fertility.

If irrigated, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. A sprinkler irrigation system is the most suitable because frequent, light applications of water are needed to prevent leaching of plant nutrients below the root zone. A system of conservation tillage that leaves close-growing crops, grasses, or crop residue on the surface can help to control soil blowing and water erosion.

Using areas of this soil for pastures of introduced grasses helps to control erosion. Cool-season grasses, such as smooth bromegrass, orchardgrass, or tall fescue, seeded in a mixture with alfalfa are suitable species. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Introduced grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer and irrigating can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. The species selected for planting should be those that are tolerant of sandy and somewhat droughty conditions. Insufficient moisture and a severe hazard of soil blowing are the main management concerns when trees are established. Irrigation can provide supplemental moisture during dry periods. Maintaining strips of sod or other vegetation between the rows can help to control soil blowing and water erosion. Weeds that compete with the trees for moisture can be controlled by cultivating or by using appropriate herbicides.

This soil is generally suited to septic tank absorption fields. The moderate permeability is a limitation. It can be overcome by increasing the size of the absorption field. Lining or sealing sewage lagoons helps to prevent seepage. The sides of shallow excavations can cave in unless they are shored. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained material for subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-6, dryland, and IIIe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

BtD—Boelus loamy sand, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on uplands. It formed in sandy eolian material over loamy material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very

friable loamy sand about 11 inches thick. The subsoil is about 29 inches thick. It is pale brown, very friable loamy sand in the upper part; pale brown, friable silty clay loam in the next part; and very pale brown, friable sandy clay loam in the lower part. The underlying material to a depth of more than 60 inches is pale yellow very fine sandy loam. In some places the surface layer is sandy loam or sand. In places the thickness of the sandy material over the loamy material ranges from less than 20 inches to more than 40 inches.

Included with this soil in mapping are small areas of Nora, Paka, and Thurman soils. Nora and Paka soils have more clay in the upper part of the profile than the Boelus soil. They are in landscape positions similar to those of the Boelus soil. Thurman soils are sandy throughout. They are in the higher landscape positions. Also included are small areas that have slopes of less than 6 percent and areas where the loamy material is exposed at the surface. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Boelus soil and moderate in the lower part. The available water capacity and the water intake rate are high. Runoff is medium. Organic matter content is moderately low. Natural fertility is medium. The soil can be easily tilled when moist or dry.

About half of the acreage of this soil is farmed, and some is irrigated. The remaining acreage supports cool-season grasses or native grasses.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, oats, and alfalfa. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and field windbreaks help to control soil blowing. Where slopes are suitable, terraces and grassed waterways can help to control water erosion. Conserving water is a management concern. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and improve the rate of water intake.

If irrigated, this soil is suited to close-growing crops, such as alfalfa, oats, rye, and introduced grasses. Center-pivot sprinkler systems are the most suitable irrigation methods. Soil blowing and water erosion are hazards. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Where slopes are suitable, terraces and grassed waterways can help to control water erosion. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and improve the rate of water intake.

Using areas of this soil for pastures of introduced grasses can help to control erosion. Cool-season grasses, such as smooth bromegrass, orchardgrass, or tall fescue, seeded in a mixture with alfalfa are suitable species. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Introduced grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer and irrigating can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. The trees and shrubs selected for planting should be those that are tolerant of sandy and somewhat droughty conditions. Insufficient moisture and a severe hazard of soil blowing are the main concerns when trees are established. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Irrigation can provide supplemental moisture during extended dry periods. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by cultivation, hand hoeing, or timely applications of herbicides.

The moderate permeability is a limitation on sites for septic tank absorption fields. It can be overcome by increasing the size of the absorption field. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Sealing lagoons helps to prevent seepage. The sides of shallow excavations can cave in unless they are shored. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IVe-6, dryland, and IVe-10, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

BvG—Bristow silty clay, 30 to 60 percent slopes. This shallow, very steep, well drained soil is on upland side slopes. It formed in light colored, calcareous shale bedrock. Catsteps are common. Areas range from 10 to 300 acres in size.

Typically, the surface layer is light olive brown, firm, calcareous silty clay about 6 inches thick. The underlying material is about 10 inches thick. It is light yellowish brown, calcareous clay. Pale yellow, calcareous shale bedrock is at a depth of about 16 inches. In places shale bedrock crops out at the surface.

Included with this soil in mapping are small areas of Labu, Lynch, Sansarc, and Verdel soils. Labu and Sansarc soils formed in darker shale bedrock than the Bristow soil. They are typically in the higher positions on slopes. Lynch soils have shale bedrock at a depth of 20 to 40 inches. They are lower on the landscape than the Bristow soil. Verdel soils are very deep. They are in the lower positions on foot slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is slow in the Bristow soil. The available water capacity is very low. Runoff is very rapid. Organic matter content is moderately low. Natural fertility is low. The shrink-swell potential is high.

Most of the acreage of this soil supports native grasses and is used for range. A few of the north-facing slopes and steep areas along upland drainageways are covered with trees. The soil is not suited to crops because it is too steep and erodible.

If this soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, western wheatgrass, and forbs make up the rest. If continuous heavy grazing is allowed, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs. If overgrazing continues for many years, the less desirable woody plants may increase in abundance.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly located fences and watering and salting facilities can result in a more uniform distribution of grazing. Livestock cannot easily cross very steep areas. Brush control may be needed in some areas to control the growth of woody plants that invade the site.

This soil is not suited to trees grown as windbreaks. Because of the slope, conventional equipment cannot be used. Onsite investigation is needed to determine small areas that can be used for plantings that enhance recreational areas and wildlife habitat. Hand planting of trees or shrubs is necessary in these areas.

This soil generally is not suited to septic tank absorption fields, sewage lagoons, or building site development because of the slope and the shallow depth to bedrock. A suitable alternative site should be selected. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling are generally needed to provide a suitable grade for roads. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is VIIs-4, dryland. The range site is Shallow Limy, and the windbreak suitability group is 10.

BwD—Brunswick fine sandy loam, 6 to 11 percent slopes. This moderately deep, strongly sloping, well drained soil is on uplands. It formed in material weathered from sandstone bedrock. Individual areas range from 5 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The subsoil is very friable fine sandy loam about 19 inches thick. It is brown in the upper part and pale brown in the lower part. The underlying material is light gray fine sandy loam about 10 inches thick. White, weakly cemented sandstone bedrock is at a depth of about 35 inches. In some places the surface layer is loamy fine sand. In other places the subsoil is loamy fine sand. In some areas the sandstone bedrock is below a depth of 40 inches. In other areas part or all of the soil profile and the underlying bedrock are calcareous.

Included with this soil in mapping are small areas of Bazile, Mariaville, Paka, and Thurman soils. Bazile and Thurman soils are higher on the landscape than the Brunswick soil. They are very deep. Bazile soils have sandy underlying material. Thurman soils are sandy throughout. Mariaville soils contain more clay than the Brunswick soil. They have siltstone bedrock at a depth of 10 to 20 inches. They are in landscape positions similar to those of the Brunswick soil. Paka soils are slightly higher on the landscape than the Brunswick soil. Also, they contain more clay and less sand. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Brunswick soil. The available water capacity is low. The water intake rate is moderately high. Runoff is medium. Organic matter content and natural fertility are low. Soft sandstone bedrock is within a depth of 20 to 40 inches. The soil is easy to till.

About half of the acreage of this soil is farmed. Most areas are dry-farmed. A few areas are irrigated by sprinklers. Some areas support native grasses and are used for grazing or hay. A few areas support pastures of introduced grasses or trees planted mainly for farmstead windbreaks.

If dry-farmed, this soil is poorly suited to small grain, alfalfa, grain sorghum, corn, and soybeans. Water erosion and soil blowing are severe hazards. Gully erosion is a major management concern. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Where slopes are suitable, terraces, contour farming, and grassed waterways help to control water erosion. Returning crop residue to the soil and applying feedlot manure improve tilth and organic matter content. Applications of lime may be needed in some areas.

If irrigated, this soil is best suited to alfalfa, corn, and grain sorghum. It is suited only to sprinkler systems because of the slope and the moderately high rate of water intake. Timely irrigation is needed because of the low available water capacity. Water erosion and soil blowing are severe hazards. Gully erosion is a major management concern. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Where slopes are suitable, terraces, contour farming, and grassed waterways help to control water erosion. Planting cover crops or leaving crop residue on the surface helps to control soil blowing and water erosion.

This soil is suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing or improper haying methods reduce productivity, the amount of protective plant cover, and the vigor of plants. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying can help to maintain or improve the range condition.

This soil is fairly suited to trees and shrubs grown as windbreaks or as plantings that enhance recreational areas and wildlife habitat. Survival and growth rates of adapted species are fair. The main concerns are drought and the weeds and grasses that compete with the trees for moisture. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Plant competition can be controlled by proper site preparation, timely cultivation, and application of approved herbicides.

The moderate depth to sandstone bedrock is a limitation on sites for septic tank absorption fields. Building up or mounding the site for septic tank absorption fields with suitable fill material can increase the filtering capacity of the soil. On sites for sewage lagoons, grading is needed to modify the slope. Sealing the lagoon helps to prevent seepage. The soil is suited to building site development and local roads and streets. Buildings should be designed to accommodate the slope. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IVe-3, dryland, and IVe-9, irrigated. The range site is Sandy, and the windbreak suitability group is 7.

BxE—Brunswick-Paka complex, 6 to 15 percent slopes. These moderately deep, strongly sloping to moderately steep, well drained soils are on uplands. They formed in material weathered from sandstone and siltstone bedrock. The Brunswick soil is generally in the more sloping areas on the lower side slopes. The Paka soil is in the less sloping areas on the upper side slopes. Areas of these soils range from 5 to 100 acres in size. They are 40 to 50 percent Brunswick soil and 30 to 40 percent Paka soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Brunswick soil is light brownish gray, very friable fine sandy loam about 9 inches thick. The subsoil is very friable fine sandy loam about 11 inches thick. It is light gray in the upper part and white in the lower part. The underlying material is white loamy fine sand about 15 inches thick. White, weakly cemented sandstone bedrock is at a depth of about 35 inches. In some areas the surface layer or subsoil is loamy fine sand. In other areas small fragments of sandstone are on the surface and throughout the solum. In some places soft sandstone bedrock is below a depth of 40 inches. In other places,

the soil contains carbonates and the sandstone bedrock is calcareous.

Typically, the surface layer of the Paka soil is dark grayish brown, friable loam about 9 inches thick. The subsoil is firm clay loam about 18 inches thick. It is grayish brown in the upper part and light brownish gray and calcareous in the lower part. The underlying material, to a depth of about 34 inches, is light gray, calcareous clay loam. Below this to a depth of more than 60 inches is white, calcareous, weakly cemented siltstone bedrock. In some places the surface layer is fine sandy loam or sandy clay loam. In other places the underlying material is very fine sandy loam or sandy clay loam. On the lower slopes the soft siltstone bedrock is below a depth of 40 inches. In some areas the soil is noncalcareous throughout.

Included with these soils in mapping are small areas of Crofton, Mariaville, Meadin, and Thurman soils. Crofton and Mariaville soils are in landscape positions similar to those of the Brunswick and Paka soils. Crofton and Thurman soils are very deep. Crofton soils are silty throughout. Mariaville soils have soft siltstone bedrock at a depth of 10 to 20 inches. Meadin and Thurman soils are higher on the landscape than the Brunswick and Paka soils. Meadin soils have gravelly coarse sand at a depth of 10 to 20 inches. Thurman soils are sandy throughout. Also included are some small areas of rock outcrop. Included areas make up 15 to 25 percent of the unit.

Permeability is moderately rapid in the Brunswick soil and moderate or moderately slow in the Paka soil. The available water capacity is low in the Brunswick soil and moderate in the Paka soil. Runoff is medium on both soils. Organic matter content is low in the Brunswick soil and moderate in the Paka soil. Natural fertility is low in the Brunswick soil and medium in the Paka soil.

About half of the acreage of these soils is farmed. Most areas are dry-farmed. A few areas are irrigated by sprinkler systems. Some areas support native grasses and are used for grazing or hay. A few areas support pastures of introduced grasses or trees planted mainly for farmstead windbreaks.

If dry-farmed, these soils are poorly suited to small grain, alfalfa, grain sorghum, and corn. Water erosion and soil blowing are severe hazards. Gully erosion is a major management concern. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Where slopes are suitable, terraces, contour farming, and grassed waterways help to control water erosion. Returning crop residue to the soil and applying feedlot manure improve tilth and organic matter content. Applications of lime may be needed in some areas.

Most areas of these soils are unsuited to irrigated cropland because they are too erodible.

These soils are suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing or improper haying methods reduce productivity, the amount of protective plant cover, and the vigor of plants. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses.

These soils are suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying can help to maintain or improve the range condition.

These soils are fairly suited to trees and shrubs grown as windbreaks and as plantings that enhance recreational areas and wildlife habitat. Survival and growth rates of adapted species are fair. The major concerns are drought and the weeds and grasses that compete with the trees for moisture. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Plant competition can be controlled by proper site preparation, timely cultivation, and application of approved herbicides.

The moderate depth to sandstone and siltstone bedrock is a limitation on sites for septic tank absorption fields. Building up or mounding the site for septic tank absorption fields with suitable fill material can increase the filtering capacity of the soils. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Sealing the lagoons helps to prevent seepage. Buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling in areas of the Paka soil. The surface pavement and base material of local roads should be thick enough to compensate for the low strength of the Paka soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action in areas of the Brunswick soil can be minimized by providing a good surface drainage system. Crowning

the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness. Cutting and filling are needed in areas of both soils to provide a suitable grade for roads.

The capability classification of the Brunswick soil is IVe-3, dryland. The range site is Sandy, and the windbreak suitability group is 7. The capability classification of the Paka soil is IVe-1, dryland. The range site is Silty, and the windbreak suitability group is 3.

BxF—Brunswick-Paka complex, 15 to 30 percent slopes. These moderately deep, steep, well drained soils are on uplands. They formed in material weathered from sandstone and siltstone bedrock. The Brunswick soil is generally in the more sloping areas on the lower side slopes. The Paka soil is in the less sloping areas on the upper side slopes. Areas of these soils range from 5 to 1,200 acres in size. They are 50 to 60 percent Brunswick soil and 20 to 40 percent Paka soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Brunswick soil is dark grayish brown, friable fine sandy loam about 5 inches thick. The subsoil also is friable fine sandy loam. It is about 11 inches thick. The upper part is grayish brown, and the lower part is light gray. The underlying material, to a depth of 36 inches, is light gray fine sandy loam. Below this to a depth of more than 60 inches is white, weakly cemented sandstone bedrock. In some places the surface layer or subsoil is loamy fine sand. In other places a few small fragments of sandstone are on the surface and throughout the solum. In some areas the soft sandstone bedrock is below a depth of 40 inches. In other areas, the profile contains carbonates and the sandstone bedrock is calcareous.

Typically, the surface layer of the Paka soil is dark gray, friable loam about 7 inches thick. The subsoil is firm, calcareous clay loam about 14 inches thick. The upper part is grayish brown, and the lower part is light brownish gray. The underlying material, to a depth of about 34 inches, is light gray, calcareous clay loam. Below this to a depth of more than 60 inches is white, calcareous, weakly cemented siltstone bedrock. In some places the surface layer is very fine sandy loam, silt loam, or sandy clay loam. In other places the subsoil is silt loam, sandy clay loam, or silty clay loam. In some areas the underlying material is very fine sandy loam, loam, sandy clay loam, or silty clay loam. In other areas the surface layer is lighter colored. In places a few small fragments of siltstone are on the surface and throughout the solum. On the lower slopes the soft sandstone bedrock is below a depth of 40 inches. In some areas the soil is noncalcareous throughout.

Included with these soils in mapping are small areas of Crofton, Mariaville, Meadin, and Thurman soils. Crofton and Mariaville soils are in landscape positions similar to those of the Brunswick and Paka soils. Crofton and Thurman soils are very deep. Crofton soils are silty throughout. Mariaville soils have soft siltstone bedrock at a depth of 10 to 20 inches. Meadin and Thurman soils are higher on the landscape than the Brunswick and Paka soils. Meadin soils have gravelly coarse sand at a depth of 10 to 20 inches. Thurman soils are sandy throughout. Also included are some small areas of rock outcrop. Included areas make up 15 to 25 percent of the unit.

Permeability is moderately rapid in the Brunswick soil and moderate or moderately slow in the Paka soil. The available water capacity is low in the Brunswick soil and moderate in the Paka soil. Runoff is rapid on both soils. Organic matter content is low in the Brunswick soil and moderate in the Paka soil. Natural fertility is low in the Brunswick soil and medium in the Paka soil.

Nearly all of the acreage of these soils supports native grasses and is used for range. Some areas on north-facing slopes and near drainageways support native trees. Because of the slope and a severe hazard of water erosion, the soils are unsuited to dryland and irrigated crops. Gully erosion is a severe hazard on slopes.

If the Brunswick soil is used as range, the climax vegetation is dominantly little bluestem, sand bluestem, needleandthread, and prairie sandreed. These species make up 65 percent or more of the total annual forage on this soil. Blue grama, sideoats grama, sedge, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem and prairie sandreed decrease in abundance and are replaced by sand dropseed, needleandthread, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, bluegrass, sand dropseed, needleandthread, Scribner panicum, and numerous annual and perennial weeds dominate the site.

If the Paka soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, sideoats grama, and needleandthread. These species make up 65 percent or more of the total annual forage on this soil. Switchgrass, indiangrass, blue grama, western wheatgrass, sedge, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, switchgrass, and indiangrass decrease in abundance and are replaced by needleandthread, sideoats grama, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, needleandthread, sedge, and numerous annual

and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control water erosion.

These soils are generally unsuited to trees grown as windbreaks. Onsite investigation is needed to determine areas that are suitable for planting. Many areas are too steep for machine planting. Some areas can be used for plantings that enhance recreational areas and wildlife habitat if trees and shrubs are hand planted or other special practices are applied. Bur oak trees are native and grow well on some north slopes in areas of these soils. The native trees provide shade for cattle and provide excellent wildlife habitat.

These soils generally are not suited to sanitary facilities because of the slope and the moderate depth to bedrock. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the soils can be graded to a suitable gradient. Cutting and filling are needed to provide a suitable grade for roads and streets. The surface pavement and base material of local roads should be thick enough to compensate for the low strength of the Paka soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification of the Brunswick soil is VIe-3, dryland. The range site is Sandy, and the windbreak suitability group is 10. The capability classification of the Paka soil is VIe-1, dryland. The range site is Silty, and the windbreak suitability group is 10.

By—Butler silt loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is in upland swales. It formed in loess. Areas range from 5 to 30 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 7 inches thick. The subsurface layer also is dark gray, friable silt loam about 7 inches thick. The subsoil extends to a depth of more than 60 inches. It is very firm silty clay. It is very dark gray in the upper part, dark gray in the next part, and light brownish gray in the lower part.

Included with this soil in mapping are small areas of Fillmore, Scott, and Trent soils. Fillmore and Scott soils are in upland depressions. Fillmore soils are somewhat poorly drained. Scott soils are poorly drained. Trent soils have less clay than the Butler soil. They are well drained or moderately well drained. They are in landscape positions similar to those of the Butler soil. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Butler soil. The available water capacity is moderate. The water intake rate is low. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. A perched seasonal high water table ranges from 0.5 foot below the surface during wet years to about 3.0 feet below the surface during dry years. The soil cannot be easily tilled during wet years because it stays wet for prolonged periods. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated or supports cool-season grasses used for grazing or hay. A few areas are irrigated. A small acreage supports native grasses.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, wheat, oats, and alfalfa. Wetness and runoff are the main concerns. Fieldwork may be delayed during the spring in some years because of excessive rainfall. Where slopes are suitable, terraces and contour farming on adjacent fields can reduce some of the runoff onto the Butler soil. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth. Applications of lime may be needed.

If irrigated, this soil is suited to most of the crops commonly grown in the county. Corn is the main irrigated crop, but grasses also are suited to irrigation. A sprinkler system is the best suited method of irrigation. Land leveling may be needed in areas where gravity irrigation is used. If the soil is irrigated by sprinklers, the rate of water application should be adjusted to the low intake rate of the soil. If border or furrow systems are used, land leveling can provide even distribution of water. In large areas, reuse pits can be dug if a gravity irrigation system is used.

This soil is suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa or orchardgrass. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying can help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are good if competing vegetation is controlled

and if the species selected for planting are those that can tolerate occasional wetness. Planting may be delayed during the spring in some years because of wetness. Weeds can be controlled by proper site preparation, timely cultivation, or application of appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the slow permeability and the wetness. A suitable alternative site should be selected. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table. Sealing the bottom of the lagoon helps to prevent seepage. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material for roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling. Providing adequate roadside ditches and culverts helps to prevent the damage caused by wetness.

The capability classification is IIw-2, dryland and irrigated. The range site is Clayey, and the windbreak suitability group is 2W.

Co—Coleridge silt loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land. It formed in silty alluvium. It is subject to occasional flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 7 inches thick. The subsurface layer is about 29 inches thick. The upper part is very dark gray, friable silt loam, and the lower part is dark grayish brown, firm silty clay loam. The subsoil is light gray, mottled, firm silty clay loam about 9 inches thick. The underlying material to a depth of more than 60 inches is light gray, mottled, calcareous silty clay loam. Some small areas have a surface layer of silty clay loam or loam. Other small areas have a subhorizon that is slightly calcareous. In places the soil has mottles at a depth of about 26 inches or is gray above a depth of 36 inches.

Included with this soil in mapping are small areas of Kezan, Obert, and Shell soils. Kezan soils are in landscape positions similar to those of the Coleridge soil. They have a surface layer that is stratified and calcareous. They are poorly drained. Obert soils are in the slightly lower landscape positions. They are very poorly drained. Shell soils are in the slightly higher landscape positions. They are well drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Coleridge soil. The available water capacity is high. The water intake rate is moderately low. Runoff is slow. Organic matter content is moderate. Natural fertility is high. Tilth is good. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to about 3.5 feet below the surface during dry years.

Most of the acreage of this soil is farmed. Most areas are dry-farmed. Some areas are irrigated. The remaining acreage mainly supports pastures of native grasses.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. The occasional flooding is the main hazard. During spring in some years, the wetness caused by the high water table is the main limitation. The flooding and the wetness sometimes delay tillage and timely planting. The wetness also slows the warming of the soil in the spring. Management practices, such as terraces, diversions, and a system of conservation tillage, are needed in adjacent upland areas to help control runoff. Grassed waterways can help to control runoff and flooding. If suitable outlets are available, tile drains can improve internal drainage. Ditches can also improve drainage. A system of conservation tillage that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. Land leveling can improve surface drainage and the efficiency of irrigation systems. The flooding and the wetness sometimes delay tillage and timely planting. Terraces, diversions, and a system of conservation tillage are needed in adjacent upland areas to help control flooding. Grassed waterways can help to control runoff and flooding. If suitable outlets are available, tile drains can improve internal drainage. Constructing ditches can also improve drainage. A system of conservation tillage that leaves part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses for pasture.

Smooth bromegrass is a common species. Overgrazing or improper haying methods reduce productivity and the amount of protective plant cover. Proper stocking rates, rotation grazing, and weed control are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that are tolerant of occasional wetness. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; through applications of the appropriate herbicide; or by cultivation practices, such as hand hoeing or rototilling.

This soil is not suited to septic tank absorption fields because of the flooding, the wetness, and the restricted permeability. A suitable alternative site should be selected. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table. Diking the lagoons helps to prevent the damage caused by flooding. The soil is not suited to building site development because of the flooding and the wetness. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding and wetness. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIw-4, dryland and irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

CrC2—Crofton silt loam, 2 to 6 percent slopes, eroded. This very deep, gently sloping, well drained soil is on long, narrow, convex ridgetops in the uplands. It formed in silty, calcareous loess. In areas of cropland, the formation of rills is common after periods of heavy rainfall. In most places erosion has removed the original dark surface layer and the transitional layer. Areas range from 5 to 40 acres in size.

Typically, the surface layer is light brownish gray, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of lime. In areas of native grasses, the upper 2 to 6 inches of the soil is darker and is leached of lime in some places. In some areas that are near older soil materials, the soil is silty clay loam and contains large concretions of lime.

Included with this soil in mapping are small areas of Betts, Nora, and Thurman soils. Betts soils are in the slightly lower landscape positions. They formed in clay loam derived from glacial till. Nora soils are in the slightly lower positions on side slopes. They have a thicker dark surface layer than the Crofton soil. They have lime below a depth of 12 inches. Thurman soils are sandy throughout. They are somewhat excessively drained. They are in the higher landscape positions. Also included near some older soil materials are a few small areas of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is low. The content of calcium is high, and the content of available phosphorus is low. Some areas have a low content of sulfur and zinc. Natural fertility is low. The soil is easy to till.

Most of the acreage of this soil is farmed. Most areas are dry-farmed. Some areas where sufficient water is available are irrigated. A few areas are seeded to introduced grasses and are used for grazing or are mowed for hay. Some areas support native grasses. A small acreage supports trees planted mainly for farmstead windbreaks.

If dry-farmed, this soil is suited to corn, oats, alfalfa, grain sorghum, and soybeans. Water erosion is the main hazard if the soil is not protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. The low fertility and conservation of water are the principal management concerns. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus,

which is unavailable for use by plants because of the excessive amount of free carbonates in the soil.

If irrigated by sprinklers, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is well suited to center-pivot sprinkler systems. Most areas are not suited to gravity irrigation because of the hazard of erosion. Water erosion, runoff, and the low fertility are management concerns. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Timely and efficiently distributed applications of water are needed. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of free carbonates in the soil.

This soil is suited to introduced or domesticated grasses or legumes for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Water erosion is a hazard in areas that are overgrazed. Rotation grazing and proper stocking rates help to keep the grasses in good condition. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled by applying appropriate herbicides.

This soil is suited to range. Using areas of this soil as range can help to control water erosion and soil blowing. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Overgrazing also can result in water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to most of the trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. The growth of some species is restricted by excessive amounts of lime in the soil. The trees and shrubs selected for planting should be those that are tolerant of a high amount of calcium. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary in some years.

This soil is generally suited to septic tank absorption fields, dwellings, and small commercial buildings. Increasing the size of the absorption field can help to overcome the moderate permeability. On sites for sewage lagoons, grading is needed to modify the slope. Sealing the lagoon helps to prevent seepage. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-8, dryland, and IIIe-6, irrigated. The range site is Limy Upland, and the windbreak suitability group is 8.

CrD2—Crofton silt loam, 6 to 11 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on side slopes in the uplands. It formed in silty, calcareous loess. In areas of cropland, rills and small gullies form after periods of heavy rainfall. In most places erosion has removed the original dark surface layer and transitional layer. Areas range from 5 to 100 acres in size.

Typically, the surface layer is light brownish gray, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of lime. In areas of native grasses, the upper 2 to 6 inches of the soil is darker and is leached of lime in some places. In some areas that are near older soil materials, the soil is silty clay loam and contains large concretions of lime.

Included with this soil in mapping are small areas of Betts, Nora, and Thurman soils. Betts soils are in the slightly lower landscape positions. They formed in clay loam derived from glacial till. Nora soils are in the lower positions on side slopes. They have a thicker dark surface layer than the Crofton soil. They have lime below a depth of 12 inches. Thurman soils are in the higher landscape positions. They are sandy throughout. They are somewhat excessively drained. Also included in some places near older soil materials are a few small areas of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content and natural fertility are low. The content of calcium is

high, and the content of available phosphorus is low. Some areas have a low content of sulfur and zinc. The soil is easy to till.

Most of the acreage of this soil is farmed. Most areas are dry-farmed. Some areas where sufficient water is available are irrigated. A few areas are seeded to introduced grasses and are used for grazing or are mowed for hay. Some areas support native grasses. A small acreage supports trees planted mainly for farmstead windbreaks.

If dry-farmed, this soil is poorly suited to cultivated crops because of the severe hazard of erosion. It is better suited to close-growing crops, such as oats and alfalfa. The hazard of sheet and rill erosion is severe. Gully erosion is common in areas near drainageways. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. The low fertility and the conservation of water are the principal management concerns. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of free carbonates in the soil.

If irrigated by sprinklers, this soil is suited to close-growing crops, such as alfalfa, and to cool-season grasses. It is well suited to center-pivot sprinkler systems. Corn, grain sorghum, and soybeans also are irrigated, but erosion is a severe hazard in irrigated areas where these crops are grown. Water erosion, runoff, and low fertility are management concerns. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Timely and efficiently distributed applications of water are needed. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of free carbonates in the soil.

This soil is suited to introduced or domesticated grasses or legumes for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Water erosion is a hazard in areas that are overgrazed. Rotation grazing and proper stocking rates help to keep the grasses in good condition. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Using areas of this soil as range helps to control water erosion and soil blowing. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Overgrazing also can result in water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to most of the trees and shrubs grown as windbreaks. The trees and shrubs selected for planting should be those that are tolerant of a high amount of calcium. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary in some years. Planting trees on the contour, using terraces, and maintaining a cover crop between the tree rows help to control erosion.

The slope and the moderate permeability are limitations on sites for septic tank absorption fields. Land shaping, installing the septic tank absorption field on the contour, and increasing the size of the field help to ensure that the field functions properly. The soil is poorly suited to sewage lagoons because of the slope. If alternative sites are not available, cutting and filling can help to modify the slope. Sealing the lagoon with chemicals helps to prevent seepage. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IVe-8, dryland, and IVe-6, irrigated. The range site is Limy Upland, and the

windbreak suitability group is 8.

CrE2—Crofton silt loam, 11 to 15 percent slopes, eroded. This very deep, moderately steep, well drained soil is on smooth to convex hillsides in the uplands. It formed in silty, calcareous loess. In areas of cropland, rills and small gullies form after periods of heavy rainfall. In most places erosion has removed the original dark surface layer and transitional layer. Areas range from 5 to 200 acres in size.

Typically, the surface layer is pale brown, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of lime. In areas of native grasses, the upper 2 to 6 inches of the soil is darker and is leached of lime in places. In some areas that are near older soil materials, the soil is silty clay loam and contains large concretions of lime.

Included with this soil in mapping are small areas of Betts, Nora, and Thurman soils. Betts soils are in the slightly lower landscape positions. They commonly occur on northwest-facing slopes. They formed in clay loam derived from glacial till. Nora soils are in the lower positions on side slopes. They have a thicker dark surface layer than the Crofton soil. They have lime below a depth of 12 inches. Thurman soils are in the higher landscape positions. They are sandy throughout. They are somewhat excessively drained. Also included near some older soil materials are a few small areas of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton soil. The available water capacity is high. Runoff is medium. Organic matter content is low. Natural fertility also is low. The content of calcium is high, and the content of available phosphorus is low. Some areas have a low content of sulfur and zinc. The soil is easy to till. In sloping areas, the use of farm machinery is difficult.

About half of the acreage of this soil is farmed. Most areas are dry-farmed. Some small areas are irrigated. Many areas support introduced or native grasses and are used for grazing or are mowed for hay. A small acreage supports trees planted for farmstead windbreaks.

If dry-farmed, this soil is poorly suited to cultivated crops because of the slope and the severe hazard of erosion. It is better suited to close-growing crops, such as alfalfa and oats, than to corn and grain sorghum. The hazard of sheet and rill erosion is very severe. Gully erosion is common in areas near drainageways. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. The low fertility and the conservation of water are the principal management concerns. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply nutrients, especially phosphorus, which is unavailable for use by plants because of excessive amounts of free carbonates in the soil.

This soil is not suited to irrigation because of the slope and the hazard of water erosion.

This soil is suited to introduced or domesticated grasses or legumes for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Water erosion is a hazard in areas that are overgrazed. Rotation grazing and proper stocking rates help to keep the grasses in good condition. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Using areas of this soil as range can help to control water erosion and soil blowing. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Overgrazing can also result in water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to most of the trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. The growth of some species is restricted by an excessive amount of lime in the soil. The trees and shrubs selected for planting should be those that are tolerant of a high amount of lime. Planting trees on the contour, using terraces, and planting a cover crop between the tree rows can help to control water erosion. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary in some years.

The slope and the moderate permeability are limitations on sites for septic tank absorption fields. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. The soil is poorly suited to sewage lagoons because of the slope. If alternative sites are not available, cutting and filling can help to modify the slope. Sealing the lagoons with chemicals helps to prevent seepage. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IVe-8, dryland. The range site is Limy Upland, and the windbreak suitability group is 8.

CrF—Crofton silt loam, 15 to 30 percent slopes. This very deep, well drained, steep soil is on side slopes in the uplands. It formed in silty, calcareous loess. A few catsteps, narrow, entrenched drainageways, and gullies occur in some places. Areas range from 5 to 400 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 6 inches thick. Below this is a transitional layer of brown, friable silt loam about 5 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of lime. In a few areas the upper 2 to 6 inches of the soil is leached of lime. In some small cultivated areas, the surface layer is eroded and lighter colored. In some places that are near older soil materials, the soil is silty clay loam and contains large concretions of lime.

Included with this soil in mapping are small areas of Betts, Nora, and Thurman soils. Betts soils are in the slightly lower landscape positions. They formed in clay loam derived from glacial till. Nora soils are in the lower positions on side slopes. They have a thicker dark surface layer than the Crofton soil. They have lime below a depth of 12 inches. Thurman soils are in the slightly higher landscape positions. They are sandy throughout. They are somewhat excessively drained. Also included near some older soil materials are a few small areas of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton soil. The available water capacity is high. Runoff is rapid. Organic matter content is moderately low. The content of calcium is high, and the content of available phosphorus is low. Moisture is released readily to plants. Natural fertility is low.

Most of the acreage of this soil supports native grasses and is used as range. Some areas are mowed for hay. A few small areas are cultivated or have been reseeded to introduced grasses for pasture. Small acreages support trees planted for farmstead windbreaks. Some small areas on north-facing slopes support native trees and shrubs.

This soil is not suited to cultivated crops. It is too erodible and steep to be crossed safely with farm machinery. If the soil is plowed, slopes are very susceptible to rill and gully erosion.

If this soil is used as range or hayland, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Plains muhly, needleandthread, western wheatgrass, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, prairie sandreed, tall dropseed, western wheatgrass, needleandthread, plains muhly, sedges, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive. Woody plants, such as bur oak, eastern redcedar, buckbrush, snowberry, and sumac, may invade the site. Brush management and prescribed burning may be needed to control the growth of woody plants.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

Onsite investigation is needed to determine the areas most suitable for trees grown as windbreaks. Some areas can be used for plantings that enhance

recreational areas or wildlife habitat if the trees and shrubs are hand planted or if other special practices are applied.

This soil generally is not suited to septic tank absorption fields and sewage lagoons because of the slope. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads.

The capability classification is VIe-9, dryland. The range site is Limy Upland, and the windbreak suitability group is 10.

CrG—Crofton silt loam, 30 to 60 percent slopes. This very deep, well drained, very steep soil is on side slopes in the uplands. It formed in silty, calcareous loess. In some areas, this soil is on the upper part of slopes and catsteps are common. The lower slopes have some gullies and entrenched, intermittent drainageways. Areas range from 5 to 200 acres in size.

Typically, the surface layer is pale brown, friable silt loam about 6 inches thick. Below this is a transitional layer that is also pale brown, friable silt loam. It is about 7 inches thick. The underlying material to a depth of more than 60 inches is very pale brown silt loam. The soil is calcareous and contains a few small concretions of lime.

Included with this soil in mapping are small areas of Betts, Nora, and Simeon soils. Betts soils formed in clay loam derived from glacial till. They contain a few stones throughout. Nora soils have a dark surface layer. They are leached of lime below a depth of 12 inches. Simeon soils formed in sandy outwash material. They are excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton soil. The available water capacity is high. Runoff is very rapid. Organic matter content is moderately low. The content of calcium is high, and the content of available phosphorus is low. Moisture is released readily to plants. Natural fertility is low.

Most of the acreage of this soil supports native grasses and is used as range. Some areas on the lower north-facing slopes support native trees and shrubs.

This soil is not suited to cultivated crops or introduced grasses. It is too erodible and steep to be crossed safely with farm machinery.

If this soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, blue grama, and sideoats grama. These species make up 70 percent or more of the total annual forage. Western wheatgrass, hairy grama, indiangrass, plains muhly, switchgrass, needleandthread, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, and sideoats grama decrease in abundance and are replaced by blue grama, hairy grama, plains muhly, prairie sandreed, needleandthread, and forbs. If overgrazing continues for many years, the plants lose vigor and are unable to stabilize the site. As a result, water erosion is excessive and bur oak, eastern redcedar, buckbrush, snowberry, and sumac invade the site. Brush management and prescribed burning may be needed to control the growth of woody plants.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope makes it difficult for livestock to graze in areas of this soil.

This soil is not suited to the mechanical planting of trees and shrubs grown as windbreaks or as plantings that enhance recreational areas and wildlife habitat. Areas are too steep for planting and cultivating with conventional equipment. Adapted seedlings can be planted by hand. Weeds can be controlled by hoeing or by applying herbicides.

This soil generally is not suited to septic tank absorption fields or sewage lagoons because of the slope. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads.

The capability classification is VIIe-9, dryland. The range site is Thin Loess, and the windbreak suitability group is 10.

CsC2—Crofton-Nora complex, 2 to 6 percent slopes, eroded. These very deep, gently sloping, well drained soils are on narrow ridgetops in the uplands. They formed in loess. The Crofton soil is on convex ridgetops. The Nora soil is in long, plane areas on the lower side slopes. Areas of these soils range from 10 to

40 acres in size. They are 50 to 65 percent Crofton soil and 30 to 40 percent Nora soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical. In areas of cropland, rills form after periods of heavy rainfall. In cultivated areas water erosion has removed the original dark surface layer of the Crofton soil and part of the dark surface layer of the Nora soil.

Typically, the surface layer of the Crofton soil is light brownish gray, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of lime. In areas of native grasses, the upper 2 to 6 inches of the soil is darker and is leached of lime in places.

Typically, the surface layer of the Nora soil is grayish brown, friable silty clay loam about 7 inches thick. The upper part of the subsoil is pale brown, friable silty clay loam about 11 inches thick. The lower part is very pale brown, calcareous, friable silt loam about 15 inches thick. It contains small concretions of lime. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

Included with these soils in mapping are small areas of Betts, Moody, and Thurman soils. Betts soils are in landscape positions similar to those of the Crofton and Nora soils. They formed in clay loam derived from glacial till. Moody soils have a dark surface layer. They have carbonates below a depth of 30 inches. They are in the slightly higher positions on broad ridgetops. Thurman soils are in the higher landscape positions. They are sandy throughout. They are somewhat excessively drained. Also included are small nearly level areas and a few strongly sloping areas. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton and Nora soils. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is low in the Crofton soil and moderate in the Nora soil. The content of calcium is high in the Crofton soil, and the content of available phosphorus is low. Both soils are easy to till. Natural fertility is low in the Crofton soil and medium in the Nora soil.

Most of the acreage of these soils is farmed. Most areas are dry-farmed. Some areas are irrigated if sufficient water is available. A few areas support introduced or native grasses. A small acreage supports trees planted mainly for farmstead windbreaks.

If dry-farmed, these soils are suited to corn, oats, alfalfa, grain sorghum, and soybeans. Water erosion is the main hazard if the soils are not protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. The low fertility and the conservation of water are the principal management concerns. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of free carbonates in the Crofton soil.

If irrigated by sprinklers, these soils are suited to corn, grain sorghum, soybeans, alfalfa, and introduced grasses. They are well suited to center-pivot sprinkler systems. Water erosion is a moderate hazard. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and erosion. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Timely and efficiently distributed applications of water are needed. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion. Most areas are not suited to gravity irrigation because of the hazard of erosion. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content and tilth. Applications of commercial fertilizer are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of free carbonates in the Crofton soil.

These soils are suited to introduced or domesticated grasses for pasture or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Water erosion is a hazard in areas that are overgrazed. Rotation grazing and proper stocking rates help to keep the grasses in good condition. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

These soils are suited to range. Using areas of these soils as range can help to control water erosion and soil blowing. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Overgrazing also can result in water erosion. Proper grazing use, timely deferment of

grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

These soils are suited to most of the trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. The growth of some species is restricted by an excessive amount of lime in the Crofton soil. The trees and shrubs selected for planting should be those that are tolerant of a high amount of calcium. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary in some years.

These soils are generally suited to septic tank absorption fields. On sites for sewage lagoons, grading is needed to modify the slope. Sealing the lagoons with chemicals helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling in areas of the Nora soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soils. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action in areas of the Nora soil can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification of the Crofton soil is IIIe-8, dryland, and IIIe-6, irrigated. The range site is Limy Upland, and the windbreak suitability group is 8. The capability classification of the Nora soil is IIIe-1, dryland, and IIIe-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

CsD2—Crofton-Nora complex, 6 to 11 percent slopes, eroded. These very deep, strongly sloping, well drained soils formed in loess on uplands. The Crofton soil is on the upper parts of hillsides or ridgetops. The Nora soil is on the lower hillsides and side slopes. In cultivated areas, erosion has removed all of the original dark surface soil of the Crofton soil and part of the dark surface layer of the Nora soil. Areas of these soils range from 10 to 200 acres in size. They are 50 to 70 percent Crofton soil and 30 to 50 percent Nora soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the surface layer of the Crofton soil is pale brown, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of carbonate. In areas of native grasses, the surface layer is darker and is leached of lime in places.

Typically, the surface layer of the Nora soil is grayish brown, friable silty clay loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is pale brown, friable silty clay loam, and the lower part is pale brown, friable, calcareous silt loam that has many concretions of lime. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

Included with these soils in mapping are small areas of Alcester, Betts, and Thurman soils. Alcester soils have a thick, dark surface soil. They are in the lower positions on foot slopes. Betts soils are in landscape positions similar to those of the Crofton and Nora soils. They formed in clay loam derived from glacial till. Thurman soils are in the higher landscape positions. They are sandy throughout. They are somewhat excessively drained. Also included are small gently sloping areas and moderately steep areas. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton and Nora soils. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is low in the Crofton soil and moderate in the Nora soil. The content of calcium is high in the Crofton soil, and the content of available phosphorus is low. Natural fertility is low in the Crofton soil and medium in the Nora soil. Both soils are easy to till.

Most of the acreage of these soils is farmed. Most areas are dry-farmed. A large area is irrigated. Some areas support native grasses or have been seeded to cool-season grasses. Some small areas support trees grown as windbreaks.

If dry-farmed, these soils are poorly suited to corn, oats, wheat, alfalfa, grain sorghum, and soybeans. Water erosion is the main hazard if the soils are not protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially

phosphorus, which is unavailable for use by plants because of the excessive amount of lime in the Crofton soil.

If irrigated by sprinklers, these soils are suited to oats, wheat, alfalfa, and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a very severe hazard in irrigated areas where these crops are grown. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of lime in the Crofton soil.

These soils are suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Proper grazing use and rotation grazing help to keep the grasses in good condition and control water erosion. Applying nitrogen fertilizer improves the growth and vigor of the grasses.

These soils are suited to native grasses used for range. Overgrazing and improper haying methods reduce the quality of the native grasses. Overgrazing also can result in water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

These soils are fairly well suited to trees and shrubs grown as windbreaks. The growth of some species is restricted by an excessive amount of lime in areas of the Crofton soil. The trees and shrubs selected for planting should be those that are tolerant of calcareous conditions. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary. Planting trees on the contour and using terraces help to control water erosion.

The slope is a limitation on sites for septic tank absorption fields. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the lagoons with chemicals helps to prevent seepage. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling in areas of the Nora soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soils. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action in areas of the Nora soil can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification of the Crofton soil is IVe-8, dryland, and IVe-6, irrigated. The range site is Limy Upland, and the windbreak suitability group is 8. The capability classification of the Nora soil is IVe-1, dryland, and IVe-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

CsE2—Crofton-Nora complex, 11 to 15 percent slopes, eroded. These very deep, moderately steep, well drained soils formed in loess on uplands. The Crofton soil is on the upper parts of hillsides and ridgetops. The Nora soil is on the lower hillsides. In cultivated areas, erosion has removed all of the original dark surface soil of the Crofton soil and the pale brown underlying material is at the surface. The formation of rills is common after periods of heavy rainfall. Areas of these soils range from 10 to 150 acres in size. They are 50 to 70 percent Crofton soil and 30 to 50 percent Nora soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Crofton soil is pale brown, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains concretions of calcium carbonate. In areas of native grasses, the surface layer is darker and is leached of lime in places.

Typically, the surface layer of the Nora soil is dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is about 23 inches thick. It is brown, friable silty clay loam in the upper part and pale brown, calcareous, friable silt loam in the lower part. The underlying material to a depth of more than 60 inches is pale brown, calcareous silt loam. In a few areas the

underlying material is silty clay loam. In other areas calcium carbonate is below a depth of 30 inches.

Included with these soils in mapping are small areas of Alcester, Betts, and Thurman soils. Alcester soils are on foot slopes. They have a thick, dark surface layer. They are in the lower landscape positions. Betts soils formed in glacial till. They are in landscape positions similar to those of the Crofton and Nora soils. Thurman soils are sandy throughout. They are somewhat excessively drained. They are in the higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Crofton and Nora soils. The available water capacity is high. Runoff is medium. Organic matter content and natural fertility of the Crofton soil are low. Organic matter content and natural fertility of the Nora soil are medium. The Crofton and Nora soils are easy to till, but in sloping areas the use of farm machinery is restricted.

Most of the acreage of these soils is dry-farmed. The soils are unsuited to irrigated crops because of the slope and the hazard of water erosion. The remaining acreage supports cool-season grasses or native grasses.

If dry-farmed, these soils are poorly suited to alfalfa, oats, corn, and grain sorghum. Water erosion is a hazard if the soils are not protected by vegetation. Row crops should not be grown continuously. The hazard of sheet and rill erosion is very severe, and gully erosion is common in areas near drainageways. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of lime in the Crofton soil.

These soils are well suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Overgrazing reduces the quality of desired grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition and control water erosion. Applying nitrogen fertilizers improves the growth and vigor of the introduced grasses. Weeds can be controlled if the appropriate herbicides are applied.

These soils are suited to native grasses used for range. Overgrazing or improper haying methods reduce the quality of the native grasses. Overgrazing also can result in water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

These soils are fairly well suited to trees and shrubs grown as windbreaks. The growth of some species is restricted by an excessive amount of lime in the Crofton soil. The trees and shrubs selected for planting should be those that are tolerant of calcareous conditions. Seedlings generally survive and grow moderately well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary in some years. Water erosion is a hazard. Planting trees on the contour and using terraces help to control water erosion and runoff.

The slope is a limitation on sites for septic tank absorption fields. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the lagoons with chemicals helps to prevent seepage. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling in areas of the Nora soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soils. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action in areas of the Nora soil can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification of the Crofton soil is IVe-8, dryland. The range site is Limy Upland, and the windbreak suitability group is 8. The capability classification of the Nora soil is IVe-1, dryland. The range site is Silty, and the windbreak suitability group is 3.

CtD2—Crofton-Thurman complex, 6 to 11 percent slopes, eroded. These very deep, strongly sloping, well drained and somewhat excessively drained soils formed in loess and sandy eolian material on uplands. The Crofton soil is on the upper side slopes. The Thurman soil is on the lower side slopes. The formation of rills is

common after periods of heavy rainfall. In cultivated areas of the Crofton soil, erosion has removed all or part of the original surface soil. Areas of these soils range from 10 to 100 acres in size. They are 30 to 70 percent Crofton soil and 30 to 70 percent Thurman soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Crofton soil is brown, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of carbonate. In areas of native grasses, the surface layer is darker and is leached of lime in places.

Typically, the surface layer of the Thurman soil is grayish brown, very friable fine sandy loam about 10 inches thick. Below this is a transitional layer of brown, very friable loamy fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is pale brown loamy fine sand. In places erosion has removed the original dark surface layer.

Included with these soils in mapping are small areas of Alcester, Nora, and Ortello soils. Alcester soils have a thick, dark, silty surface soil. They are in the lower positions on foot slopes. Nora soils have a dark, silty surface layer. They are leached of lime in the upper part of the profile. They are in landscape positions similar to those of the Crofton soil. Ortello soils have a loamy subsoil. They are in landscape positions similar to those of the Thurman soil. Also included are small gently sloping areas and moderately steep areas. Included areas make up 10 to 20 percent of the unit.

Permeability is moderate in the Crofton soil and rapid in the Thurman soil. The available water capacity is high in the Crofton soil and low in the Thurman soil. The water intake rate is moderate in the Crofton soil and very high in the Thurman soil. Runoff is medium on the Crofton soil and slow on the Thurman soil. Organic matter content is low in the Crofton soil and moderately low in the Thurman soil. Natural fertility is low in both soils.

More than half of the acreage of these soils is farmed. Most areas are dry-farmed. A few areas are irrigated. Some areas support native or cool-season grasses.

If dry-farmed, these soils are poorly suited to corn, soybeans, grain sorghum, oats, and alfalfa. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of lime in the Crofton soil.

If irrigated by sprinklers, these soils are suited to oats, alfalfa, and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a severe hazard in irrigated areas where these crops are grown. Adjusting the rate of water application to the moderate intake rate of the Crofton soil minimizes the amount of water that runs off and helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Applying feedlot manure and commercial fertilizers and returning crop residue to the soil help to maintain or improve organic matter content and fertility.

These soils are suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Warm-season grasses also can be grown. Overgrazing can reduce the amount of protective plant cover and the quality of the grasses and thus can result in the formation of rills after periods of heavy rainfall. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

These soils are suited to trees and shrubs grown as windbreaks. The growth of some species is restricted by an excessive amount of lime in the Crofton soil. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if

trees are planted. Irrigation may be necessary. Planting trees on the contour and using terraces help to control water erosion.

These soils are limited for use as sites for sanitary facilities. Land shaping and installing septic tank absorption fields on the contour help to ensure that the fields function properly. The Thurman soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the bottom of the lagoons helps to prevent seepage. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the Crofton soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads in areas of the Thurman soil.

The capability classification of the Crofton soil is IVe-8, dryland, and IVe-6, irrigated. The range site is Limy Upland, and the windbreak suitability group is 8. The capability classification of the Thurman soil is IVe-3, dryland, and IVe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 7.

CtE2—Crofton-Thurman complex, 11 to 15 percent slopes, eroded. These very deep, moderately steep, well drained and somewhat excessively drained soils formed in loess and sandy eolian material on uplands. The Crofton soil is on the upper side slopes and ridgetops. The Thurman soil is on the lower side slopes. In cultivated areas of the Crofton soil, erosion has removed all of the original dark surface layer. The formation of rills is common after periods of heavy rainfall. Areas of these soils range from 10 to 150 acres in size. They are 30 to 70 percent Crofton soil and 30 to 70 percent Thurman soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Crofton soil is brown, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. The soil is calcareous and contains small concretions of carbonate. In areas of native grasses, the surface soil is darker and is leached of lime in places.

Typically, the surface layer of the Thurman soil is grayish brown, very friable fine sandy loam about 10 inches thick. Below this is a transitional layer of brown, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is loamy fine sand. It is pale brown in the upper part and very pale brown in the lower part. In a few cultivated areas, erosion has removed the dark surface layer.

Included with these soils in mapping are small areas of Alcester, Nora, and Ortello soils. Alcester soils have a thick, dark, silty surface soil. They are in the lower positions on foot slopes. Nora soils have a dark, silty surface layer. They are leached of carbonates in the upper part of the profile. They are in landscape positions similar to those of the Crofton soil. Ortello soils have a loamy subsoil. They are in landscape positions similar to those of the Thurman soil. Also included are a few small strongly sloping and steep areas. Included areas make up 10 to 20 percent of the unit.

Permeability is moderate in the Crofton soil and rapid in the Thurman soil. The available water capacity is high in the Crofton soil and low in the Thurman soil. Runoff is medium on both soils. Organic matter content is low in the Crofton soil and moderately low in the Thurman soil. Natural fertility is low in both soils.

About half of the acreage of these soils is dry-farmed.

These soils are unsuited to irrigated crops because of the slope and the hazard of water erosion. The remaining areas support native grasses or are seeded to cool-season grasses.

If dry-farmed, these soils are poorly suited to crops, such as oats, alfalfa, corn, grain sorghum, and soybeans. Water erosion and soil blowing are severe hazards in areas where the surface is not adequately protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Applications of commercial fertilizers are needed to supply plant nutrients, especially phosphorus, which is unavailable for use by plants because of the excessive amount of lime in the Crofton soil.

These soils are suited to pasture. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa or other cool-season grasses. Warm-season grasses also can be grown. Overgrazing can reduce the amount of protective plant cover and the quality of the grasses and thus can cause the formation of rills after periods of heavy rainfall. Proper stocking

rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

These soils are suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

These soils are fairly well suited to trees and shrubs grown as windbreaks. The growth of some species is restricted by an excessive amount of lime in the Crofton soil. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of the appropriate herbicides. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary. Planting trees on the contour and using terraces help to control water erosion.

These soils are limited for use as sites for sanitary facilities. Land shaping and installing septic tank absorption fields on the contour help to ensure that the fields function properly. The Thurman soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the bottom of the lagoon helps to prevent seepage. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the Crofton soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads in areas of the Thurman soil.

The capability classification of the Crofton soil is IVe-8, dryland. The range site is Limy Upland, and the windbreak suitability group is 8. The capability classification of the Thurman soil is VIe-3, dryland. The range site is Sandy, and the windbreak suitability group is 7.

CtF—Crofton-Thurman complex, 15 to 30 percent slopes. These very deep, steep, well drained and somewhat excessively drained soils formed in loess and sandy eolian material on uplands. The Crofton soil is on the upper side slopes. The Thurman soil is on the lower side slopes. A few catsteps, narrow, entrenched drainageways, and gullies occur in some places. Areas of these soils range from 10 to 150 acres in size. They are 30 to 60 percent Crofton soil and 30 to 60 percent Thurman soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Crofton soil is dark grayish brown, friable silt loam about 6 inches thick. Below this is a transitional layer of light brownish gray, friable silt loam about 5 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is pale brown in the upper part and very pale brown in the lower part. It is calcareous and contains small concretions of carbonate below a depth of 6 inches. In some areas the surface layer is calcareous. In cultivated areas the surface layer is calcareous and light colored.

Typically, the surface layer of the Thurman soil is dark grayish brown, very friable fine sandy loam about 11 inches thick. Below this is a transitional layer of grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is loamy fine sand. It is brown in the upper part and pale brown in the lower part.

Included with these soils in mapping are small areas of Alcester, Nora, and Ortello soils. Alcester soils have a thick, dark, silty surface soil. They are in the lower positions on foot slopes. Nora soils are in landscape positions similar to those of the Crofton soil. They have a dark, silty surface layer. They are leached of carbonates below a depth of 12 inches. Ortello soils have a loamy subsoil. They are in landscape positions similar to those of the Thurman soil. Also included are a few small moderately steep and very steep areas. Included areas make up 10 to 20 percent of the unit.

Permeability is moderate in the Crofton soil and rapid in the Thurman soil. The available water capacity is high in the Crofton soil and low in the Thurman soil. Runoff is medium on the Thurman soil and rapid on the Crofton soil. Organic matter content is moderately low in both soils. Natural fertility is low.

Most of the acreage of these soils supports native grasses and is used for grazing. A few areas are mowed for hay. A few small areas that have been cultivated have been reseeded to cool-season grasses or native grasses and are used for pasture or hay.

These soils are not suited to cultivated crops because they are too erodible and steep. The sloping areas are very susceptible to water erosion. Areas that were once cultivated are now mainly used for pastures of bromegrass.

If the Crofton soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage on this soil. Western wheatgrass, sedges, and other annual

and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the Thurman soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 85 percent or more of the total annual forage on this soil. Switchgrass, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Crofton soil and 0.9 animal unit month per acre on the Thurman soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control soil blowing and water erosion. Areas once used as cropland should be reseeded to a suitable grass mixture if they are used as range.

These soils are unsuited to the mechanical planting of trees and shrubs grown as windbreaks. Most areas are too steep for planting and cultivating with conventional equipment. When farmstead windbreaks are established, hand planting of adapted seedlings and applications of the appropriate herbicides may be needed. The growth of some species is restricted by an excessive amount of lime in the Crofton soil. Seedlings generally survive and grow well if competing vegetation is controlled. Insufficient rainfall is the main limitation if trees are planted. Irrigation may be necessary.

These soils generally are not suited to septic tank absorption fields and sewage lagoons because of the slope. A suitable alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the Crofton soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads.

The capability classification of the Crofton soil is VIe-9, dryland. The range site is Limy Upland, and the windbreak suitability group is 10. The capability classification of the Thurman soil is VIe-3, dryland. The range site is Sandy, and the windbreak suitability group is 10.

Ef—Elsmere loamy fine sand, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on stream terraces and in upland valleys. It formed in sandy alluvium. It is subject to rare flooding. Areas range from 5 to 50 acres in size.

Typically, the surface layer is dark gray, very friable loamy fine sand about 8 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 11 inches thick. Below this is a transitional layer of grayish brown, mottled, very friable loamy fine sand about 6 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray, mottled loamy fine sand in the upper part and pale brown, mottled fine sand in the lower part. In a few areas the surface soil is more than 20 inches thick.

Included with this soil in mapping are small areas of Orwet and Thurman soils. The poorly drained Orwet soils are lower on the landscape than the Elsmere soil. Thurman soils are somewhat excessively drained. They are in the higher landscape positions. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Elsmere soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil can be easily tilled. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to about 3.0 feet below the surface during dry years.

About half of the acreage of this soil is cultivated. The remaining areas support native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn and grain sorghum. It is less well suited to alfalfa because of wetness. The main limitation affecting dry-farming is the seasonal high water table, which delays tillage and slows the warming of the soil in the spring. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as chiseling, disking, or no-till planting, that leaves crop residue on the surface helps to control soil blowing. Narrow field windbreaks also help to prevent excessive soil blowing. Returning crop residue to the soil conserves moisture.

Applying feedlot manure helps to maintain organic matter content and improves fertility.

If irrigated, this soil is suited to sprinkler systems. Corn and sorghum are the main crops grown. Frequent applications of water are needed because of the very high rate of water intake and the low available water capacity, but overwatering can cause leaching of plant nutrients below the root zone. Land leveling may be needed to provide even distribution of water in areas where gravity systems are used. A system of conservation tillage, such as chiseling or no-till planting, that leaves crop residue on the surface helps to control soil blowing. Cover crops also help to control soil blowing. Drainage ditches can lower the seasonal high water table.

This soil is suited to introduced grasses, such as reed canarygrass and creeping foxtail. The species selected should be those that are tolerant of a high water table. Using areas of this soil for pasture or hayland helps to control soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Overgrazing reduces the amount of protective plant cover and thus increases the hazard of soil blowing. Proper stocking rates, rotation grazing, and weed control help to keep the grasses in good condition. Applying nitrogen fertilizers and irrigating can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks and to plantings that enhance wildlife habitat. Survival rates of adapted species are good. Establishing seedlings is difficult in some years because of wetness. Maintaining cover crops between the tree rows helps to control soil blowing. Weeds and grasses that compete with the trees for moisture are a concern. Competing vegetation can be controlled by cultivating between the rows with conventional equipment and by hand hoeing or rototilling within the row. The species selected for planting should be those that are tolerant of wetness.

This soil is poorly suited to septic tank absorption fields because of the wetness and a poor filtering capacity. Constructing the septic tank absorption field on fill material can raise the absorption field high enough above the seasonal high water table. The poor filtering capacity can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoons on fill material can raise the bottom of the lagoon above the seasonal high water table. The sides of shallow excavations can cave in unless they are temporarily shored during dry periods. Constructing dwellings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by flooding. Constructing local roads on suitable, well compacted fill material, providing adequate roadside ditches, and installing culverts help to prevent the damage caused by flooding and wetness. The damage caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIw-5, dryland, and IIIw-11, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Eh—Elsmere fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on high bottom land and in sandhill valleys. It formed in sandy alluvium. It is subject to rare flooding. Areas range from 5 to 50 acres in size.

Typically, the surface layer is dark gray, friable fine sandy loam about 5 inches thick. The subsurface layer is also dark gray, friable fine sandy loam. It is about 13 inches thick. Below this is a transitional layer of grayish brown, mottled, very friable loamy sand about 9 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray, mottled loamy sand in the upper part and light gray, mottled fine sand in the lower part. In some areas the dark surface soil is more than 20 inches thick. In other areas the surface layer is loam. Some small areas have a seasonal high water table below a depth of 3 feet.

Included with this soil in mapping are small areas of Loretto and Thurman soils. Loretto soils are well drained. They have more silt and clay in the lower part of the profile than the Elsmere soil. Also, they are higher on the landscape. Thurman soils are somewhat excessively drained. They are in the higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Elsmere soil. The available water capacity is moderate. The water intake rate is very high. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. This soil warms up more slowly in the spring than better drained soils. The surface layer can be easily tilled throughout a fairly wide range in moisture content. The seasonal high

water table ranges from about 1.5 feet below the surface during wet years to about 3.0 feet below the surface during dry years.

Most of the acreage of this soil is cultivated. Some areas support native grasses and are used for grazing or hay. Some areas are irrigated by sprinkler systems.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. Small grain is generally not planted in the spring because of the wetness. The main limitation affecting dry-farming is wetness, which delays tillage early in the spring. Soil blowing is a hazard in areas where the surface is not protected by crops or crop residue. If suitable outlets are available, tile drains may be beneficial. A system of conservation tillage, such as disking, chiseling, or no-till planting, that leaves most of the crop residue on the surface helps to control runoff and soil blowing. Returning crop residue to the soil improves organic matter content and fertility. Applying feedlot manure also helps to maintain fertility.

If irrigated, this soil is suited to both gravity and sprinkler systems. It is suited to corn, sorghum, alfalfa, and soybeans. In most years, tillage is delayed in the spring because of wetness. If suitable outlets are available, tile drains can be installed or V-shaped ditches can be provided. Land leveling can improve surface drainage and the efficiency of irrigation systems. A system of conservation tillage, such as disking or no-till planting, that leaves crop residue on the surface helps to control soil blowing and conserves moisture.

This soil is suited to introduced grasses for pasture. Using areas of this soil for pasture is effective in controlling soil blowing. Cool-season grasses, such as reed canarygrass and creeping foxtail, can be grown. Warm-season grasses can also be grown. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Pasture grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Grazing when the soil is wet can result in surface compaction and the formation of small mounds. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Pasture grasses are well suited to irrigation. They can benefit from applications of nitrogen fertilizer.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. The trees and shrubs selected should be those that are tolerant of wetness. Survival and growth rates of seedlings are good. Establishing seedlings can be a problem during wet years. Undesirable grasses and weeds can be controlled by cultivation between the tree rows and by applications of appropriate herbicides. Areas near the trees can be hoed by hand.

This soil is poorly suited to septic tank absorption fields because of the wetness and a poor filtering capacity. Constructing the septic tank absorption field on fill material can raise the absorption field high enough above the seasonal high water table. The poor filtering capacity can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. Constructing the lagoon on fill material can raise the bottom of the lagoon above the seasonal high water table. The sides of shallow excavations can cave in unless they are temporarily shored during dry periods. Constructing dwellings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by flooding. Constructing local roads on suitable, well compacted fill material, providing adequate roadside ditches, and installing culverts help to prevent the damage caused by flooding and wetness. The damage caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIw-6, dryland, and IIw-11, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Et—Eltree silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands and foot slopes. It formed in colluvial and alluvial sediments. Areas range from 5 to 80 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 4 inches thick. The subsurface layer is grayish brown and dark grayish brown, friable, calcareous silt loam about 21 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 17 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray, calcareous silt loam. In some areas carbonates are below a depth of 15 inches. In a few areas the dark surface soil is more than 40 inches thick.

Included with this soil in mapping are small areas of Nora and Verdel soils. Nora soils are in the higher landscape positions. They have a thinner dark surface soil than the Eltree soil. Verdel soils have more clay throughout the profile than the Eltree soil. They are in landscape positions similar to those of the Eltree soil.

Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Eltree soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is high. Tilth is good.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated. Other areas support pastures of cool-season grasses or native grasses.

If dry-farmed, this soil is suited to corn, soybeans, alfalfa, and oats. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, soybeans, and alfalfa. It is best suited to gravity and sprinkler irrigation systems. Some land leveling may be needed in areas where gravity systems are used, but less land leveling is needed in areas where sprinkler systems are used. Timely and efficiently distributed applications of water are needed. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses for pasture. Commonly grown species include smooth bromegrass. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. If pastures are irrigated, sprinkler or gravity systems can be used. If the soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational areas and wildlife habitat. Survival and growth rates of adapted species are good. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through application of herbicides.

This soil is generally suited to septic tank absorption fields and dwellings. Lining or sealing sewage lagoons helps to prevent seepage. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is I-1, dryland, and I-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

EtC—Eltree silt loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands and foot slopes. It formed in loamy colluvial and alluvial sediments. Areas range from 5 to 40 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is friable silt loam about 13 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown and calcareous. The subsoil is grayish brown and light brownish gray, friable, calcareous silt loam about 17 inches thick. The underlying material to a depth of more than 60 inches is light gray, calcareous silt loam. In some places the dark surface soil is less than 20 inches or more than 40 inches thick. In some small areas the soil has carbonates below a depth of 20 inches.

Included with this soil in mapping are small areas of Nora, Labu, and Verdel soils. Nora soils are in the slightly higher landscape positions. They have a dark surface soil less than 12 inches thick. They generally have carbonates below a depth of 15 inches. Labu and Verdel soils have more clay throughout the profile than the Eltree soil. They formed in material weathered from shale bedrock. Labu soils are in the higher landscape positions. Verdel soils are in landscape positions similar to those of the Eltree soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Eltree soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is high. Tilth is good.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated. The remaining acreage supports native or cool-season grasses.

If dry-farmed, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as disking or chiseling, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. Grassed waterways, terraces, and contour farming help to control water erosion. Including grasses and legumes in the cropping sequence helps to control water erosion; improves and maintains organic matter content, fertility, and tilth; and increases the rate of water intake.

If irrigated, this soil is suited to corn, soybeans, and alfalfa. It is best suited to sprinkler irrigation systems. Water erosion is the main hazard in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as disking or chiseling, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. Grassed waterways, terraces, and contour farming help to control water erosion. Including grasses and legumes in the cropping sequence helps to control water erosion; improves and maintains organic matter content, fertility, and tilth; and increases the rate of water intake. Because of the hazard of water erosion, careful applications of water are needed to prevent crop damage and a reduction in soil productivity.

This soil is suited to introduced or domesticated grasses for pasture. Using areas of this soil as pasture can help to control water erosion. Grasses can be rotated with other crops. Commonly grown species include smooth bromegrass. Overgrazing can reduce the vigor of plants and thus can cause the formation of small gullies and rills after periods of heavy rainfall. Proper stocking rates and rotation grazing help to keep the grasses in good condition. If the soil is used as hayland, timely mowing helps to maintain high productivity. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good, and growth rates are fair. The main concerns are drought and the weeds and grasses that compete with the trees for moisture. Irrigation can provide supplemental moisture during periods of low rainfall. Competing vegetation can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through application of appropriate herbicides.

This soil is generally suited to septic tank absorption fields and dwellings. If the less sloping areas are selected as sites for sewage lagoons, some leveling and banking may be necessary. Lining or sealing sewage lagoons helps to prevent seepage. Larger buildings in the more sloping areas should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-1, dryland, and IIIe-6, irrigated. The range site is Silty, and the windbreak suitability group is 3.

Fm—Fillmore silt loam, 0 to 1 percent slopes. This very deep, nearly level, somewhat poorly drained soil is in upland depressions. It formed in loess. Ponding occurs for brief periods during wet seasons and after periods of heavy rainfall. Some areas receive runoff from adjacent soils. Areas range from 3 to 15 acres in size.

Typically, the surface layer is gray, friable silt loam about 10 inches thick. The subsurface layer is light gray, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 35 inches thick. The upper part is dark gray, the next part is gray, and the lower part is grayish brown. The underlying material to a depth of more than 60 inches is light brownish gray silty clay. In places the soil does not have a light gray subsurface layer.

Included with this soil in mapping are small areas of Moody and Trent soils. These soils have less clay in the subsoil than the Fillmore soil. Also, they are better drained. They are higher on the landscape than the Fillmore soil. They make up 5 to 15 percent of the unit.

Permeability is very slow in the Fillmore soil. The available water capacity is high. The water intake rate is low. Runoff is very slow or ponded. Organic matter content is moderate. Natural fertility is medium. The perched seasonal high water table ranges from about 0.5 foot above the surface during wet years to 1.0 foot below the surface during dry years. Tillage is often delayed because of wetness. The shrink-swell potential is high.

Most areas of this soil are dry-farmed. The remaining

acreage is mainly used for pasture.

If dry-farmed, this soil is suited to corn, grain sorghum, and soybeans. It is usually too wet for alfalfa and oats unless drainage is provided. The main limitations are excessive wetness and ponding during wet seasons and after periods of heavy rainfall. A drainage system is needed for maximum crop production. The excessive wetness and ponding commonly delay planting. Crops are sometimes drowned following periods of heavy summer rainfall. The excessive wetness can hinder timely cultivation and the effective control of weeds. It can be overcome by land leveling and surface drainage ditches in areas where outlets are available. Terraces, grassed waterways, and contour farming in the higher adjacent areas help to control runoff. Applications of lime commonly are needed for maximum production. Using a system of conservation tillage that leaves crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. It is best suited to sprinkler irrigation systems. Ponding and excessive wetness commonly delay tillage and can damage crops. Terraces, grassed waterways, and diversions in the adjacent higher areas help to control runoff. If the soil is irrigated, the rate of water application should be adjusted to the low intake rate.

This soil is suited to introduced grasses for pasture. Common species include reed canarygrass, birdsfoot trefoil, and tall fescue. Overgrazing or improper haying methods reduce productivity and the amount of protective plant cover. Proper stocking rates, rotation grazing, and weed control are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying can help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that are tolerant of occasional wetness and ponding. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through application of the appropriate herbicides.

This soil is not suited to sanitary facilities and dwellings because of the ponding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the level of ponding and providing adequate roadside ditches and culverts help to prevent the damage caused by ponding. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is IIIw-2, dryland, and IVw-2, irrigated. The range site is Clayey Overflow, and the windbreak suitability group is 2W.

Fu—Fluvaquents, silty, 0 to 2 percent slopes. These very deep, nearly level, very poorly drained soils are mainly on low bottom land along the Missouri River. They are frequently flooded. They formed in stratified, silty alluvium. Areas range from 5 to 1,000 acres in size.

Typically, the surface layer is about 10 inches thick. It is black, mottled silt loam with a high content of decomposed organic material. The underlying material extends to a depth of more than 60 inches. It is dark gray, mottled silt loam in the upper part and light gray or white, stratified loam and silt loam in the lower part. It is calcareous in some areas. In some places the texture of the surface layer ranges from fine sandy loam to sand.

Included with these soils in mapping are small areas of Albaton, Barney, and Obert soils. These included soils have a lower seasonal high water table than the Fluvaquents. They are not covered by water during most of the growing season. They are slightly higher on the landscape than the Fluvaquents. Also included are areas of water that do not support plants. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Fluvaquents. The available water capacity is high. Runoff is ponded. Organic matter content is high. The seasonal high water table ranges from 2 feet above the surface during wet years to about 1 foot below the surface during dry years.

Areas of these soils are used mostly as wildlife habitat. Wetland wildlife species are the most abundant, but upland wildlife species also inhabit these areas, especially during dry periods. Some areas can be mowed for mulching material if the water table is below the surface.

Areas of these soils are too wet for cultivated crops or for introduced or native grasses for hayland or range. The vegetation is coarse and is unpalatable to livestock. Vegetation consists mainly of cattails, rushes, arrowheads, willows, and other water-tolerant plants.

These soils are not suited to trees and shrubs grown as windbreaks because of the wetness. A few areas can be used for plantings that enhance recreational areas and wildlife habitat and for forests if trees and shrubs are planted by hand or if other special practices are applied.

These soils are not suited to sanitary facilities or building site development because of the flooding and the wetness. A suitable alternative site should be selected. Constructing local roads on suitable, well compacted fill material above the level of ponding and flooding, providing adequate roadside ditches, and installing culverts help to prevent the damage caused by flooding and wetness.

The capability classification is VIIIw-7, dryland, and the windbreak suitability group is 10. No range site is assigned.

GaG—Gavins silt loam, 30 to 60 percent slopes. This shallow, very steep, well drained soil is on uplands. It formed in sediment weathered from soft siltstone bedrock. Areas range from 10 to 80 acres in size.

Typically, the surface layer is grayish brown, very friable silt loam about 3 inches thick. Below this is a transitional layer of very pale brown, very friable silt loam about 5 inches thick. The underlying material is very pale brown silt loam about 4 inches thick. Very pale brown siltstone bedrock is at a depth of about 12 inches. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Crofton, Redstoe, and Sansarc soils. Crofton soils are deep. They formed in loess. They are higher on the landscape than the Gavins soil. Redstoe soils are moderately deep over siltstone bedrock. They are in the slightly higher landscape positions. Sansarc soils have more clay than the Gavins soil. Also, they are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Gavins soil. The available water capacity is very low. Runoff is very rapid. Organic matter content is moderate. Natural fertility is low.

This soil supports native grasses and is used as range. Redcedar and bur oak grow along the lower north-facing slopes and drainageways in some areas.

This soil is not suited to farming. It is too erodible and steep to be crossed safely with farm machinery.

If this soil is used as range, the climax vegetation is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, prairie dropseed, needlegrass, big bluestem, and threadleaf sedge. These species make up 95 percent or more of the total annual forage. Prairie sandreed, needleandthread, hairy grama, and forbs make up the rest. If continuous heavy grazing is allowed, little bluestem and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Livestock cannot easily cross very steep areas. Brush control may be needed in some areas to control the growth of woody plants.

This soil is not suited to trees and shrubs grown as windbreaks. In some areas trees and shrubs can be planted only if special measures, such as specialized site preparation or irrigation, are applied.

This soil is generally not suited to sanitary facilities or building site development because of the shallow depth to bedrock and the slope. A suitable alternative site should be selected. Cutting and filling are generally needed to provide a suitable grade for roads. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is VIIs-4, dryland. The range site is Shallow Limy, and the windbreak suitability group is 10.

Gf—Gibbon silt loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land. It formed in calcareous alluvium. It is subject to occasional flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 6 inches thick. The subsurface layer also is dark gray, friable silt loam about 6 inches thick. Below this is a transitional layer of gray, friable silty clay loam about 6 inches thick. The underlying material to a depth of more than 60 inches is light gray, mottled silty clay loam. It is calcareous throughout. In some places the surface soil is 20 to 30 inches thick. In some areas on the bottom land along the Missouri River, the soil is very fine sandy loam to a depth of more than 60 inches. In other areas sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Kezan, Ord, and Shell soils. Kezan soils are poorly drained. They are in landscape positions similar to those of the Gibbon soil. Ord soils are sandy in the lower part of the profile. They are in landscape positions similar to those of the Gibbon soil. Shell soils are well drained. They have a dark surface soil that is more than 20 inches thick. They are slightly higher on the landscape than the Gibbon soil. Also included are a few small areas of alkaline soils. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Gibbon soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is high. Tilth is good. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to about 3.0 feet below the surface during dry years. The water table is generally highest in spring.

More than half of the acreage of this soil is used for cultivated crops. The remaining acreage mainly supports native grasses. A few areas are irrigated. Some areas support introduced grasses for hay or pasture or support trees grown as windbreaks.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is less well suited to small grain planted in the spring because the wetness in early spring delays planting. If suitable outlets are available, tile drains can lower the seasonal high water table and help to control wetness. Leaving crop residue on the surface and applying feedlot manure help to maintain fertility and tilth.

If irrigated, this soil is suited to gravity or sprinkler systems. Corn, soybeans, and alfalfa are the main irrigated crops. The main limitation is wetness. If suitable outlets are available, tile drains can lower the seasonal high water table. Land leveling may be needed in areas where gravity systems are used. Leaving crop residue on the surface and applying feedlot manure help to maintain or improve fertility and tilth.

This soil is suited to introduced grasses, such as bromegrass or orchardgrass, seeded in a mixture with alfalfa. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Overgrazing reduces the quality of the desired grasses. Grazing when the soil is wet can result in surface compaction, which makes grazing and haying more difficult. Proper stocking rates and rotation grazing help to keep the desired grasses in good condition. Applying nitrogen and phosphate fertilizers and irrigating improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range or hayland. Overgrazing, untimely mowing, or improper mowing heights reduce the quality of native plants. Overgrazing when the soil is wet can result in surface compaction, which makes grazing and haying difficult. Proper grazing use, timely deferment of grazing and haying, and restricted use during wet periods help to keep the desired grasses in good condition.

This soil is suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that are tolerant of wetness. Establishing seedlings may be difficult in spring during wet years. The grasses and weeds that compete with the trees for moisture can be controlled by cultivating between the rows, by applying the appropriate herbicides, or by rototilling.

This soil is not suited to septic tank absorption fields because of the flooding, the wetness, and the restricted permeability. A suitable alternative site should be selected. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table. Diking the lagoons helps to prevent the damage caused by flooding. The soil is not suited to building site development because of the flooding and the wetness. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding and wetness. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIw-4, dryland, and IIw-6, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Hd—Hobbs silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on bottom land. It formed in stratified alluvium. It is subject to occasional flooding. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The underlying material is stratified grayish brown and light brownish gray silt loam about 28 inches thick. Below this to a depth of more than 60 inches is a buried soil of very dark grayish brown, friable silt loam. In some areas the underlying material has strata that contain carbonates or strata that have a high content of sand. In a few areas the soil has mottles below a depth of 40 inches.

Included with this soil in mapping are small areas of Aowa, Coleridge, and Shell soils. Aowa and Coleridge soils are in landscape positions similar to those of the

Hobbs soil. Aowa soils have carbonates in the upper part of the profile. Coleridge soils are somewhat poorly drained. Shell soils have a dark surface soil that is more than 20 inches thick. They are slightly higher on the landscape than the Hobbs soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Hobbs soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is high. The soil is easy to till.

About half of the acreage of this soil is dry-farmed. Some areas are irrigated. The remaining acreage supports cool-season and native grasses and is used for grazing.

If dry-farmed, this soil is best suited to corn, soybeans, and grain sorghum. Alfalfa and oats are more susceptible to the damage caused by flooding, but they can be included in rotations. Flooding is the main hazard, but the damage to crops caused by flooding is seldom severe. Because of the flooding, reseeding the crop or delaying tillage and harvest may be necessary. Terraces, diversions, and a system of conservation tillage help to control runoff. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is best suited to gravity and sprinkler irrigation systems. Some land leveling may be needed in areas where gravity systems are used. Flooding is the main hazard, but the damage to crops caused by flooding is seldom severe. Because of the flooding, reseeding the crop or delaying tillage and harvest may be necessary. Terraces, diversions, and a system of conservation tillage help to control runoff. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses for pasture. Commonly grown species include smooth bromegrass and orchardgrass. Overgrazing or improper haying methods reduce productivity and the amount of protective plant cover. Rotation grazing and applications of fertilizer are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity. Flooding can be a hazard.

This soil is suited to range and hay. Continuous heavy grazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to keep the native plants in good condition. Although flooding is brief, it can deposit debris and weed seeds. Grazing when the soil is wet can result in surface compaction.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are good. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through applications of the appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the flooding. A suitable alternative site should be selected. Diking sewage lagoons helps to prevent the damage caused by flooding. The soil is not suited to building site development because of the flooding. A suitable alternative site should be selected. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding.

The capability classification is IIw-3, dryland, and IIw-6, irrigated. The range site is Silty Overflow, and the windbreak suitability group is 1.

Ho—Hord silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on stream terraces. It formed in silty alluvium and loess. Areas range from 5 to 40 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 10 inches thick. The subsoil is dark grayish brown and grayish brown, friable silt loam about 29 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray, calcareous silt loam. In places the surface soil is less than 20 inches or more than 40 inches thick. In some areas calcium carbonate is below a depth of 48 inches. In other areas mottles or sandy strata are in the underlying material.

Included with this soil in mapping are small areas of Alcester and Shell soils. Alcester soils are in the slightly higher positions on foot slopes. Shell soils are stratified

in the lower part of the profile. They are in the slightly lower landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Hord soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is high. The soil is easy to till.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated. The remaining acreage is used for pasture or range.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, alfalfa, oats, and wheat. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. It is suited to gravity and sprinkler irrigation systems. Some land leveling may be needed in areas where gravity systems are used. A system of conservation tillage, such as chiseling or disking, that leaves all or part of the crop residue on the surface conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced or domesticated grasses for pasture. Grasses can be rotated with other crops. Commonly grown species include smooth bromegrass. Overgrazing or improper haying methods reduce productivity and the amount of protective plant cover. Rotation grazing and applications of fertilizer are needed for maximum forage production. If the soil is used as hayland, timely mowing helps to maintain high productivity. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Irrigation water can be applied by sprinkler or gravity systems.

This soil is suited to native grasses used for range. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are good. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation; by timely cultivation between the rows with conventional equipment; by cultivation practices, such as hand hoeing or rototilling; or through applications of the appropriate herbicides.

This soil is generally suited to septic tank absorption fields, dwellings, and small commercial buildings. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is I-1, dryland, and I-6, irrigated. The range site is Silty Lowland, and the windbreak suitability group is 1.

If—Inavale fine sand, 0 to 2 percent slopes. This very deep, nearly level, excessively drained soil is on bottom land. It formed in sandy alluvium. Some areas are near stream channels and are hummocky. The soil is subject to rare flooding, mainly in the spring after periods of rapid snowmelt or heavy rainfall. Areas range from 5 to 50 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 9 inches thick. The underlying material to a depth of more than 60 inches is light gray, stratified fine sand. In some places the surface layer is dark and is more than 5 inches thick. In other places the surface layer is loamy sand or sandy loam. In some areas a thin, dark buried layer is in the lower part of the profile. In other areas coarse sand or gravelly coarse sand is below a depth of 20 inches.

Included with this soil in mapping are small areas of Barney, Boel, and Orwet soils. Barney and Orwet soils are lower on the landscape than the Inavale soil. They are very poorly drained and poorly drained. Boel soils are somewhat poorly drained. They are in the slightly lower landscape positions. Also included are areas that have slopes of more than 2 percent, some small areas that are gravelly, and a few lower areas that are frequently flooded. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content and natural fertility are low.

A large acreage of this soil supports native grasses and is used for range or hayland. Some areas support trees.

If dry-farmed, this soil is not suited to cultivated crops. In areas that do not have a cover of grasses, the soil is droughty and highly susceptible to soil blowing.

If irrigated, this soil is poorly suited to corn, alfalfa, and cool-season grasses. It is suited only to sprinkler systems. Frequent, light applications of water are

needed to prevent leaching of plant nutrients below the root zone. Planting winter cover crops and leaving crop residue on the surface help to control soil blowing. Applying barnyard manure can improve or maintain organic matter content and fertility.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 95 percent or more of the total annual forage. Blue grama, sand dropseed, porcupinegrass, indiangrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, porcupinegrass, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can occur.

If the range is in excellent condition, the suggested initial stocking rate is 1 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to trees and shrubs grown as windbreaks. Because the soil is loose, trees should be planted in a shallow furrow with as little disturbance of the soil as possible. Young seedlings can be damaged by high winds and can be covered by drifting sand. Soil blowing can be controlled by maintaining strips of sod between the tree rows. The weeds and undesirable grasses that compete with trees for moisture can be controlled by hand hoeing.

Seepage can result in pollution of underground water supplies in areas used for septic tank absorption fields. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the structural damage caused by flooding. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding.

The capability classification is VIe-5, dryland, and IVe-12, irrigated. The range site is Sandy Lowland, and the windbreak suitability group is 7.

Ig—Inavale fine sand, channeled, 0 to 2 percent slopes. This very deep, nearly level, excessively drained soil is on bottom land. It formed in sandy alluvium. It is frequently flooded for very brief periods. Flooding can deposit trash and debris on the surface in some areas. Areas of this soil are long and narrow and are dissected by stream channels or old dry creek beds and channels that meander through the flood plains. Individual areas range from 5 to 200 acres in size.

Typically, the surface layer is pale brown, loose fine sand about 7 inches thick. The subsurface layer is light brownish gray, very friable fine sandy loam about 3 inches thick. The underlying material extends to a depth of more than 60 inches. The upper part is light brownish gray fine sand that has thin strata of loam. The lower part is white sand that has thin strata of gravelly coarse sand. In some places the surface layer is loamy fine sand, fine sandy loam, loam, silty clay loam, or silty clay. In other places the underlying material is gravelly coarse sand. In a few areas the lower part of the underlying material is loamy or clayey material.

Included with this soil in mapping are small areas of Aowa, Barney, and Boel soils. Aowa soils are stratified and silty. They are lower on the landscape than the Inavale soil. Barney soils are very poorly drained. They are in the lower positions in old stream channels. Boel soils are somewhat poorly drained. They are in the slightly lower landscape positions. Also included are higher areas of Inavale soils that are subject to rare flooding, low marshy areas that are covered by water throughout much of the year, a few small areas of sand or gravelly sand that do not support vegetation, and steep streambanks and narrow gullied areas. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. The available water capacity, organic matter content, and natural fertility are low. Runoff is slow.

Most of the acreage of this soil is used for range or wildlife habitat. Trees and shrubs are scattered throughout areas of this soil.

This soil is not suited to cultivated crops because of the hazard of flooding and the high susceptibility to soil blowing in areas that are not covered by vegetation.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass.

These species make up 80 percent or more of the total annual forage. Blue grama, sand dropseed, bluegrass, indiangrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, bluegrass, needleandthread, Scribner panicum, sedges, and forbs dominate the site. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 1 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is generally not suited to trees and shrubs grown as windbreaks because of the hazard of flooding. Some small areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted or if other special practices are applied. Wooded or brushy areas that are not used for grazing can provide excellent habitat for wildlife.

This soil is not suited to sanitary facilities or to building site development because of the flooding. A suitable alternative site should be selected. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding.

The capability classification is VIw-7, dryland. The range site is Sandy Lowland, and the windbreak suitability group is 10.

Ih—Inavale loamy fine sand, 0 to 2 percent slopes. This very deep, nearly level, excessively drained soil is on bottom land. It formed in sandy alluvium. Areas are commonly long and narrow and are on the highest part of the flood plain near the stream channel. Some areas are dissected by shallow drainage channels. The soil is subject to rare flooding. Areas range from 5 to 800 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 11 inches thick. Below this is a transitional layer of light brownish gray, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is stratified light gray and white fine sand. In some places the dark surface soil is more than 20 inches thick. In other places mottles are below a depth of 42 inches. In some areas the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Boel, Ord, and Orwet soils. Boel and Ord soils are slightly lower on the landscape than the Inavale soil. They are somewhat poorly drained. Orwet soils are in the lower landscape positions. They are poorly drained. Also included are some low areas that are frequently flooded for short periods following heavy rainfall. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. The available water capacity, natural fertility, and organic matter content are low. The water intake rate is very high. Runoff is slow. The soil can be easily tilled.

About half of the acreage of this soil is cropland. The remaining acreage supports native grasses and is used for grazing or hay. A few trees and shrubs are in some areas. A few small areas are used as irrigated cropland.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, and soybeans. It is generally better suited to small grain and alfalfa, which grow in spring when the amount of rainfall is highest. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves crops, grasses, or crop residue on the surface helps to control soil blowing, conserves moisture, and helps to maintain organic matter content and fertility.

If irrigated, this soil is suited to corn, soybeans, small grain, alfalfa, and cool-season grasses. It is best suited to sprinkler systems. Frequent applications of water are needed because the available water capacity is low. Light applications of water are needed to prevent excessive leaching of plant nutrients below the root zone. Returning crop residue to the soil and applying barnyard manure can improve or maintain organic matter content and fertility. Leaving crop residue on the surface helps to control soil blowing.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as

windbreaks. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation generally should be restricted to the tree rows. The weeds and undesirable grasses that compete with the trees for moisture can be controlled by rototilling or hand hoeing. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted.

Seepage can result in pollution of underground water supplies in areas used for septic tank absorption fields. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of excavations can slough or cave unless they are shored. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the structural damage caused by flooding. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding.

The capability classification is IVe-5, dryland, and IIIe-11, irrigated. The range site is Sandy Lowland, and the windbreak suitability group is 5.

Im—Inavale fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, excessively drained soil is on bottom land. It formed in sandy alluvium. It is subject to rare flooding. Areas are commonly long and narrow. They range from 5 to 50 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 12 inches thick. The underlying material extends to a depth of more than 60 inches. The upper part is light brownish gray loamy fine sand that has thin strata of fine sandy loam. The lower part is light gray fine sand. In some places the dark surface soil is more than 20 inches thick. In other places the surface layer is loam or loamy sand. In some areas gravelly coarse sand is below a depth of 40 inches. In other areas mottles are below a depth of 40 inches.

Included with this soil in mapping are small areas of Boel and Ord soils. These soils are slightly lower on the landscape than the Inavale soil. They are somewhat poorly drained. They make up 5 to 15 percent of the unit.

Permeability is rapid in the Inavale soil. The available water capacity is moderate. The water intake rate is very high. Runoff is slow. Organic matter content is low. Natural fertility is medium. The soil can be tilled throughout a wide range in moisture content.

About half of the acreage of this soil is used as cropland. Some of these areas are irrigated. The remaining areas support introduced or native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, alfalfa, small grain, and soybeans. Soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing. Row crops can be rotated with small grain and legumes. Returning crop residue to the soil and applying barnyard manure can improve or maintain organic matter content and fertility.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, alfalfa, small grain, and introduced grasses. Some land leveling may be needed in areas where gravity systems are used. Keeping the length of runs somewhat short can minimize the amount of water lost because of deep percolation into the sandy underlying material. The soil is best suited to sprinkler systems. Excessive watering can result in leaching of fertilizers into the water table. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content and fertility.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes can be rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. The grazing season can be extended by managing cool-season grasses along with warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers can improve the growth and vigor of the grasses. Weeds can be controlled by using appropriate herbicides.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Trees grow well after taproots reach the water table, which is 5 to 15 feet below the surface. Insufficient moisture and soil blowing are the main hazards when trees are established. Soil blowing can be controlled by maintaining strips of sod or a cover

crop between the tree rows. Drip irrigation systems can provide the moisture needed during dry periods. Weeds and undesirable grasses can be controlled by cultivating with conventional equipment, by rototilling or hand hoeing, or by applying herbicides in a timely manner.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the structural damage caused by flooding. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding.

The capability classification is IIIe-3, dryland, and IIIe-11, irrigated. The range site is Sandy Lowland, and the windbreak suitability group is 5.

Ke—Kezan silt loam, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is on bottom land along narrow upland drainageways. It formed in silty alluvial sediments. It is subject to occasional flooding. Areas range from 5 to 100 acres in size.

Typically, the surface layer is stratified grayish brown and brown, mottled, friable, calcareous silt loam about 10 inches thick. The underlying material is stratified light brownish gray and grayish brown, mottled, calcareous silt loam about 12 inches thick. A buried layer of dark gray, friable silt loam about 10 inches thick is at a depth of about 22 inches. Below this to a depth of more than 60 inches is dark gray, mottled silty clay loam.

Included with this soil in mapping are small areas of Aowa, Coleridge, and Obert soils. Aowa soils are higher on the landscape than the Kezan soil. They are well drained. The somewhat poorly drained Coleridge soils are in landscape positions similar to those of the Kezan soil. They have a thick, dark, noncalcareous surface soil. Obert soils are lower on the landscape than the Kezan soil. They are very poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Kezan soil. The available water capacity is high. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. Depth to the seasonal high water table ranges from about 1 foot during wet years to about 3 feet in most dry years.

Most of the acreage of this soil supports introduced or native grasses and is used for grazing. Some areas are used for wetland wildlife habitat. A few areas are farmed.

If dry-farmed, this soil is poorly suited to cultivated crops because of the wetness and the hazard of flooding. It is best suited to corn, grain sorghum, and soybeans. Alfalfa and oats are also grown, but they are more susceptible to damage from flooding than other crops.

This soil is not suited to irrigation because of the wetness and flooding. It warms up slowly in the spring, and tillage is commonly delayed. Reseeding of crops may be necessary.

This soil is suited to introduced grasses for pasture or hay. Commonly grown species include smooth bromegrass, orchardgrass, reed canarygrass, and bluegrass. Rotation grazing and applications of fertilizer are needed for maximum forage production. In areas used as hayland, flooding can be a hazard.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 65 percent or more of the total annual forage. Bluejoint, reedgrass, northern reedgrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If continuous heavy grazing is allowed or the soil is improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by reedgrass, slender wheatgrass, western wheatgrass, and sedges. If the range is overseeded, timothy, redtop, and red clover also increase in abundance. If overgrazing continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Grazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of small mounds and ruts, which make grazing and harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. After the ground is frozen, livestock can graze without damaging the meadows. The livestock should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that are tolerant of wetness and flooding. The wetness may restrict machine planting during the spring in some years. Weeds and grasses can be controlled

by cultivating between the tree rows, hand hoeing or rototilling, or applying appropriate herbicides.

This soil is not suited to septic tank absorption fields or building site development because of the flooding and the wetness. A suitable alternative site should be selected. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table and the flood level. Diking the lagoons helps to prevent the damage caused by flooding. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding and wetness. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IVw-7, dryland. The range site is Wet Subirrigated, and the windbreak suitability group is 2W.

KzB—Kezan silt loam, channeled, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is on bottom land. It formed in silty alluvial sediments. It is dissected by meandering stream channels that are 1 to 5 feet deep. It is frequently flooded. Areas are long and narrow. They range from 5 to 100 acres in size.

Typically, the surface layer is stratified grayish brown and light gray, mottled, friable, calcareous silt loam about 12 inches thick. The underlying material is stratified light brownish gray and grayish brown, mottled, calcareous silt loam about 10 inches thick. A buried soil is at a depth of about 22 inches. It is about 22 inches thick. It is very dark gray, friable silt loam in the upper part and dark gray, firm silty clay loam in the lower part. Below this to a depth of more than 60 inches is gray, mottled silty clay loam.

Included with this soil in mapping are small areas of Aowa, Coleridge, and Obert soils. Aowa soils are higher on the landscape than the Kezan soil. They are well drained. The somewhat poorly drained Coleridge soils are in landscape positions similar to those of the Kezan soil. They have a thick, dark, noncalcareous surface soil. Obert soils are in the lowest landscape positions. They are very poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Kezan soil. The available water capacity is high. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The seasonal high water table ranges from about 1 foot below the surface during wet years to 3 feet below the surface during dry years.

Most of the acreage of this soil supports native grasses or introduced cool-season grasses and is used for grazing. Some areas are mowed for hay. A few areas are used as cropland.

This soil is not suited to crops because of the flooding and the meandering drainage channels that generally cannot be crossed with tillage equipment.

This soil is suited to introduced grasses for pasture or hay. Smooth bromegrass, orchardgrass, reed canarygrass, and creeping foxtail are suitable species. Rotation grazing and applications of fertilizer are needed for maximum forage production. Sediments deposited by floodwater may partially cover the grasses and reduce their vigor and growth.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 65 percent or more of the total annual forage. Bluejoint reedgrass, northern reedgrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If the soil is subject to continuous heavy grazing or improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by reedgrass, slender wheatgrass, western wheatgrass, plains muhly, and sedges. If the range is overseeded, timothy, redtop, and red clover also increase in abundance. If overgrazing or improper haying methods continue for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Grazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of small mounds and ruts, which make grazing and harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. After the ground is frozen, livestock can graze without damaging the meadows. The livestock should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is generally unsuited to trees and shrubs grown as windbreaks. Some small areas can be used

for plantings that enhance recreational areas and wildlife habitat and for forests. The species selected for planting should be those that are tolerant of wetness and flooding. The wetness may restrict machine planting during the spring in most years. Weeds and grasses can be controlled by cultivating between the tree rows with conventional equipment, hoeing by hand or rototilling, or applying appropriate herbicides.

This soil is not suited to septic tank absorption fields or building site development because of the flooding and the wetness. A suitable alternative site should be selected. Constructing sewage lagoons on fill material can raise the bottom of the lagoon high enough above the seasonal high water table and the flood level. Diking the lagoons helps to prevent the damage caused by flooding. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding and wetness. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is VIw-7, dryland. The range site is Wet Subirrigated, and the windbreak suitability group is 10.

LbD—Labu silty clay, 6 to 11 percent slopes. This moderately deep, well drained, strongly sloping soil is on upland side slopes, knolls, and ridges. It formed in material weathered from dark shale bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, firm, calcareous silty clay about 6 inches thick. The subsoil is grayish brown, very firm, calcareous clay about 20 inches thick. The underlying material is light olive gray, calcareous clay about 9 inches thick. Light gray shale bedrock is at a depth of about 35 inches. In some places the shale bedrock is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bristow, Lynch, Sansarc, and Verdel soils. Bristow and Lynch soils are slightly lower on the landscape than the Labu soil. Also, they formed in lighter colored shale bedrock. Bristow soils are shallow. Lynch soils are moderately deep over shale bedrock. Sansarc soils are on convex shoulder slopes and ridgetops in the slightly higher landscape positions. They are shallow over shale bedrock. Verdel soils are very deep. They are on foot slopes in the lower landscape positions. They have a thick, dark surface soil. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Labu soil. The available water capacity is low. The water intake rate is very low. Runoff is medium or rapid. Organic matter content is moderately low. Natural fertility is low. Working the soil and maintaining tilth are difficult. Ponding occurs if the soil is worked when too wet. Cracks can form when the soil is dry. The shrink-swell potential is high. The soil releases water slowly to plants.

This soil is used as cropland or range.

If dry-farmed, this soil is poorly suited to cultivated crops. Small grain, grain sorghum, and alfalfa are the main crops. Corn is grown in some areas. Water erosion is a hazard. Terraces, contour farming, and crop residue management help to control erosion. A cover of grasses helps to control erosion in natural drainageways. A cropping system that includes grasses and legumes improves tilth and the organic matter content.

If irrigated, this soil is poorly suited to cropland. It is best suited to alfalfa and grain sorghum. It is suited only to sprinkler systems.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Water erosion can be a hazard. Overgrazing can reduce the vigor of plants and thus can cause the formation of rills after periods of heavy rainfall. Gully erosion is a severe hazard in drainageways. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying can help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Because of the high content of clay, the soil should be worked when moist but not wet. The high content of clay restricts the growth of trees and shrubs. The species selected for planting should be those that are extremely tolerant of drought. Planting trees on the contour helps to control runoff and erosion. Weeds can

be controlled by cultivating with conventional equipment and applying the appropriate herbicides in a timely manner.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked only during the proper moisture conditions. Working the soil is hindered by the slope. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Slides are a hazard during wet periods.

The capability classification is IVe-4, dryland, and IVe-1, irrigated. The range site is Clayey, and the windbreak suitability group is 4C.

LcF—Labu-Sansarc complex, 11 to 30 percent slopes. These well drained, moderately steep and steep soils are on upland ridges and side slopes. They are moderately deep and shallow over shale bedrock. Some catsteps and soil slips occur in areas of these soils. The Labu soil is on the long, smooth, lower slopes. The Sansarc soil is on ridgetops and shoulder slopes along drainageways. Most areas of these soils are deeply dissected by drainageways. Individual areas range from 5 to more than 500 acres in size. They are 55 to 65 percent Labu soil and 20 to 30 percent Sansarc soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Labu soil is dark grayish brown, firm, calcareous silty clay about 4 inches thick. The subsoil is about 21 inches thick. The upper part is grayish brown, very firm, calcareous silty clay, and the lower part is light olive gray, very firm, calcareous clay. The underlying material is light olive gray, calcareous clay about 9 inches thick. Light gray, calcareous shale bedrock is at a depth of about 34 inches.

Typically, the surface layer of the Sansarc soil is dark grayish brown, very firm, calcareous silty clay about 4 inches thick. Below this is a transitional layer of olive gray, very firm, calcareous clay about 5 inches thick. The underlying material is light olive gray, calcareous clay about 9 inches thick. Light gray, calcareous shale bedrock is at a depth of about 18 inches.

Included with these soils in mapping are small areas of Bristow, Lynch, and Verdel soils. Bristow and Lynch soils are slightly lower on the landscape than the Labu and Sansarc soils. They formed in light colored shale bedrock. Verdel soils are very deep. They are on foot slopes. They have a thick, dark surface soil. In a few places sandstone fragments or glacial stones that range from a few inches to several feet in diameter are on the surface. In places the ridgetop is capped with a thin mantle of gravel. Included areas make up 5 to 20 percent of the unit.

Permeability is slow in the Labu and Sansarc soils. The available water capacity is low in the Labu soil and very low in the Sansarc soil. Runoff is rapid or very rapid on both soils. Organic matter content is moderately low. Natural fertility is low. Because of the fine, plastic clay in the soils, some of the moisture is not released to plants. The shrink-swell potential is high in the Labu soil and very high in the Sansarc soil. The soils have cracks 1 to 3 inches wide during dry periods. The root zone extends to shale bedrock.

Almost all of this unit supports native grasses and is used for range. The soils are unsuited to cropland. Areas on a few of the north-facing slopes support trees.

If the Labu soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, and green needlegrass. These species make up 55 percent or more of the total annual forage. Sideoats grama, western wheatgrass, blue grama, bluegrass, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, the major grasses decrease in abundance and are replaced by western wheatgrass, blue grama, sideoats grama, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, sedges, common pricklypear, and numerous annual and perennial weeds dominate the site.

If the Sansarc soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, green needlegrass, and sideoats grama. These species make up 65 percent or more of the total annual forage. Western wheatgrass, needleandthread, blue grama, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, green needlegrass, and sideoats grama decrease in abundance and are replaced by needleandthread, western wheatgrass, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre on

the Labu soil and 0.7 animal unit month per acre on the Sansarc soil. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control water erosion.

These soils are generally unsuited to trees grown as windbreaks. Onsite investigation is needed to determine areas that are suitable for planting. Some areas can be used for plantings that enhance recreational areas or wildlife habitat if trees and shrubs are hand planted or if other special practices are applied.

These soils are generally not suited to sanitary facilities because of the slope, the slow permeability, and the shallow depth to bedrock in areas of the Sansarc soil. A suitable alternative site should be selected. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling can provide a suitable grade for roads. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Slides are a hazard during wet periods.

The capability classification of the Labu soil is VIe-4, dryland. The range site is Clayey, and the windbreak suitability group is 10. The capability classification of the Sansarc soil is VIs-4, dryland. The range site is Shallow Clay, and the windbreak suitability group is 10.

LhC2—Longford silty clay loam, 2 to 6 percent slopes, eroded. This very deep, gently sloping, well drained soil is on uplands. It formed in loess or alluvial sediments. In most areas of cropland, erosion has removed the original dark surface layer. Areas range from 5 to 40 acres in size.

Typically, the surface layer is dark grayish brown, firm silty clay loam about 6 inches thick. The subsoil is about 32 inches thick. It is brown, very firm silty clay in the upper part; pinkish gray, very firm silty clay in the next part; and pink, very firm silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is pink silty clay loam. In some places the surface layer is sandy loam, loam, or silty clay. In other places the underlying material is silty clay or sandy clay loam.

Included with this soil in mapping are small areas of Betts and Paka soils. These soils contain less clay than the Longford soil. Betts soils are lower on the landscape than the Longford soil. They are calcareous and have small stones throughout the profile. Paka soils do not have pinkish profiles. They are in landscape positions similar to those of the Longford soil. Also included are a few alkaline areas and a few wet areas that have a perched water table. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Longford soil. The available water capacity is moderate. The water intake rate is low. Runoff is medium. Organic matter content is moderately low. Natural fertility is low. The shrink-swell potential is high.

More than half of the acreage of this soil is dry-farmed. A few areas are irrigated by sprinklers. The remaining acreage supports cool-season or native grasses and is used for grazing.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, wheat, and alfalfa. Water erosion is a hazard. Conserving water is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. The soil cannot be easily tilled because it is firm when moist and hard and cloddy when dry. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth. Terraces and grassed waterways help to control water erosion.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to center-pivot sprinkler systems. Adjusting the rate of water application to the low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure can improve or maintain organic matter content, fertility, and tilth. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to cool-season introduced grasses for pasture and hayland. Grasses can be rotated with other crops. Smooth bromegrass and orchardgrass are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing when the soil is wet can result in surface compaction and poor tilth. Rotation grazing and proper stocking rates help to keep the grasses in good

condition. Applying nitrogen and phosphate fertilizers increases the growth and vigor of the grasses.

This soil is suited to native grasses for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Growth rates of trees and shrubs are fair because of the high content of clay. The species selected for planting should be those that are tolerant of drought. Irrigation may be necessary during periods of insufficient rainfall. Weeds can be controlled by cultivating between the tree rows, hand hoeing within the rows, and carefully applying the appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. If the less sloping areas are selected as sites for sewage lagoons, some leveling and banking may be necessary. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is IIIe-8, dryland, and IIIe-3, irrigated. The range site is Clayey, and the windbreak suitability group is 3.

LhD2—Longford silty clay loam, 6 to 11 percent slopes, eroded. This very deep, strongly sloping, well drained soil is on uplands. It formed in loess or alluvial sediments. In most areas of cropland, erosion has removed the original dark surface layer. Areas range from 5 to 60 acres in size.

Typically, the surface layer is grayish brown, firm silty clay loam about 6 inches thick. The subsoil is about 34 inches thick. The upper part is pinkish gray, very firm silty clay, and the lower part is pink, firm silty clay loam. The underlying material to a depth of more than 60 inches is pink silty clay loam. In some places the surface layer is sandy loam, loam, or silty clay. In other places the underlying material is silty clay or sandy clay loam.

Included with this soil in mapping are small areas of Betts and Paka soils. These soils contain less clay than the Longford soil. Betts soils are lower on the landscape than the Longford soil. They are calcareous and have small stones throughout the profile. Paka soils do not have pinkish profiles. They are in landscape positions similar to those of the Longford soil. Also included are some areas that have slopes of more than 11 percent and a few alkaline areas on the lower slopes. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Longford soil. The available water capacity is moderate. The water intake rate is low. Runoff is medium. Organic matter content is moderately low. Natural fertility is low. The shrink-swell potential is high.

A large acreage of this soil is dry-farmed. A few areas are irrigated by sprinklers. The remaining areas support cool-season or native grasses and are used for grazing.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, oats, wheat, and alfalfa. Water erosion is a hazard. Conserving water is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. The soil cannot be easily tilled because it is firm when moist and hard and cloddy when dry. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure can improve or maintain organic matter content, fertility, and tilth. Where slopes are suitable, terraces and grassed waterways help to control water erosion.

If irrigated, this soil is poorly suited to corn, grain sorghum, and alfalfa. It is suited only to center-pivot sprinkler systems. Adjusting the rate of water application to the low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to cool-season introduced grasses or warm-season grasses for grazing. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing and grazing when the soil is wet can result in surface compaction and poor tilth. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers increases the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Growth rates of trees and shrubs are only fair because of the high content of clay. The species selected for planting should be those that are tolerant of drought. Irrigation may be necessary during periods of insufficient rainfall. Weeds can be controlled by cultivating between the tree rows, hand hoeing within the rows, and carefully applying the appropriate herbicides.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is IVe-8, dryland, and IVe-3, irrigated. The range site is Clayey, and the windbreak suitability group is 3.

Lk—Loretto fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands. It formed in loamy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer also is grayish brown, very friable fine sandy loam. It is about 9 inches thick. The subsoil is friable loam about 38 inches thick. The upper part is brown, and the lower part is pale brown. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of Boelus and Ortello soils. These soils are in landscape positions similar to those of the Loretto soil. Boelus soils have more sand in the upper part of the profile than the Loretto soil, and Ortello soils have less clay in the subsoil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Loretto soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The soil releases moisture readily to plants. It can be easily tilled.

Most of the acreage of this soil is dry-farmed. A small acreage is irrigated by sprinklers. Small areas support native or cool-season grasses and are used for grazing.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, small grain, alfalfa, and introduced grasses. Soil blowing is a moderate hazard. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil and applying fertilizer and feedlot manure help to maintain organic matter content, fertility, and tilth.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. It is suited to gravity and sprinkler systems. Some land leveling may be needed in areas where gravity systems are used. The rate of water application should be adjusted to the moderate intake rate of the soil. Soil blowing is a moderate hazard. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil and applying fertilizer and feedlot manure help to maintain organic matter content, fertility, and tilth.

This soil is suited to cool-season introduced grasses used for grazing or hay. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Warm-season grasses also can be grown. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is well suited to trees and shrubs grown as windbreaks. Soil blowing is a moderate hazard. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, by timely cultivation, or by applications of appropriate herbicides. Limited rainfall is the principal limitation if trees are planted. Irrigation may be necessary during dry periods. Soil blowing can be controlled by maintaining a cover crop between the tree rows.

This soil is generally suited to septic tank absorption fields, dwellings, and small commercial buildings. Lining or sealing sewage lagoons helps to prevent seepage.

The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIe-3, dryland, and IIe-5, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

LkC—Loretto fine sandy loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in loamy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 5 inches thick. The subsurface layer also is grayish brown, friable fine sandy loam about 5 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is brown, and the lower part is pale brown. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of Boelus and Ortello soils. These soils are in landscape positions similar to those of the Loretto soil. Boelus soils have more sand in the upper part of the profile than the Loretto soil, and Ortello soils have less clay in the subsoil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Loretto soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. The soil can be easily tilled.

Most of the acreage of this soil is dry-farmed. A small acreage is irrigated by sprinklers. Small areas support native or cool-season grasses and are used for grazing.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, small grain, alfalfa, and introduced grasses. Soil blowing and water erosion are moderate hazards. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and water erosion. Returning crop residue to the soil and applying fertilizer and feedlot manure help to maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. Soil blowing and water erosion are moderate hazards. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. Returning crop residue to the soil and applying fertilizer and feedlot manure help to maintain organic matter content, fertility, and tilth.

This soil is suited to cool-season introduced grasses used for grazing or hay. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Warm-season grasses also can be grown. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen fertilizer improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is well suited to trees and shrubs grown as windbreaks. Soil blowing and water erosion are moderate hazards. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, by timely cultivation, or by applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall. Soil blowing can be controlled by maintaining a cover crop between the tree rows. Planting trees on the contour and using terraces help to control water erosion and runoff.

This soil is generally suited to septic tank absorption fields and dwellings. Lining or sealing sewage lagoons helps to prevent seepage. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-3, dryland, and IIIe-5, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

LyF—Lynch-Bristow complex, 11 to 30 percent slopes. These moderately steep and steep, well drained soils formed in material weathered from calcareous and gypsiferous shale bedrock on upland ridges and side slopes. The Lynch soil is moderately deep over shale bedrock. The Bristow soil is shallow over shale bedrock. The Lynch soil is on the smoother, lower slopes. The Bristow soil is on ridgetops or shoulder slopes along drainageways. Most areas of these soils are dissected by shallow drainageways and deep gullies. Some catsteps occur on the steeper slopes. Areas of these soils range from 10 to 300 acres

in size. They are 40 to 55 percent Lynch soil and 35 to 50 percent Bristow soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Lynch soil is light brownish gray, firm, calcareous silty clay about 5 inches thick. The subsoil is pale yellow, firm, calcareous silty clay about 18 inches thick. The underlying material is light gray and pale yellow, calcareous clay about 12 inches thick. Pale yellow and white, calcareous shale bedrock is at a depth of about 35 inches. A few areas have a dark surface soil more than 6 inches thick.

Typically, the surface layer of the Bristow soil is grayish brown, firm, calcareous silty clay about 4 inches thick. Below this is a transitional layer of light brownish gray, firm, calcareous silty clay about 3 inches thick. The underlying material is very pale brown, calcareous clay about 9 inches thick. Yellow, calcareous shale bedrock is at a depth of about 16 inches. In some areas accumulations of gypsum and carbonates are below a depth of 6 inches.

Included with these soils in mapping are small areas of Labu, Sansarc, and Verdel soils. Labu and Sansarc soils are slightly higher on the landscape than the Lynch and Bristow soils. Also, they formed in darker shale bedrock. Verdel soils are on foot slopes in the lower landscape positions. They have a thick, dark surface soil. Also included are areas of shale outcrop on some of the ridgetops. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Lynch and Bristow soils. The available water capacity is low in the Lynch soil and very low in the Bristow soil. Runoff is rapid on the Lynch soil and very rapid on the Bristow soil. Organic matter content is moderately low in both soils. Natural fertility is low. The shrink-swell potential is high. Moisture is released slowly to plants.

Most of the acreage of these soils supports native range. Areas of these soils are too erodible and steep to support cultivated crops.

If the Lynch soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, blue grama, and sideoats grama. These species make up 55 percent or more of the total annual forage. Green needlegrass, western wheatgrass, needleandthread, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by sideoats grama, blue grama, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, and numerous annual and perennial weeds dominate the site.

If the Bristow soil is used as range, the climax vegetation is dominantly big bluestem, little bluestem, sideoats grama, and blue grama. These species make up 70 percent or more of the total annual forage. Needleandthread, western wheatgrass, prairie sandreed, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, western wheatgrass, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, western wheatgrass, and numerous annual and perennial grasses and weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control water erosion.

These soils are generally not suited to trees and shrubs grown as windbreaks because of the slope.

These soils are generally not suited to sanitary facilities because of the slope, the slow permeability, and the shallow depth to bedrock in areas of the Bristow soil. A suitable alternative site should be selected. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling can provide a suitable grade for roads. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Slides are a hazard during wet periods.

The capability classification of the Lynch soil is VIe-4, dryland. The range site is Limy Upland, and the windbreak suitability group is 10. The capability classification of the Bristow soil is VIs-4, dryland. The range site is Shallow Limy, and the windbreak suitability group is 10.

LzD—Lynch-Verdel complex, 6 to 11 percent slopes. These strongly sloping, well drained soils are on uplands and foot slopes. The Lynch soil formed in material weathered from calcareous shale bedrock. The

Verdel soil formed in clayey alluvium. The moderately deep Lynch soil is on the smooth or slightly convex upper side slopes. The very deep Verdel soil is on the lower, smooth or slightly concave foot slopes or in swales. Areas of these soils range from 5 to 80 acres in size. They are 70 to 85 percent Lynch soil and 15 to 30 percent Verdel soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Lynch soil is light brownish gray, firm, calcareous silty clay about 5 inches thick. The subsoil is firm, calcareous silty clay about 15 inches thick. It is light brownish gray in the upper part and mixed light gray and light yellowish brown in the lower part. The underlying material is mixed light olive gray and olive yellow, calcareous clay about 15 inches thick. Pale yellow and light gray, calcareous shale bedrock is at a depth of about 35 inches. The soil has a high content of gypsum.

Typically, the surface layer of the Verdel soil is dark grayish brown, firm, calcareous silty clay about 6 inches thick. The subsurface layer is grayish brown, firm, calcareous silty clay about 9 inches thick. The subsoil is firm, calcareous silty clay about 39 inches thick. It is grayish brown in the upper part and brown in the lower part. The underlying material to a depth of more than 60 inches is yellowish brown, calcareous silty clay.

Included with these soils in mapping are small areas of Bristow and Labu soils. Bristow soils are on ridgetops and knolls in the slightly higher landscape positions. They are shallow over shale bedrock. Labu soils are slightly higher on the landscape than the Lynch and Verdel soils. They are moderately deep over dark shale bedrock. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Lynch and Verdel soils. The available water capacity is low in the Lynch soil and moderate in the Verdel soil. The water intake rate is very low in both soils. Runoff is medium or rapid. Organic matter content is moderately low in the Lynch soil and moderate in the Verdel soil. Natural fertility is low in the Lynch soil and medium in the Verdel soil. The shrink-swell potential is high in both soils. Moisture is released slowly to plants.

About half of the acreage of these soils is used as cropland or pastures of cool-season grasses. A small acreage is irrigated. The remaining acreage supports native grasses and is used for grazing. A few small areas support trees and shrubs.

These soils are poorly suited to cultivated crops. Water erosion is a hazard. The most common crops are alfalfa, wheat, oats, and bromegrass. Grain sorghum and corn are also grown. Erosion is a severe hazard in areas used for row crops. Where slopes are suitable, grassed waterways, minimum tillage, contour farming, and terraces help to prevent excessive soil and moisture losses. Returning crop residue to the soil and applying feedlot manure and phosphate fertilizers help to maintain fertility.

If irrigated, these soils are poorly suited to cropland. A small acreage of alfalfa and grain sorghum is irrigated by sprinklers. Erosion is a severe hazard in areas used for row crops. If irrigated by sprinklers, the very low water intake rate limits the amount of water available for crops.

These soils are suited to cool-season introduced grasses or legumes for pasture or hayland. Grasses or legumes can be rotated with other crops. Smooth bromegrass and intermediate wheatgrass are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. These soils are subject to water erosion. Overgrazing can reduce the vigor of plants and thus can cause the formation of rills after periods of heavy rainfall. Gully erosion is a severe hazard in drainageways. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

These soils are suited to native grasses for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

These soils are poorly suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that are tolerant of drought and a high content of calcium. Planting trees on the contour conserves moisture and helps to control runoff and erosion. Irrigation may be necessary during periods of insufficient rainfall. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides.

These soils are not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soils should be worked when moist but not wet. The slope can also hinder working the soils. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads

should be thick enough to compensate for the low strength of the soils. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Slides are a hazard during wet periods.

The capability classification is IVe-4, dryland, and IVe-1, irrigated. The range site of the Lynch soil is Limy Upland, and that of the Verdel soil is Clayey. The windbreak suitability group of both soils is 4C.

MbF—Mariaville very fine sandy loam, 3 to 30 percent slopes. This gently sloping to steep, well drained soil is on convex ridgetops and side slopes in the uplands. It is shallow over weakly cemented siltstone bedrock. Areas range from 5 to 30 acres in size.

Typically, the surface layer is grayish brown, friable, calcareous very fine sandy loam about 3 inches thick. Below this is a transitional layer of light brownish gray and light gray, friable, calcareous very fine sandy loam about 3 inches thick. The underlying material is light gray, calcareous very fine sandy loam about 6 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 12 inches. In some places the soil is fine sandy loam or loamy fine sand. In other places the bedrock is weakly cemented sandstone.

Included with this soil in mapping are small areas of Brunswick and Paka soils. These soils are in landscape positions similar to those of the Mariaville soil. Brunswick soils contain less clay than the Mariaville soil. They are moderately deep over sandstone bedrock. Paka soils have a dark surface soil. They are deep over siltstone bedrock. Also included are small outcrops of quartzite, siltstone, and sandstone. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Mariaville soil. The available water capacity is very low. Runoff is rapid. Organic matter content is moderately low. Natural fertility is low.

Nearly all areas of this soil support native grasses and are used as range or hayland. Some small areas are cultivated. A few small areas that were formerly cultivated have been reseeded to introduced grasses for pasture or hay. A few areas support trees planted for farmstead windbreaks.

This soil is not suited to cultivated crops because of the slope and because of droughtiness resulting from the shallow depth to bedrock. Water erosion is a severe hazard in areas that are cultivated or overgrazed.

In areas used for range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 50 percent or more of the total annual forage. Needleandthread, prairie sandreed, plains muhly, green needlegrass, western wheatgrass, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, little bluestem, big bluestem, and sideoats grama decrease in abundance and are replaced by western wheatgrass, blue grama, prairie sandreed, sand dropseed, threadleaf sedge, forbs, and other annual and perennial grasses. If overgrazing continues for many years, annual and perennial grasses, weeds, and woody plants dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Brush control may be needed in some areas to control the growth of woody plants.

This soil is generally unsuited to trees and shrubs grown as windbreaks. Onsite investigation is needed to determine small areas that are suitable for planting. The shallow depth to bedrock limits the amount of water available for the survival and growth of trees and shrubs. Some areas are too steep for machine planting. A few areas can be used for plantings that enhance recreational areas or wildlife habitat if trees and shrubs are hand planted or if other special practices are applied.

This soil is generally not suited to sanitary facilities because of the shallow depth to bedrock and the slope in some areas. A suitable alternative site should be selected. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads.

The capability classification is VIs-4, dryland. The range site is Shallow Limy, and the windbreak suitability group is 10.

MeB—Meadin sandy loam, 0 to 3 percent slopes. This nearly level or very gently sloping, excessively drained soil is on uplands and stream terraces. It is shallow over gravelly coarse sand. Areas range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 9 inches thick. Below this

is a transitional layer of grayish brown, very friable loamy sand about 4 inches thick. The underlying material to a depth of 60 inches or more is very pale brown and light gray gravelly coarse sand. In some places the surface layer is loam, sandy loam, gravelly sandy loam, or loamy sand. In a few places gravelly coarse sand is at the surface. In the eastern part of the county, a few glacial cobbles and stones are on the surface of the soil and throughout the profile.

Included with this soil in mapping are small areas of O'Neill and Simeon soils. These soils are in landscape positions similar to those of the Meadin soil. O'Neill soils are moderately deep over gravelly coarse sand. Simeon soils are very deep. They have sand throughout the profile and do not have a dark surface layer. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the upper part of the Meadin soil and very rapid in the lower part. The available water capacity and natural fertility are low. Runoff is slow. Organic matter content is moderately low. The water intake rate is moderately high or high. The soil can be easily tilled throughout a wide range in moisture content.

About half of the acreage of this soil is cultivated, and these areas are used about equally for dryland and irrigated crops. The remaining acreage supports native grasses and is used for grazing or hay.

If dry-farmed, this soil is poorly suited to corn, soybeans, small grain, alfalfa, and introduced grasses. It is droughty. The amount of rainfall received in July and August of most years is limited. Small grain and the first cutting of alfalfa are generally the most suitable crops because they grow in spring when the amount of rainfall is highest. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture.

If irrigated, this soil is poorly suited to corn, alfalfa, soybeans, and sorghum. Small grain and introduced grasses are better suited crops. The soil is best suited to sprinkler systems. Because of the moderately high or high intake rate and the rapid permeability, overwatering can cause leaching of nutrients below the root zone. Frequent, light applications of water are needed to prevent leaching of plant nutrients below the root zone. Because of the low available water capacity, timely irrigation is a management concern. Slight delays in the application of water can result in partial or complete loss of crops. A system of conservation tillage, such as disking, that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil and applying barnyard manure can improve or maintain fertility and the organic matter content.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is generally unsuited to trees and shrubs grown as windbreaks because of the shallow root zone and the low available water capacity. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted or if other special practices are applied.

This soil is generally suited to dwellings, small commercial buildings, and local roads and streets. Seepage can result in pollution of water supplies in areas used for septic tank absorption fields. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored.

The capability classification is IVs-4, dryland, and IVs-14, irrigated. The range site is Shallow to Gravel, and the windbreak suitability group is 10.

MgF—Meadin-O'Neill complex, 3 to 30 percent slopes. These well drained and excessively drained, gently sloping to steep soils are on uplands. The Meadin soil is shallow over gravelly coarse sand. The O'Neill soil is moderately deep over gravelly coarse sand. The Meadin soil is on the convex upper side slopes, shoulder slopes, and narrow ridgetops. The O'Neill soil is on the concave mid and lower side slopes. Areas of these soils range from 5 to 300 acres in size. They are 40 to 65 percent Meadin soil and 25 to 50 percent O'Neill soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Meadin soil is dark grayish brown, friable sandy loam about 7 inches thick. Below this is a transitional layer of dark grayish brown, friable gravelly sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown and very pale brown gravelly coarse sand. In some places the surface layer is loam, gravelly sandy loam, or loamy sand. In other places gravelly coarse sand is at the surface. In the eastern part of the county, a few glacial cobbles and stones are on the surface and throughout the profile.

Typically, the surface layer of the O'Neill soil is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is grayish brown, friable sandy

loam about 6 inches thick. The subsoil is brown, very friable sandy loam about 9 inches thick. The underlying material to a depth of more than 60 inches is pale brown gravelly coarse sand. In some places the surface layer is loam, gravelly sandy loam, or loamy sand. In other places it is less than 7 inches thick. In some areas the underlying material is sand.

Included with these soils in mapping are small areas of Brunswick, Paka, Simeon, and Thurman soils. Brunswick and Paka soils are lower on the landscape than the Meadin and O'Neill soils. Simeon and Thurman soils are in landscape positions similar to those of the Meadin and O'Neill soils. Brunswick soils have sandstone bedrock at a depth of 20 to 40 inches. Paka soils are deep. They contain more clay than the Meadin and O'Neill soils. Simeon and Thurman soils are very deep. They are sandy. Included soils make up 5 to 20 percent on the unit.

Permeability is rapid in the upper part of the Meadin soil and very rapid in the lower part. It is moderately rapid in the upper part of the O'Neill soil and very rapid in the lower part. The available water capacity is low in both soils. Runoff is slow to rapid. Organic matter content is moderately low. Natural fertility is low in the Meadin soil and medium in the O'Neill soil.

Most of the acreage of these soils supports native grasses and is used for grazing. These soils are not suited to cropland because of the droughtiness and the hazard of erosion.

If the Meadin soil is used as range, the climax vegetation is dominantly blue grama, clubmoss, needleandthread, and prairie sandreed. These species make up 65 percent or more of the total annual forage. Sand bluestem, hairy grama, sand dropseed, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem and prairie sandreed decrease in abundance and are replaced by hairy grama, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, fringed sagewort, and numerous annual and perennial weeds dominate the site.

If the O'Neill soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, blue grama, and needleandthread. These species make up 70 percent or more of the total annual forage. Switchgrass, sand dropseed, sedges, cudweed sagewort, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre on the Meadin soil and 0.9 animal unit month per acre on the O'Neill soil. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Because of the low available water capacity, the soils are droughty. The amount of forage produced depends on the frequency and amount of rainfall. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range.

The Meadin soil is generally unsuited to trees and shrubs grown as windbreaks because of the low available water capacity. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted or if other special practices are applied.

The O'Neill soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. The soil is droughty because of the low available water capacity. Only those trees and shrubs that can withstand the droughtiness should be selected for planting unless supplemental water is supplied by irrigation. Soil blowing can be controlled by maintaining strips of sod between the tree rows. Rototilling areas near the trees helps to control grasses and weeds.

These soils generally are not suited to sanitary facilities because of the slope. In areas that are gently sloping to moderately sloping, the soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. If the less sloping areas are selected for sewage lagoons, a minimal amount of leveling and banking is needed. Sealing the bottom of the lagoon helps to prevent excessive seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Buildings in the strongly sloping areas should be designed so that they conform to the natural slope of the land, or the sites should be graded to a suitable gradient. Cutting and filling can provide a suitable grade for roads and streets. The damage to roads caused by frost action in areas of the O'Neill soil can be minimized

by providing a good surface drainage system. Crowning the road by grading and providing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification of the Meadin soil is VIs-4, dryland. The range site is Shallow to Gravel, and the windbreak suitability group is 10. The capability classification of the O'Neill soil is VIe-3, dryland. The range site is Sandy, and the windbreak suitability group is 6G.

Mm—Moody loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on broad uplands. It formed in loess. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is brown and pale brown, firm silty clay loam about 25 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown, calcareous silt loam in the upper part and very pale brown very fine sandy loam in the lower part. In some areas the surface layer is silt loam or silty clay loam. In a few places the sandy underlying material is within a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Bazile, Butler, Paka, Thurman, and Trent soils. Bazile and Paka soils are in landscape positions similar to those of the Moody soil. Bazile soils have sandy underlying material at a depth of 20 to 40 inches. Paka soils formed in material weathered from siltstone bedrock. Butler and Trent soils are in upland basins or swales. They are in slightly lower landscape positions than the Moody soil. Butler soils have a clayey subsoil. They are somewhat poorly drained. Trent soils have a thick, dark surface soil. Thurman soils are commonly slightly higher on the landscape than the Moody soil. They are sandy. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Moody soil. The available water capacity is high. The water intake rate is moderately low. Runoff is slow. Organic matter content is moderate. Natural fertility is high. The soil is easy to till.

Most of the acreage of this soil is dry-farmed. A few areas are irrigated by sprinklers. A small acreage supports cool-season or native grasses used for grazing.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, alfalfa, oats, and wheat. Water erosion and soil blowing are slight hazards. Returning crop residue to the soil and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. If furrow systems are used, land leveling can provide even distribution of water. If a sprinkler irrigation system is used, the rate of water application should be adjusted to the intake rate of the soil. A cropping system that includes grasses and legumes improves or maintains organic matter content, fertility, and tilth and increases the rate of water intake.

This soil is suited to cool-season introduced grasses used for grazing. Grasses are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with alfalfa. Overgrazing or improper haying methods reduce the quality of the native grasses. Rotation grazing and applications of nitrogen and phosphate fertilizers are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good, and growth rates are fair. The major concerns are drought and the weeds and grasses that compete with the trees for moisture. Irrigation may be necessary during periods of insufficient rainfall. Competing vegetation can be controlled by proper site preparation, by cultivating with conventional equipment between the tree rows, by hand hoeing or rototilling, or by applying appropriate herbicides.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface

drainage system. Crowning the road by grading and establishing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is I-1, dryland, and I-4, irrigated. The range site is Silty, and the windbreak suitability group is 3.

MmC—Moody loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in loess. Areas range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsoil is about 35 inches thick. It is dark grayish brown, friable silty clay loam in the upper part; brown, firm silty clay loam in the next part; and pale brown, firm silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam and loam. In some places the surface layer is silt loam. In other places it is brown silty clay loam. In some areas lime is at a depth of less than 30 inches.

Included with this soil in mapping are small areas of Bazile and Thurman soils. Bazile soils are in landscape positions similar to those of the Moody soil. They have sand at a depth of 20 to 40 inches. Thurman soils are higher on the landscape than the Moody soil. They are sandy. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Moody soil. The available water capacity is high. The water intake rate is moderately low. Runoff is medium. Organic matter content is moderate. Natural fertility is high. The soil is easy to till.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but many areas are irrigated by sprinklers. A few areas support cool-season grasses and are used for grazing. Numerous small areas support native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn, sorghum, alfalfa, soybeans, small grain, and introduced grasses. Water erosion is a hazard. Terraces and contour stripcropping can help to control runoff and erosion. A system of conservation tillage, such as no-till planting, that leaves crops or crop residue on the surface helps to control erosion and conserves moisture. Applying barnyard manure improves organic matter content and fertility.

If irrigated, this soil is suited to corn, sorghum, alfalfa, soybeans, and introduced grasses. It is suited to sprinkler irrigation. Bench leveling or contour bench leveling may be needed in areas where gravity systems are used. Water erosion is a hazard. In areas where center-pivot systems are used, wheel-track erosion can be a problem. Adjusting the rate of water application to the intake rate of the soil helps to control erosion in the wheel tracks. Terraces, contour farming, and stripcropping help to control runoff and erosion. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control runoff and conserves moisture. Returning crop residue to the soil improves the organic matter content and increases the rate of water intake.

This soil is suited to cool-season introduced grasses used for grazing. Pasture grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass, are suitable species. They can be seeded or used in a mixture with smooth bromegrass and alfalfa or intermediate wheatgrass and alfalfa. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Drought, water erosion, and the weeds and undesirable grasses that compete with the trees for moisture are the main concerns. Irrigation may be necessary during periods of insufficient rainfall. Planting trees on the contour and using terraces conserve moisture and help to control undesirable grasses and weeds. Carefully applying the appropriate herbicides or hoeing by hand can help to control weeds in the tree rows.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-1, dryland, and IIIe-4, irrigated. The range site is Silty, and the

windbreak suitability group is 3.

Mo—Moody silty clay loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on broad uplands. It formed in loess. Areas range from 10 to 1,000 acres in size.

Typically, the surface layer is dark grayish brown, firm silty clay loam about 16 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is brown, and the lower part is pale brown. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of Butler, Fillmore, and Trent soils. These soils are in the slightly lower landscape positions in upland basins, swales, or depressions. Butler and Fillmore soils have a clayey subsoil. They are somewhat poorly drained. Trent soils have a thick, dark surface soil. Also included are small areas of gently sloping Moody soils. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Moody soil. The available water capacity is high. The water intake rate is low. Runoff is slow. Organic matter content is moderate. Natural fertility is high. Tilth is good.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some areas are irrigated. A few small areas support introduced or native grasses.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, oats, and alfalfa. Conserving water is a management concern. A system of conservation tillage that leaves crop residue on the surface conserves moisture and helps to control soil blowing. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited to row crops, such as corn and soybeans, and to close-growing crops, such as alfalfa and oats. It tends to form clods if tilled when wet. If row crops are grown, gravity and sprinkler systems are suitable methods of irrigation. Land leveling and a tailwater recovery system can improve the efficiency of gravity systems. The soil is well suited to center-pivot systems. The rate of water application should be adjusted so that it does not exceed the water intake rate of the soil. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the water intake rate. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses for pasture. Pastures commonly consist of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Rotation grazing, applications of nitrogen fertilizer, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Healthy seedlings of adapted species can survive and grow well if properly planted in a well prepared site and if they receive proper care after planting. Weeds can be controlled by cultivating between the tree rows, hand hoeing within the rows, and carefully applying the appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is I-1, dryland, and I-3, irrigated. The range site is Silty, and the windbreak suitability group is 3.

MoC—Moody silty clay loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on smooth ridgetops and side slopes in the uplands. It formed in loess. Areas range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown, firm silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 41 inches thick. The upper part is grayish brown, the next part is pale brown, and the lower part is very pale brown and calcareous. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam. In some areas the surface layer is eroded and is lighter colored.

Included with this soil in mapping are small areas of Crofton and Nora soils. Crofton soils are in the lower landscape positions. They have a lighter colored surface layer than the Moody soil. They are calcareous near the surface. Nora soils are calcareous at a depth of less than 30 inches. They are in landscape positions similar to those of the Moody soil. Also included are

small areas of nearly level or strongly sloping Moody soils. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Moody soil. The available water capacity is high. The water intake rate is low. Runoff is medium. Organic matter content is moderate. Natural fertility is high. Tilth is good.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but many areas are irrigated by sprinklers. A few areas support cool-season or native grasses and are used for grazing.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. Water erosion is a slight or moderate hazard. Conserving water is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. If alfalfa is grown, applications of lime are needed. Terraces and grassed waterways help to control erosion.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is particularly well suited to center-pivot sprinkler systems. The major hazard is erosion. Adjusting the rate of water application to the low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to cool-season introduced grasses used for grazing. Pastures generally consist of smooth bromegrass or a mixture of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control soil blowing and water erosion. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Healthy seedlings of adapted species can survive and grow well if properly planted on a well prepared site and if they receive proper care after planting. Weeds can be controlled by cultivating between the tree rows, hand hoeing within the rows, or carefully applying the appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing adequate roadside ditches help to provide good surface drainage and minimize the damage caused by frost action.

The capability classification is IIe-1, dryland, and IIIe-3, irrigated. The range site is Silty, and the windbreak suitability group is 3.

NoC—Nora silty clay loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on smooth ridgetops and side slopes in the uplands. It formed in loess. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer also is dark grayish brown, friable silty clay loam. It is about 5 inches thick. The subsoil is about 27 inches thick. The upper part is brown, friable silty clay loam, and the lower part is pale brown, friable, calcareous silt loam. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam. In some places the soil is silt loam throughout. In other places it is silty clay loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Crofton, Moody, and Ortello soils. Crofton soils have a lighter colored surface layer than the Nora soil. They are calcareous near the surface. They are in the slightly higher landscape positions. Moody soils are in landscape positions similar to those of the Nora soil. They are calcareous below a depth of 30 inches. Ortello

soils are higher on the landscape than the Nora soil. Also, they have more sand. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Nora soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. Tilth is good.

Most of the acreage of this soil is farmed. A large acreage is irrigated if water is available. Some areas support cool-season or native grasses and are used for grazing.

If dry-farmed, this soil is suited to corn, oats, wheat, alfalfa, grain sorghum, and soybeans. Water erosion is a slight or moderate hazard if the surface is not protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Most areas are not suited to gravity irrigation because of the hazard of erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content and tilth.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition and help to control water erosion. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Overgrazing and improper haying methods reduce the quality of the native grasses and thus can increase the hazard of water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

This soil is generally suited to septic tank absorption fields. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-1, dryland, and IIIe-3, irrigated. The range site is Silty, and the windbreak suitability group is 3.

NoD—Nora silty clay loam, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on plane hillsides in the uplands. It formed in loess. Areas range from 5 to 40 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is about 28 inches thick. The upper part is brown, friable silty clay loam, and the lower part is pale brown, friable, calcareous silt loam. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam. In some places the soil is silt loam throughout. In other places it is silty clay loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Betts and Crofton soils. Crofton soils are in the slightly higher landscape positions on the upper side slopes. They have a lighter colored surface layer than the Nora soil. Crofton and Betts soils are calcareous near the surface. Betts soils are in landscape positions similar to those of the Nora soil. They formed in glacial till. In a few areas erosion has removed all or most of the original surface layer. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Nora soil. The available water capacity is high. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. Tilth is good.

Most of the acreage of this soil is farmed. Most areas

are dry-farmed, but a large acreage is irrigated. Some areas support cool-season or native grasses and are used for grazing.

If dry-farmed, this soil is suited to corn, oats, wheat, alfalfa, grain sorghum, and soybeans. Water erosion is a moderate hazard if the surface is not protected by crops or crop residue. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

If irrigated by sprinklers, this soil is suited to wheat, alfalfa, and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a severe hazard in areas where these crops are grown. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content and tilth.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition and help to control water erosion. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to range. Overgrazing or improper haying methods reduce the quality of the native grasses and thus increase the hazard of water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

If this soil is used as a site for septic tank absorption fields, land shaping and installing the field on the contour help to ensure that the field functions properly. If the less sloping areas are selected as sites for sewage lagoons, some leveling and banking may be necessary. Sealing the bottom of the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Crowning the road by grading and constructing adequate roadside ditches help to provide good surface drainage and minimize the damage to roads caused by frost action.

The capability classification is IIIe-1, dryland, and IVe-3, irrigated. The range site is Silty, and the windbreak suitability group is 3.

NoE—Nora silty clay loam, 11 to 15 percent slopes. This very deep, moderately steep, well drained soil is on upland side slopes. It formed in loess. Areas range from 5 to 40 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is about 23 inches thick. It is brown, friable silty clay loam in the upper part and pale brown, friable, calcareous silt loam in the lower part. The underlying material to a depth of more than 60 inches is very pale brown, calcareous silt loam. In some places the soil is silty clay loam to a depth of 60 inches or more. In other places the soil is strongly sloping or steep.

Included with this soil in mapping are small areas of Alcester and Betts soils. Alcester soils are lower on the landscape than the Nora soil. They have a thick, dark surface soil. Betts soils are in landscape positions similar to those of the Nora soil. They are calcareous near the surface. They formed in glacial till. In a few small areas, erosion has removed all or most of the original surface layer and the brown subsoil is exposed at the surface. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Nora soil. The available water capacity is high. Runoff is medium. Organic matter content is moderate. Natural fertility is medium.

About half of the acreage of this soil is farmed. The remaining acreage supports cool-season or native grasses and is used for grazing.

If dry-farmed, this soil is poorly suited to alfalfa, oats, corn, and grain sorghum. If the surface is not protected by crops or crop residue, water erosion is a severe hazard. Row crops should not be grown continuously.

Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth.

This soil is not suited to irrigation because of the severe hazard of water erosion.

This soil is well suited to introduced grasses for pasture. Pastures are mainly smooth bromegrass or, in some areas, a mixture of bromegrass and alfalfa or other cool-season grasses. Overgrazing reduces the amount of protective vegetative cover and the quality of desired grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition and control water erosion. Applying nitrogen fertilizer increases the growth and vigor of the grasses.

This soil is suited to native grasses for range. Overgrazing or improper haying methods reduce the quality of the native grasses and thus can increase the hazard of water erosion. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. The lack of seasonal rainfall is a limitation during some years. Irrigation may be necessary.

If this soil is used as a site for septic tank absorption fields, land shaping and installing the field on the contour help to ensure that the field functions properly. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Crowning the road by grading and constructing adequate roadside ditches help to provide good surface drainage and minimize the damage to roads caused by frost action.

The capability classification is IVe-1, dryland. The range site is Silty, and the windbreak suitability group is 3.

Ob—Obert silt loam, wet, 0 to 2 percent slopes. This very deep, nearly level, very poorly drained soil is on bottom land. It formed in calcareous alluvium. It is subject to occasional flooding. Areas range from 5 to 100 acres in size.

Typically, the surface layer is gray, friable, calcareous silt loam about 10 inches thick. The subsurface layer is dark gray, firm, calcareous silty clay loam about 15 inches thick. Below this is a transitional layer of dark gray, firm silty clay loam about 15 inches thick. The underlying material to a depth of more than 60 inches is stratified dark gray and light brownish gray loam. Some small areas are somewhat poorly drained or poorly drained.

Included with this soil in mapping are small areas of Fluvaquents and Kezan and Orwet soils. Fluvaquents are covered by shallow water for a large part of the year. They are in the lowest landscape positions. Kezan and Orwet soils are higher on the landscape than the Obert soil. They are poorly drained. Orwet soils have sand in the lower part of the profile. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Obert soil. The available water capacity is high. Runoff is slow. Organic matter content is moderate. Natural fertility is high. The seasonal high water table ranges from about 0.5 foot above the surface during wet years to about 1.0 foot below the surface during dry years.

Most of the acreage of this soil supports native grasses and is used for grazing or hay. These areas also are used as habitat for wildlife. The soil is too wet to be used as cropland.

This soil is poorly suited to cool-season grasses used for grazing. It is suited to reed canarygrass and creeping foxtail. The pasture grasses and legumes selected for planting are limited by the excessive wetness. Grazing when the water table is at its highest level can damage grasses. It can also leave the surface rough and thus increase the difficulty of mowing for hay. Because of the wetness, seeding grasses can be difficult. An artificial drainage system that includes perforated tile can help to control the wetness caused by the high water table. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Weeds can be controlled if the appropriate herbicides are applied.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and slender wheatgrass. These species make up 70 percent or more of the total

annual forage. Bluegrass, green muhly, and forbs make up the rest. If the soil is subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying methods continue for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.1 animal unit months per acre. Areas of this soil produce a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods can help to maintain or improve the range condition. Grazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of mounds and ruts, which can hinder grazing and the harvesting of hay.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. In wet years, some areas of this soil cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. The livestock should be removed in the spring before the ground thaws.

This soil is generally not suited to trees and shrubs grown as windbreaks or to plantings that enhance recreational areas and wildlife habitat. Survival and growth rates of adapted species are poor. Establishing seedlings can be difficult because the soil is very poorly drained. In some areas trees and shrubs can be grown only if special practices, such as hand planting, proper site preparation, or drainage measures, are applied.

This soil is not suited to septic tank absorption fields, sewage lagoons, or building site development because of the seasonal high water table, ponding, and flooding. A suitable alternative site should be selected. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the level of ponding and providing adequate roadside ditches and culverts help to prevent the road damage caused by ponding and wetness. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is Vw-7, dryland. The range site is Wetland, and the windbreak suitability group is 10.

Od—Onawa silty clay, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land along the Missouri and Niobrara Rivers. It formed in clayey alluvium over loamy alluvium. It is subject to rare flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is gray, very firm silty clay about 6 inches thick. The subsurface layer is stratified dark gray and gray, very firm, calcareous silty clay about 4 inches thick. The underlying material is light brownish gray, mottled, calcareous silty clay about 15 inches thick. Below this to a depth of more than 60 inches is light gray, mottled, calcareous silt loam and very fine sandy loam. In some places the surface layer is silty clay loam or silt loam. In other places the clayey layer is less than 18 inches or more than 30 inches thick. In some areas the water table is below a depth of 4 feet.

Included with this soil in mapping are small areas of Blyburg and Solomon soils. Blyburg soils are in the higher landscape positions and are well drained. They are loamy throughout. Solomon soils are in landscape positions similar to those of the Onawa soil. They are clayey throughout. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the upper part of the Onawa soil and moderate in the lower part. The available water capacity is high. The water intake rate is very low. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The seasonal high water table ranges from about 2 feet below the surface during wet years to 4 feet below the surface during dry years. The shrink-swell potential is high.

Most areas of this soil are dry-farmed. A few areas are irrigated. The remaining areas support cool-season or native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, wheat, oats, and alfalfa. The main limitations are excessive wetness and poor tilth. These limitations can sometimes delay tillage in the spring. In areas where outlets are available, the wetness can be overcome by land leveling and surface drainage ditches. Tilth can be improved by incorporating crop residue into the soil and tilling only during the optimum moisture conditions. Cracks may form during droughty periods. These cracks can contribute to crop stress, injure the roots of plants, and accelerate drying. Cultivation can minimize cracking. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping system help to maintain or improve organic matter content, fertility, and tilth and

increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. Land leveling can improve surface drainage and the efficiency of irrigation systems. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence help to maintain or improve organic matter content, fertility, and tilth and increase the rate of water intake. Crop stress may occur because transpiration and evaporation rates may exceed the very low water intake rate.

This soil is suited to cool-season grasses used for grazing or hay. Grasses can be rotated with other crops. Bromegrass and orchardgrass are suitable species. Grazing when the water table is high can damage the grasses and can leave the surface rough. The rough surface makes mowing for hay difficult. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates for adapted species that can tolerate occasional wetness are good. Cracks can form in the summer because of the high shrink-swell potential. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation, timely cultivation between the tree rows with conventional equipment, applications of appropriate herbicides, or rototilling or hand hoeing.

If this soil is used as a site for sanitary facilities or buildings, the flooding is a hazard. Constructing septic tank absorption fields and sewage lagoons on fill material can raise the absorption field and the bottom of the lagoon high enough above the seasonal high water table. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the structural damage caused by flooding and wetness. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIw-1, dryland and irrigated. The range site is Clayey Overflow, and the windbreak suitability group is 2S.

Oe—O'Neill sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on uplands and stream terraces. It is moderately deep over gravelly coarse sand. Areas range from 5 to 75 acres in size.

Typically, the surface layer is grayish brown, friable sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, friable sandy loam about 3 inches thick. The subsoil is brown, friable sandy loam about 14 inches thick. The underlying material to a depth of more than 60 inches is very pale brown gravelly coarse sand. In some places the surface layer is loamy sand. In a few places the soil is dark to a depth of more than 20 inches. In some areas the lower part of the subsoil is loamy sand. In other areas the lower part of the underlying material is sand or fine sand.

Included with this soil in mapping are small areas of Meadin and Ortello soils. These soils are in landscape positions similar to those of the O'Neill soil. Meadin soils have underlying material of gravelly coarse sand within a depth of 8 to 20 inches. Ortello soils have sandy underlying material that does not contain coarse sand and gravel. Included soils make up 5 to 20 percent of the unit.

Permeability is moderately rapid in the solum of the O'Neill soil and very rapid in the underlying material. The available water capacity is low. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The soil can be easily tilled.

More than half of the acreage of this soil is cropland. The remaining acreage supports native or introduced grasses and is used for grazing or haying. Some of the cropland is irrigated.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, small grain, alfalfa, and introduced grasses. Soil blowing is the main hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. The soil is droughty because of the low available water capacity. Applying barnyard manure and returning crop residue to the soil help to maintain the content of organic matter and fertility.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, alfalfa, and introduced grasses. It is suited to sprinkler and gravity systems. Some land leveling may be needed in areas where gravity systems are used. In areas where deep cuts are made into the underlying material, backfilling with finer textured material may be needed. Frequent, light applications of water are needed. Soil blowing is a severe hazard. A system of conservation tillage that leaves crops or crop residue on the surface most of the time helps to control soil blowing and conserves moisture. Applying barnyard manure improves organic matter content and fertility.

This soil is suited to cool-season introduced grasses used for grazing or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Soil blowing is a hazard. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers can improve the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Insufficient seasonal rainfall is a limitation. Irrigation may be needed. The soil has a low available water capacity. The species selected for planting should be those that are tolerant of drought. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation, timely cultivation, and applications of herbicides.

This soil is generally suited to dwellings and small commercial buildings. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of nearby water supplies. Sealing the bottom of sewage lagoons can help to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-3, dryland, and IIIe-9, irrigated. The range site is Sandy, and the windbreak suitability group is 6G.

OeC—O'Neill sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on uplands and stream terraces. It is moderately deep over gravelly coarse sand. Areas range from 5 to 150 acres in size.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 8 inches thick. The subsurface layer is dark grayish brown, friable sandy loam about 10 inches thick. The subsoil is brown, friable sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is very pale brown gravelly coarse sand. In some places the lower part of the subsoil is loamy sand. In other places the lower part of the underlying material is sand or fine sand.

Included with this soil in mapping are small areas of Meadin, Ortello, and Thurman soils. These soils are in landscape positions similar to those of the O'Neill soil. Meadin soils have underlying material of gravelly coarse sand within a depth of 8 to 20 inches. Ortello soils have sandy underlying material. Thurman soils are sandy throughout. Included soils make up 10 to 20 percent of the unit.

Permeability is moderately rapid in the solum of the O'Neill soil and very rapid in the underlying material. The available water capacity is low. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The soil is easy to work, and good tilth can easily be maintained.

About half of the acreage of this unit supports native grasses and is used for grazing or hay. The remaining acreage is used as cropland or as pastures of introduced grasses.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, soybeans, small grain, and alfalfa. Soil blowing and water erosion are hazards. Leaving crops or crop residue on the surface most of the time helps to control erosion and conserves moisture. Contour farming helps to prevent excessive water erosion. Applying barnyard manure improves fertility. Wind stripcropping helps to control soil blowing.

If irrigated by sprinklers, this soil is suited to corn, grain sorghum, soybeans, alfalfa, and introduced grasses. Frequent, light applications of water are needed. Contour farming and stripcropping help to control water erosion. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control erosion and conserves moisture. Applying barnyard manure helps to maintain fertility and improves organic matter content.

This soil is suited to cool-season introduced grasses

used for grazing or hay. Grasses can be rotated with other crops. Cool-season grasses, such as smooth bromegrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Soil blowing and water erosion are hazards. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazards of soil blowing and water erosion. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. It is droughty because of the low available water capacity. The species selected for planting should be those that are tolerant of drought. Irrigation may be needed. The weeds and grasses that compete with the trees for moisture can be controlled by cultivating with conventional equipment or by rototilling. Soil blowing can be controlled by maintaining strips of sod between the tree rows.

This soil is generally suited to dwellings. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of nearby water supplies. Sealing the bottom of sewage lagoons can help to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IVe-3, dryland, and IVe-9, irrigated. The range site is Sandy, and the windbreak suitability group is 6G.

Og—Ord fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land. It formed in alluvium. It is subject to occasional flooding. Areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown and grayish brown, friable fine sandy loam about 12 inches thick. Below this is a transitional layer of light brownish gray, friable, calcareous fine sandy loam about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is light gray, mottled, calcareous loamy fine sand in the upper part and white, mottled, calcareous loamy fine sand and fine sand in the lower part. In some places the surface layer is loam.

Included with this soil in mapping are small areas of Boel, Inavale, and Orwet soils. Boel soils have sand at a shallower depth than the Ord soil. They are in landscape positions similar to those of the Ord soil. Inavale soils are in the higher landscape positions. They are excessively drained. Orwet soils are lower on the landscape than the Ord soil. They are poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Ord soil and rapid in the underlying material. The available water capacity is moderate. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to 3.5 feet below the surface during dry years. Tilth is good.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas support introduced or native grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, small grain, and legumes. Tillage may be delayed early in the spring during wet years. Soil blowing is a minor hazard. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control soil blowing and can improve or maintain organic matter content and fertility.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity or sprinkler systems. Land leveling is generally needed in areas where gravity systems are used. Tillage may be delayed in the spring during wet years. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control soil blowing and can improve or maintain organic matter content and fertility.

This soil is suited to introduced grasses used for grazing or haying. These grasses generally consist of smooth bromegrass or a mixture of smooth bromegrass and legumes. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep

the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. The weeds and grasses that compete with the trees for moisture are a management concern. Weeds can be controlled by cultivating between the tree rows, hand hoeing within the rows, and carefully applying the appropriate herbicides. The species selected for planting should be those that are tolerant of a moderately high water table.

This soil is not suited to septic tank absorption fields or building site development because of the flooding. A suitable alternative site should be selected. Lining or sealing sewage lagoons helps to prevent seepage. Diking lagoons helps to prevent the damage caused by flooding. Constructing sewage lagoons on fill material is necessary to raise the bottom of the lagoon above the seasonal high water table. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding and wetness. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading helps to prevent the damage caused by wetness.

The capability classification is IIw-6, dryland, and IIw-8, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Oh—Ord loam, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land. It formed in alluvium. It is subject to occasional flooding. Areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, friable, calcareous loam about 6 inches thick. The subsurface layer also is dark grayish brown, friable, calcareous loam. It is about 4 inches thick. Below this is a transitional layer about 14 inches thick. It is light gray, friable, calcareous loam in the upper part and gray, friable, calcareous fine sandy loam in the lower part. The underlying material extends to a depth of more than 60 inches. It is light gray, mottled, calcareous loamy fine sand in the upper part and white, mottled, calcareous fine sand in the lower part.

Included with this soil in mapping are small areas of Boel, Inavale, and Orwet soils. Boel soils are in landscape positions similar to those of the Ord soil. They have sand at a shallower depth than the Ord soil. Inavale soils are higher on the landscape than the Ord soil. They are excessively drained. Orwet soils are in the lower landscape positions. They are poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Ord soil and rapid in the underlying material. The available water capacity is moderate. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The seasonal high water table ranges from about 1.5 feet below the surface during wet years to 3.5 feet below the surface during dry years. Tilth is good.

Most of the acreage of this soil is used for cultivated crops. A few areas are irrigated. Some areas support introduced or native grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, small grain, and legumes. Tillage may be delayed early in the spring during wet years. Using a system of conservation tillage that leaves crop residue on the surface, returning crop residue to the soil, growing green manure crops, and applying feedlot manure help to maintain organic matter content and tilth.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. Land leveling is generally needed in areas where gravity systems are used. Tillage may be delayed in the spring during wet years. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure help to maintain organic matter content and tilth.

This soil is suited to introduced grasses for pasture. Pastures generally consist of smooth bromegrass or a mixture of smooth bromegrass and legumes. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. The weeds and grasses that compete with the trees for moisture are a management concern. They can be controlled by cultivating between the tree rows, hand hoeing, or applying the appropriate herbicides. The species selected for planting should be those that can tolerate a moderately high water table.

This soil is not suited to septic tank absorption fields or building site development because of the flooding. A suitable alternative site should be selected. Lining or sealing sewage lagoons helps to prevent seepage. Diking lagoons helps to prevent the damage caused by flooding. Constructing sewage lagoons on fill material can raise the bottom of the lagoon above the seasonal high water table. The walls or sides of shallow excavations can slough or cave unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate roadside ditches and culverts help to prevent the road damage caused by flooding and wetness. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading helps to prevent the damage caused by wetness.

The capability classification is IIw-4, dryland, and IIw-8, irrigated. The range site is Subirrigated, and the windbreak suitability group is 2S.

Or—Ortello fine sandy loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands and stream terraces. It formed in sandy and loamy sediments. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 9 inches thick. The subsoil is brown and pale brown, friable fine sandy loam about 27 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sandy loam. In some places the surface layer is loam or loamy fine sand.

Included with this soil in mapping are small areas of Bazile, Blendon, Loretto, and Thurman soils. Bazile and Loretto soils have more clay in the subsoil than the Ortello soil. They are in landscape positions similar to those of the Ortello soil. Blendon soils have a dark surface soil more than 20 inches thick. They are slightly lower on the landscape than the Ortello soil. Thurman soils have more sand than the Ortello soil. They are slightly higher on the landscape than the Ortello soil. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderately rapid in the Ortello soil. The available water capacity is moderate. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. The soil can be easily tilled throughout a wide range in moisture content.

Most of the acreage of this soil is cultivated. A few areas support native or introduced grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, sorghum, soybeans, oats, and alfalfa. Soil blowing is the main hazard. The main management need is maintaining fertility and the content of organic matter. Using a system of conservation tillage, such as disking or chiseling, that leaves crop residue on the surface and planting cover crops help to control soil blowing and conserve moisture.

If irrigated, this soil is suited to gravity and sprinkler systems. It is suited to corn, soybeans, and alfalfa. Land leveling is generally needed in areas where gravity irrigation is used, but deep cuts should be avoided. Returning crop residue to the soil and applying feedlot manure help to control soil blowing. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control soil blowing. Adjusting the rate of water application to the moderately high intake rate of the soil is needed to prevent leaching of nutrients.

This soil is suited to introduced grasses for pasture. Cool-season grasses, such as smooth bromegrass and orchardgrass, can be seeded in a mixture with alfalfa. Grasses can be rotated with row crops. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the desired grasses in good condition. Applying nitrogen fertilizer and irrigating improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows and by cultivating only between the tree rows. Weeds and grasses can be controlled by applying the appropriate herbicides or by rototilling.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption systems. Seepage can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The walls or sides of shallow excavations can slough or cave unless they are shored. The soil is suitable as a site for buildings or dwellings. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing

adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIe-3, dryland, and IIe-8, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

OrC—Ortello fine sandy loam, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on uplands. It formed in sandy and loamy sediments. Areas range from 5 to 150 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsoil is grayish brown and pale brown, friable fine sandy loam about 26 inches thick. The underlying material to a depth of more than 60 inches is very pale brown loamy sand. In some places silt loam or sandy clay loam is below a depth of 40 inches. In other places the surface soil is more than 20 inches thick. In some areas the soil is calcareous throughout.

Included with this soil in mapping are small areas of Bazile, Loretto, and Thurman soils. Bazile and Loretto soils are in landscape positions similar to those of the Ortello soil. They have more clay in the subsoil than the Ortello soil. Thurman soils are sandy throughout. They are slightly higher on the landscape than the Ortello soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Ortello soil. The available water capacity is moderate. The water intake rate is moderately high. Runoff is slow. Organic matter content is moderately low. Natural fertility is medium. Tilth is good. The soil can be easily tilled throughout a wide range in moisture content.

More than half of the acreage of this soil is dry-farmed. A small acreage is irrigated. The remaining areas support native or introduced grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and oats. Water erosion and soil blowing are the principal hazards. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Grassed waterways, terraces, and contour farming help to control water erosion and improve and maintain organic matter content, fertility, and tilth.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. It is best suited to sprinkler systems. The major hazards are water erosion and soil blowing. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface helps to control water erosion and conserves moisture. Grassed waterways, terraces, and contour farming help to control water erosion. Including grasses and legumes in the cropping sequence helps to control water erosion and improves or maintains organic matter content, fertility, and tilth. The rate of water application should be adjusted to the moderately high intake rate of the soil. Overwatering can cause deep leaching of fertilizers below the root zone.

This soil is suited to introduced or domesticated grasses for pasture. Using areas of this soil for pasture can help to control water erosion and soil blowing. Grasses can be rotated with other crops. Species are commonly smooth bromegrass or intermediate wheatgrass. Overgrazing or improper haying methods reduce the vigor of plants and can cause the formation of small gullies and rills after periods of heavy rainfall. Rotation grazing and applications of fertilizer are needed for maximum forage production. If the soil is used as hayland, timely mowing helps to maintain high productivity. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. The weeds and grasses that compete with the trees for moisture are a management concern. Irrigation may be necessary during periods of insufficient rainfall. Competing vegetation can be controlled by proper site preparation, by cultivating between tree rows with conventional equipment in a timely manner, by hand hoeing or rototilling, and by applying appropriate herbicides.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. The soil is generally suited to sites for dwellings. Small commercial buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The damage to roads and streets caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is IIIe-3, dryland, and IIIe-8, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

Ou—Orwet loam, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is on bottom land. It formed in loamy and sandy alluvium. It is subject to rare flooding. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark gray, friable, calcareous loam about 10 inches thick. The subsurface layer also is dark gray, friable, calcareous loam. It is about 9 inches thick. Below this is a transitional layer of light brownish gray, mottled, very friable loamy sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light gray, mottled sand. In a few areas the soil is noncalcareous throughout.

Included with this soil in mapping are small areas of Barney, Kezan, Obert, and Ord soils. Barney and Obert soils are lower on the landscape than the Orwet soil. They are very poorly drained. Kezan soils have more clay throughout than the Orwet soil. They are in landscape positions similar to those of the Orwet soil. Ord soils are somewhat poorly drained. They are higher on the landscape than the Orwet soil. Also included are a few small areas of alkaline soils. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Orwet soil. The available water capacity is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. The seasonal high water table ranges from about 1 foot below the surface during wet years to 3 feet below the surface during dry years.

Most of the acreage of this soil supports native grasses and is used as range or hayland. A few areas are dry-farmed or support introduced grasses for hayland or pasture.

If dry-farmed, this soil is poorly suited to cultivated crops because of excessive wetness. It is best suited to corn, grain sorghum, and soybeans. The wetness delays tillage during most years. During wet years some fields cannot be planted. Returning crop residue to the soil and applying manure increase the content of organic matter and maintain fertility. Irrigation is generally not needed because of subirrigation from the high water table.

This soil is suited to introduced or domesticated grasses for pasture or hay. Pasture grasses can be rotated with other crops. Cool-season grasses, such as reed canarygrass and orchardgrass, are suitable species. Grazing when the water table is high can damage the grasses and can leave the surface rough. The rough surface makes mowing for hay difficult. Because of the wetness, seeding of grasses may be delayed until late summer. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers can improve the growth and vigor of the grasses.

If this soil is used as range for grazing or haying, the climax vegetation is dominantly switchgrass, indiangrass, prairie cordgrass, and big bluestem. These species make up 60 percent or more of the total annual forage. Plains bluegrass, western wheatgrass, northern reedgrass, and other perennial grasses, forbs, and sedges make up the rest. If the soil is subject to continuous heavy grazing or improper haying methods, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by slender wheatgrass, western wheatgrass, and various sedges. If overseeded, timothy, redtop, and clover also increase in abundance. If overgrazing or improper haying methods continue for many years, plains bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. Overgrazing and operating heavy machinery when the soil is wet can result in surface compaction and the formation of small mounds and ruts, which can hinder grazing and the harvesting of hay.

If the range is in excellent condition, the suggested initial stocking rate is 1.9 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods help to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed when grazed in conjunction with better drained, sandy soils. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hayland should not be mowed in the period between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between the boot stage and seed maturity. The maximum carbohydrate storage in dominant grasses generally occurs by the first frost. Large meadows can be divided into three sections and the sections mowed in rotation. One section should be mowed 2 weeks before seed stalks appear in the dominant plants, one section should be mowed at the boot stage, and one section should be mowed early in the flowering period. Adjusting the mowing height helps to maintain the stand of grasses and high forage production. The proper mowing height is 3 or more inches. After the ground is frozen, livestock can graze without damaging the meadows. The livestock should be removed in the spring before the ground thaws and before the water table reaches a high level.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good.

The species selected for planting should be those that can tolerate occasional wetness. Establishing seedlings may be difficult during some wet years. Weeds and grasses can be controlled by cultivating between the rows and by applying herbicides in a timely manner.

This soil is not suited to septic tank absorption fields because of the wetness. A suitable alternative site should be selected. Constructing sewage lagoons and dwellings on raised, well compacted fill material helps to prevent the damage caused by wetness and flooding. Sealing the bottom of the lagoon can help to prevent seepage. Constructing roads on suitable, well compacted fill material and providing adequate roadside ditches and culverts help to prevent the road damage caused by wetness and flooding. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading helps to prevent the damage caused by wetness.

The capability classification is IVw-4, dryland. The range site is Wet Subirrigated, and the windbreak suitability group is 2D.

Ph—Paka loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands. It formed in loamy or silty material weathered from siltstone bedrock. Areas range from 5 to 30 acres in size.

Typically, the surface layer is dark gray, friable loam about 9 inches thick. The subsoil is firm silty clay loam about 35 inches thick. It is dark grayish brown in the upper part, grayish brown in the next part, and light brownish gray in the lower part. The underlying material is white, calcareous silt loam about 11 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 55 inches.

Included with this soil in mapping are small areas of Moody and Trent soils. Moody soils are in landscape positions similar to those of the Paka soil. They formed in loess. Trent soils are lower on the landscape than the Paka soil. They have a dark surface soil more than 20 inches thick. Also included are small depressional areas in the uplands. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Paka soil. The available water capacity is high. The water intake rate is moderately low. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. Tilth is good.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some areas are irrigated. A few small areas support introduced or native grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, oats, and alfalfa. Conserving water is a management concern. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface conserves moisture and helps to control soil blowing. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to row crops, such as corn and soybeans, and to close-growing crops, such as alfalfa and oats. It tends to form clods if tilled when wet. If row crops are grown, the soil is suited to gravity and sprinkler systems. Land leveling and a tailwater recovery system can improve the efficiency of gravity systems. The soil is well suited to center-pivot sprinkler systems. The rate of water application should be adjusted so that it does not exceed the water intake rate of the soil. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses for pasture. Pastures commonly consist of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Rotation grazing, applications of nitrogen fertilizer, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing grasses and weeds are controlled by proper site preparation, by timely cultivation or hand hoeing, or by applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

If this soil is used as a site for sanitary facilities or buildings, onsite investigation is needed. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. The poor filtering capacity can result in the pollution of underground water supplies. Lining or sealing sewage lagoons helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low

strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is I-1, dryland, and I-4, irrigated. The range site is Silty, and the windbreak suitability group is 3.

PhC—Paka loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It formed in loamy or silty material weathered from siltstone bedrock. Areas range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 3 inches thick. The subsoil is firm silty clay loam about 22 inches thick. It is light brownish gray in the upper part and light gray and calcareous in the lower part. The underlying material is light gray and white, calcareous silty clay loam about 22 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 54 inches.

Included with this soil in mapping are small areas of Brunswick, Longford, and O'Neill soils. Brunswick soils are lower on the landscape than the Paka soil. Also, they have less clay. They have weakly cemented sandstone bedrock at a depth of 20 to 40 inches. Longford soils are in landscape positions similar to those of the Paka soil. They have more clay in the subsoil than the Paka soil. O'Neill soils are higher on the landscape than the Paka soil. They have gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Paka soil. The available water capacity is high. The water intake rate is moderately low. Runoff is medium. The content of organic matter is moderate. Natural fertility is medium. Tilth is good.

Most of the acreage of this soil is dry-farmed. A few areas are irrigated. A few small areas support introduced or native grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. The main hazard is water erosion. Conserving water also is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Terraces and grassed waterways help to control erosion.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. It is particularly well suited to center-pivot sprinkler systems. The major hazard is erosion. Adjusting the rate of water application to the moderately low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to introduced grasses for pasture. Pastures generally consist of smooth bromegrass or a mixture of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control soil blowing and water erosion. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can result in erosion. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing grasses and weeds are controlled by proper site preparation, by timely cultivation or hand hoeing, or by applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

If this soil is used as a site for sanitary facilities or buildings, onsite investigation is needed. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. The poor filtering capacity can result in the pollution of underground water supplies. If the less sloping areas are selected as sites for sewage lagoons, some leveling and banking may be necessary. Sealing the bottom of the lagoon helps to prevent excessive seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIe-1, dryland, and

IIIe-4, irrigated. The range site is Silty, and the windbreak suitability group is 3.

PhD—Paka loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on side slopes in the uplands. It formed in loamy or silty materials weathered from siltstone bedrock. Areas range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 11 inches thick. The subsoil is firm silty clay loam about 25 inches thick. It is brown in the upper part and light gray and calcareous in the lower part. The underlying material is light gray, calcareous silt loam about 16 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 52 inches.

Included with this soil in mapping are small areas of Longford and O'Neill soils. Longford soils are in landscape positions similar to those of the Paka soil. They have more clay in the subsoil than the Paka soil. O'Neill soils are higher on the landscape than the Paka soil. They have gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Paka soil. The available water capacity is high. The water intake rate is moderately low. Runoff is medium. The content of organic matter is moderate. Natural fertility is medium. Tilth is good.

About half of the acreage of this soil is farmed. Most areas are dry-farmed, but a small acreage is irrigated by sprinklers. A few small areas support introduced or native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. The main hazard is water erosion. Conserving water also is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Terraces and grassed waterways help to control erosion.

If irrigated, this soil is best suited to alfalfa, small grain, and introduced grasses. It is poorly suited to row crops, such as corn and soybeans. The major hazard is water erosion. The soil is suited to center-pivot sprinkler systems. Adjusting the rate of water application to the moderately low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to introduced grasses for pasture. Pastures generally consist of smooth bromegrass or a mixture of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control soil blowing and water erosion. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can result in erosion. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing grasses and weeds are controlled by proper site preparation, by timely cultivation or hand hoeing, or by applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

If this soil is used as a site for sanitary facilities or buildings, onsite investigation is needed. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. The poor filtering capacity can result in the pollution of underground water supplies. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. Installing sewage lagoons in the less sloping areas and sealing the bottom of the lagoon can help to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-1, dryland, and IVe-4, irrigated. The range site is Silty, and the windbreak suitability group is 3.

PhE—Paka loam, 11 to 15 percent slopes. This deep, moderately steep, well drained soil is on side slopes in the uplands. It formed in loamy or silty material weathered from siltstone bedrock. Individual areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 10 inches thick. The subsoil is firm silty clay loam about 19 inches thick. It is brown in the upper part and grayish brown and calcareous in the lower part. The underlying material is light brownish gray, calcareous sandy clay loam about 19 inches thick. White, calcareous, weakly cemented siltstone bedrock is at a depth of about 48 inches. In some cultivated areas water erosion has removed the original surface layer and exposed the brown subsoil.

Included with this soil in mapping are small areas of Brunswick, Longford, and O'Neill soils. Brunswick soils are lower on the landscape than the Paka soil. Also, they have less clay. They are moderately deep over sandstone bedrock. Longford soils are in landscape positions similar to those of the Paka soil. They have more clay in the subsoil than the Paka soil. O'Neill soils are higher on the landscape than the Paka soil. They have gravelly coarse sand at a depth of 20 to 40 inches. Also included are some areas that have weakly cemented siltstone bedrock at a depth of less than 40 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Paka soil. The available water capacity is high. Runoff is medium. The content of organic matter is moderate. Natural fertility is medium.

Less than half of the acreage of this soil is farmed. Most of these areas are dry-farmed. The major acreage supports native grasses and is used for range or hayland. A few areas support pastures of introduced grasses.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, soybeans, oats, and alfalfa. The main hazard is water erosion. Conserving water also is a management concern. If row crops are grown, contour farming can be used. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Terraces and grassed waterways help to control erosion.

This soil is not suited to irrigation because of the severe hazard of water erosion.

This soil is suited to introduced grasses for pasture. Pastures generally consist of smooth bromegrass or a mixture of smooth bromegrass and alfalfa or orchardgrass and alfalfa. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control water erosion. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can result in erosion. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow well if competing grasses and weeds are controlled by proper site preparation, by timely cultivation or hand hoeing, or by applications of appropriate herbicides. Irrigation may be necessary during periods of insufficient rainfall.

If this soil is used as a site for sanitary facilities or buildings, onsite investigation is needed. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It generally can be overcome by increasing the size of the absorption field. Land shaping and installing the septic tank absorption field on the contour help to ensure that the field functions properly. The poor filtering capacity can result in the pollution of underground water supplies. On sites for sewage lagoons, extensive grading is needed to modify the slope and to shape the lagoon. Sealing the lagoon helps to prevent seepage. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IVe-1, dryland. The range site is Silty, and the windbreak suitability group is 3.

Pt—Percival silty clay, 0 to 2 percent slopes. This very deep, nearly level, somewhat poorly drained soil is on bottom land. It formed in alluvium. It is subject to rare flooding. Individual areas range from 5 to 50 acres.

Typically, the surface layer is dark grayish brown, very firm silty clay about 8 inches thick. The underlying material extends to a depth of more than 60 inches. It is stratified grayish brown and light brownish gray silty

clay in the upper part and stratified, light gray fine sand and loamy fine sand in the lower part. The soil is calcareous throughout. In places the surface layer is silty clay loam. In some areas the clayey material is less than 15 or more than 30 inches thick.

Included with this soil in mapping are small areas of Onawa and Solomon soils. Onawa soils are in landscape positions similar to those of the Percival soil. They have more silt and clay in the lower part of the profile than the Percival soil. Solomon soils are clayey throughout. They are poorly drained and are slightly lower on the landscape than the Percival soil. Included soils make up 5 to 20 percent of the unit.

Permeability is slow in the upper part of the Percival soil and rapid in the lower part. The available water capacity is low. The water intake rate is very low. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The shrink-swell potential is high in the upper part and low in the lower part. The seasonal high water table ranges from about 2 feet below the surface during wet years to 4 feet below the surface during dry years. Tilth is poor.

Most areas of this soil are dry-farmed. A small acreage is irrigated. A few areas support introduced or native grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to oats, wheat, grain sorghum, corn, soybeans, and alfalfa. The main management concern is drought. Also, excessive wetness in spring can delay tillage in some years. In areas where outlets are available, the wetness can be overcome by land leveling and surface drainage ditches. Tilth can be improved by incorporating crop residue into the soil and tilling only during optimum moisture conditions. Cracks may form during droughty periods. These cracks can contribute to crop stress, injure the roots of plants, and accelerate drying. Cultivation can minimize the cracking. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, and alfalfa. It is suited to gravity and sprinkler systems. Land leveling can improve surface drainage and the efficiency of irrigation systems. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake. Crop stress may occur because transpiration and evaporation rates may exceed the very low water intake rate.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good, and growth rates are fair. Cracks can form in summer because of the high shrink-swell potential. The weeds and grasses that compete with the trees for moisture can be controlled by proper site preparation, by cultivating with conventional equipment in a timely manner, by applying appropriate herbicides, or by hand hoeing or rototilling.

Constructing septic tank absorption fields and sewage lagoons on fill material can raise the absorption field and the bottom of the lagoon above the seasonal high water table. In areas used for septic tank absorption fields, seepage can cause the pollution of underground water supplies. Sealing the bottom of the lagoon helps to prevent seepage. Constructing dwellings and buildings on raised, well compacted fill material above the flood level helps to prevent the damage caused by wetness. Constructing roads on suitable, well compacted fill material and providing adequate roadside ditches and culverts help to prevent the road damage caused by wetness and flooding. The damage to roads caused by frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading helps to prevent the damage caused by wetness.

The capability classification is IIw-1, dryland and irrigated. The range site is Clayey Overflow, and the windbreak suitability group is 2S.

RdD—Redstoe silt loam, 6 to 11 percent slopes. This moderately deep, strongly sloping, well drained soil is on uplands. It formed in material weathered from soft,

calcareous siltstone bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is grayish brown, friable silt loam about 4 inches thick. The subsoil is friable silt loam about 15 inches thick. It is light brownish gray in the upper part and very pale brown in the lower part. The underlying material is very pale brown silt loam about 6 inches thick. Yellow, calcareous siltstone bedrock is at a depth of about 31 inches. In some places the bedrock is at a depth of less than 20 or more than 40 inches.

Included with this soil in mapping are small areas of Crofton, Gavins, and Labu soils. Crofton and Labu soils are higher on the landscape than the Redstoe soil. Crofton soils are deep. They formed in loess. Crofton and Gavins soils do not have a dark surface layer. Labu soils contain more clay throughout than the Redstoe soil. Gavins soils are lower on the landscape than the Redstoe soil. They are shallow to siltstone bedrock. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Redstoe soil. The available water capacity is low. The water intake rate is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is low.

About half of the acreage of this soil is used for pasture or range. The remaining areas are mainly dry-farmed.

If dry-farmed, this soil is poorly suited to corn, alfalfa, soybeans, and oats. The main hazard is water erosion. A system of conservation tillage, such as no-till planting, chiseling, or disking, that leaves all or part of the crop residue on the surface can help to control erosion. Including grasses and legumes in the cropping sequence helps to control water erosion, improves or maintains organic matter content, fertility, and tilth, and increases the rate of water intake.

If irrigated by sprinklers, this soil is suited to alfalfa and cool-season grasses. Corn, grain sorghum, and soybeans also are irrigated, but water erosion is a severe hazard in areas where these crops are grown. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control erosion. Where slopes are suitable, contour farming, terraces, and grassed waterways help to control runoff and prevent excessive water erosion. Returning crop residue to the soil and applying feedlot manure can improve or maintain organic matter content and tilth.

This soil is suited to introduced and domesticated grasses for pasture. Using areas of this soil for pasture can help to control water erosion. Grasses can be rotated with other crops. Common species include smooth bromegrass. Overgrazing or improper haying methods can reduce the vigor of plants and can result in the formation of small gullies and rills after periods of heavy rainfall. Rotation grazing and applications of fertilizer are needed for maximum forage production. If this soil is used as hayland, timely mowing helps to maintain high productivity. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Drought, the low available water capacity, the weeds and grasses that compete with the trees for moisture, and an excessive amount of carbonates are management concerns. Irrigation may be necessary. Competing vegetation can be controlled by proper site preparation, by cultivating between the tree rows with conventional equipment, by carefully applying the appropriate herbicides, or by hand hoeing.

Constructing septic tank absorption fields on suitable fill material can increase the filtering capacity of the soil. In areas used for septic tank absorption fields, seepage can result in the pollution of underground water supplies. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Sealing the lagoon helps to prevent seepage. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The soft bedrock generally can be easily excavated during construction of dwellings with basements or of buildings that have deep foundations. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength.

The capability classification is IVe-1, dryland, and IVe-7, irrigated. The range site is Limy Upland, and the windbreak suitability group is 6R.

RgF—Redstoe-Gavins complex, 11 to 30 percent slopes. These well drained, moderately steep and steep soils are on upland side slopes. They are moderately deep or shallow over siltstone bedrock. They formed in material weathered from soft,

calcareous siltstone bedrock. The Redstoe soil is on the upper smooth side slopes. The Gavins soil is on the lower slopes or convex knolls. A few deeply entrenched drainageways are in some areas. Areas of these soils range from 5 to 200 acres in size. They are 40 to 55 percent Redstoe soil and 35 to 50 percent Gavins soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Redstoe soil is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is pale brown, friable silt loam about 4 inches thick. The underlying material is yellow silt loam about 14 inches thick. It has many fragments of siltstone and accumulations of calcium carbonate and gypsum. Yellow siltstone bedrock is at a depth of about 25 inches. It contains seams of calcium carbonate and gypsum. The soil is calcareous throughout. In places the surface layer is silty clay loam.

Typically, the surface layer of the Gavins soil is dark grayish brown, friable silt loam about 4 inches thick. Below this is a transitional layer of light brownish gray, friable silt loam about 5 inches thick. The underlying material is white silt loam about 5 inches thick. White siltstone bedrock is at a depth of about 14 inches. It contains seams of calcium carbonate and gypsum. The soil is calcareous and contains few to many fragments of siltstone throughout.

Included with these soils in mapping are small areas of Crofton, Labu, and Sansarc soils. These included soils are higher on the landscape than the Redstoe and Gavins soils. The very deep Crofton soils formed in loess on the upper side slopes. Crofton and Labu soils formed in material weathered from clayey shale bedrock. Also included are small outcrops of siltstone bedrock. Included areas make up 10 to 20 percent of the unit.

Permeability is moderate in the Redstoe and Gavins soils. The available water capacity is low in the Redstoe soil and very low in the Gavins soil. Runoff is rapid on both soils. Organic matter content is moderate. Natural fertility is low.

Most areas of these soils support native grasses and are used for grazing. A few small areas are mowed for hay or used for cultivated crops. Some areas that have been cultivated have been reseeded to grasses. Native trees are on many of the north-facing slopes.

These soils are not suited to cultivated crops or introduced grasses used for pasture. In sloping areas, water erosion can result in the formation of rills and gullies.

If the Redstoe soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, needleandthread, and sideoats grama. These species make up 65 percent or more of the total annual forage. Green needlegrass, blue grama, prairie dropseed, western wheatgrass, and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem and little bluestem decrease in abundance and are replaced by hairy grama, tall dropseed, western wheatgrass, plains muhly, sedges, and forbs.

If the Redstoe soil is used as range, the climax vegetation is dominantly little bluestem, big bluestem, sideoats grama, needleandthread, and prairie dropseed. These species make up 75 percent or more of the total annual forage. Blue grama, green needlegrass, sedges, western wheatgrass, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, and green needlegrass decrease in abundance and are replaced by hairy grama, blue grama, western wheatgrass, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, and numerous annual and perennial weeds dominate the site.

If the Gavins soil is used as range, the climax vegetation is dominantly little bluestem, needlegrass, sideoats grama, and big bluestem. These species make up 75 percent or more of the total annual forage. Prairie dropseed, western wheatgrass, blue grama, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, little bluestem, big bluestem, and sideoats grama decrease in abundance and are replaced by western wheatgrass, prairie dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, and numerous annual and perennial weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing helps to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control water erosion. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

These soils are not suited to trees and shrubs grown as windbreaks. Some areas can be used for plantings that enhance recreational areas or wildlife habitat or for forests if trees and shrubs are hand planted or if other special practices are applied.

These soils generally are not suited to sanitary facilities because of the slope and the shallow depth to bedrock. A suitable alternative site should be selected. Dwellings and commercial buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The

soft bedrock generally can be easily excavated during the construction of dwellings with basements or of buildings that have deep foundations. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade.

The capability classification of the Redstoe soil is VIe-1, dryland. The range site is Limy Upland, and the windbreak suitability group is 10. The capability classification of the Gavins soil is VIs-4, dryland. The range site is Shallow Limy, and the windbreak suitability group is 10.

SaG—Sansarc silty clay, 30 to 60 percent slopes. This shallow, very steep, well drained soil is on narrow, convex ridgetops and the upper side slopes along upland drainageways. It formed in clayey material weathered from dark shale bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very firm, calcareous silty clay about 4 inches thick. The underlying material is olive gray, calcareous clay about 14 inches thick. Gray, calcareous shale bedrock is at a depth of about 18 inches.

Included with this soil in mapping are small areas of Bristow, Labu, Lynch, and Verdel soils. Bristow and Lynch soils are lower on the landscape than the Sansarc soil. Also, they formed in lighter colored shale bedrock. Labu soils are slightly lower on the landscape than the Sansarc soil. They are more than 20 inches deep over dark shale bedrock. Verdel soils are on foot slopes. They have shale bedrock below a depth of 60 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Sansarc soil. The available water capacity is very low. Runoff is very rapid. Organic matter content is moderately low. Natural fertility is low. The shrink-swell potential is high.

Areas of this soil support native grasses and are used for range. A few north-facing slopes and some steep areas along upland drainageways support trees.

If this soil is used as range, the climax vegetation is dominantly little bluestem, western wheatgrass, green needlegrass, sideoats grama, and big bluestem. These species make up 80 percent or more of the total annual forage. Blue grama, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, green needlegrass, and sideoats grama decrease in abundance and are replaced by blue grama, needleandthread, threadleaf sedge, western wheatgrass, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is a hazard.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control water erosion. The slope, dense clumps of trees, and rock outcrops can hinder the movement of livestock from one area to another. Measures that control the growth of woody plants may be needed.

This soil is not suited to trees and shrubs grown as windbreaks because of the slope. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees or shrubs are hand planted or if other special practices are applied.

This soil generally is not suited to sanitary facilities or building site development because of the slope and the shallow depth to bedrock. A suitable alternative site should be selected. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling are needed to provide a suitable grade for roads. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is VIIs-4, dryland. The range site is Shallow Clay, and the windbreak suitability group is 10.

Sc—Scott silt loam, 0 to 1 percent slopes. This very deep, nearly level, poorly drained soil is in depressions on uplands. It formed in loess. Areas range from 5 to 60 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 5 inches thick. The subsurface layer is light gray, friable silt loam about 4 inches thick. The subsoil to a depth of about 55 inches is very firm silty clay. It is dark gray in the upper part and gray in the lower part. The underlying material to a depth of more than 60 inches is light brownish gray silty clay loam. In some places the surface layer is light gray. In other places the underlying material is silt loam.

Included with this soil in mapping are small areas of Butler and Fillmore soils. Butler and Fillmore soils are better drained than the Scott soil. They are not ponded for long periods. Butler soils are higher on the landscape than the Scott soil. Fillmore soils are in landscape positions similar to those of the Scott soil.

Included soils make up 5 to 15 percent of the unit.

Permeability is very slow in the Scott soil. The available water capacity is moderate. Runoff is ponded. The soil is ponded for long periods from March through August. In wet years the soil is covered with water most of the summer. Organic matter content is moderate. Natural fertility is medium. A perched seasonal high water table ranges from about 1 foot above the surface during wet years to 1 foot below the surface during dry years. The shrink-swell potential is high in the subsoil.

Most areas are used as cropland or pasture. Other areas support native grasses used as range or hayland.

If dry-farmed, this soil is poorly suited to the crops commonly grown in the county. In the spring of most years, runoff from adjacent areas ponds in areas of this soil and drowns wheat, oats, and alfalfa. Because spring tillage and planting are delayed, planting corn, grain sorghum, or soybeans is not commonly profitable. Where slopes are suitable, terraces and contour farming help to control runoff from soils in the higher landscape positions.

This soil is not suited to irrigation because it is ponded for long periods.

This soil is generally poorly suited to pasture, range, and native hayland. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is not suited to trees and shrubs grown as windbreaks. The species selected for planting should be those that can tolerate the excessive wetness. Some areas can be used for plantings that enhance recreational areas or wildlife habitat.

This soil is not suitable as a site for septic tank absorption fields or for dwellings because of the ponding and the very slow permeability. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the level of ponding and providing adequate roadside ditches and culverts help to prevent the road damage caused by ponding. The damage to roads caused by frost action can be minimized by providing a good surface drainage system. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is IVw-2, dryland. The range site is Clayey Overflow, and the windbreak suitability group is 10.

Sh—Shell silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on bottom land. It formed in silty alluvium. It is subject to occasional flooding. Areas range from 5 to 500 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 5 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 19 inches thick. The next layer is grayish brown silt loam about 9 inches thick. Below this is a buried layer of dark grayish brown silty clay loam about 17 inches thick. The underlying material to a depth of more than 60 inches is grayish brown silty clay loam. In places calcium carbonate is at a depth of less than 48 inches.

Included with this soil in mapping are small areas of Aowa, Coleridge, Hobbs, and Hord soils. Aowa and Hobbs soils are in the lower landscape positions. They are stratified in the upper part. Coleridge soils are lower on the landscape than the Shell soil. They are somewhat poorly drained. Hord soils are higher on the landscape than the Shell soil. They are not stratified. They have a profile that is more developed than that of the Shell soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Shell soil. The available water capacity is high. The water intake rate is moderate. Runoff is slow. Organic matter content is moderate. Natural fertility is high. The soil is easy to till.

Most of the acreage of this soil is used for crops. Most areas are dry-farmed, but some areas are irrigated. Some areas are used for pasture.

If dry-farmed, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and oats. Flooding is the principal hazard, but the damage to crops caused by flooding is seldom severe. Flooding can be controlled by intercepting runoff from adjacent upland areas. Terraces on adjacent upland areas, diversions, and conservation tillage conserve moisture and help to control runoff. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence can improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. It is suited to gravity and sprinkler systems. Some land leveling may be needed in areas where gravity systems are used to provide uniform distribution of water. Flooding is the principal

hazard, but the damage to crops caused by flooding is seldom severe. Flooding can be controlled by intercepting runoff from adjacent upland areas. Using a system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including grasses and legumes in the cropping sequence improve or maintain organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses for pasture. Grasses can be rotated with other crops. Common species include smooth bromegrass. Sediments deposited by floodwater may partially cover the grasses and reduce their vigor and growth. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Irrigating can increase productivity. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good. The major management concern is the weeds and grasses that compete with the trees for moisture. Plant competition can be controlled by proper site preparation, by cultivating with conventional equipment in a timely manner, or by hand hoeing or rototilling.

This soil is not suited to septic tank absorption fields or building site development because of the flooding. A suitable alternative site should be selected. Diking sewage lagoons helps to prevent the damage caused by flooding. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to prevent the damage caused by low strength. Constructing roads on suitable, well compacted fill material above the flood level and providing roadside ditches and culverts help to prevent the damage to roads caused by flooding.

The capability classification is IIw-3, dryland, and IIw-6, irrigated. The range site is Silty Lowland, and the windbreak suitability group is 1.

SsF2—Simeon sand, 6 to 30 percent slopes, eroded. This very deep, strongly sloping to steep, excessively drained soil is on smooth to convex ridgetops and side slopes along drainageways. It formed in sandy alluvium and outwash material. The steep areas are eroded and have many gullies. Individual areas range from 5 to 1,000 acres in size.

Typically, the surface layer is grayish brown, loose sand about 5 inches thick. Below this is a transitional layer of grayish brown, loose sand about 8 inches thick. The underlying material to a depth of more than 60 inches is sand. It is very pale brown in the upper part and white in the lower part. Some gravel is throughout the profile.

Included with this soil in mapping are small areas of Meadin, O'Neill, and Valentine soils. Meadin and O'Neill soils are in landscape positions similar to those of the Simeon soil. Meadin soils have gravelly coarse sand within a depth of 20 inches. O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches. Valentine soils are higher on the landscape than the Simeon soil. They are fine sand throughout. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Simeon soil. The available water capacity is low. Runoff is very slow. Organic matter content and natural fertility are low.

This soil supports native grasses and is used for grazing. It is not suited to dryland or irrigated crops because of the slope, the droughtiness, and the hazard of soil blowing.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, sand dropseed, sand lovegrass, sedges, and other grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem and little bluestem decrease in abundance and are replaced by prairie sandreed, needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should

be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

Areas of this soil generally are too droughty, too sandy, and too steep for the trees commonly grown as windbreaks. Some sites can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted.

This soil generally is not suited to sanitary facilities because of the slope and a poor filtering capacity, which can result in the pollution of underground water supplies. A suitable alternative site should be selected. Because of the slope, excavating is difficult. The sides of shallow excavations can cave in unless they are shored. In areas where the slope is less than 8 percent, the soil is generally suited to dwellings and local roads. In areas where the slope is more than 8 percent, the dwellings and roads should be designed so that they conform to the natural slope of the land and building sites should be graded to a suitable gradient. Cutting and filling can establish a suitable grade for roads.

The capability classification is VIs-4, dryland. The range site is Sands, and the windbreak suitability group is 10.

StC—Simeon loamy sand, 0 to 6 percent slopes. This very deep, nearly level to gently sloping, excessively drained soil is on uplands and stream terraces. It formed in sandy outwash material and sandy alluvium. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. The subsurface layer is about 8 inches thick. It is dark grayish brown, very friable loamy sand in the upper part and grayish brown, very friable sand in the lower part. Below this is a transitional layer of brown, very friable sand about 10 inches thick. The underlying material to a depth of more than 60 inches is very pale brown and white sand. It contains about 5 percent gravel. In a few places the underlying material is fine sand below a depth of 40 inches. In other places the underlying material has strata of gravelly coarse sand. In some areas in the eastern part of Knox County, a few glacial cobbles are on the surface of the soil and throughout the profile.

Included with this soil in mapping are small areas of Meadin, O'Neill, Thurman, and Valentine soils. Meadin and O'Neill soils are in landscape positions similar to those of the Simeon soil. They have gravelly coarse sand at a depth of 8 to 40 inches. Thurman and Valentine soils are higher on the landscape than the Simeon soil. Also, they contain less medium and coarse sand. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Simeon soil. The available water capacity is low. The water intake rate is very high. Runoff is very slow. Organic matter content and natural fertility are low. The soil can be easily tilled throughout a wide range in moisture content.

More than half of the acreage of this soil supports native grasses and is used for range. Some areas are dry-farmed. A few areas are irrigated. A few areas are seeded to introduced grasses or planted to trees for farmstead and field windbreaks.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, and soybeans. It is better suited to wheat, oats, rye, and alfalfa, which grow in spring when the amount of rainfall is highest. Soil blowing is a hazard, and water erosion is a concern in some drainageways. Stripcropping and planting narrow rows of trees along fields help to control soil blowing. A system of conservation tillage, such as no-till planting, that leaves all or part of the crop residue on the surface helps to control soil blowing and water erosion and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is poorly suited to introduced grasses, corn, soybeans, and alfalfa. It is suited only to sprinkler irrigation. It is too sandy for a gravity irrigation system. Frequent, light applications of water help to prevent leaching of plant nutrients below the root zone. Controlling soil blowing and maintaining productivity are the principal management concerns. Gully erosion can be a problem near drainageways. Maintaining a high amount of crop residue on the surface and minimizing tillage help to control soil blowing. Applying barnyard manure increases the content of organic matter and improves fertility. Planting single rows of trees on the edge of irrigated fields helps to control soil blowing.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

If this soil is used as range or hayland, the climax

vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, sand dropseed, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem and little bluestem decrease in abundance and are replaced by prairie sandreed, needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Soil blowing is a severe hazard affecting young seedlings. The species selected for planting should be those that are tolerant of drought. Trees should be planted in a shallow furrow with as little disturbance of the soil as possible. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. A drip irrigation system helps to provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IVe-5, dryland, and IVe-11, irrigated. The range site is Sands, and the windbreak suitability group is 7.

SuC—Simeon sandy loam, 0 to 6 percent slopes. This very deep, nearly level to gently sloping, excessively drained soil is on uplands and stream terraces. It formed in sandy alluvium and outwash material. Areas range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 9 inches thick. The subsurface layer is grayish brown, very friable loamy sand about 6 inches thick. Below this is a transitional layer of brown, loose sand about 9 inches thick. The underlying material to a depth of more than 60 inches is sand. It is pale brown in the upper part and very pale brown in the lower part. The content of gravel in the lower part of the profile is about 5 percent. In some areas in the eastern part of Knox County, a few glacial cobbles are on the surface of the soil and throughout the profile.

Included with this soil in mapping are small areas of Blendon, Meadin, O'Neill, Thurman, and Valentine soils. Blendon soils are in the lower landscape positions in swales. They have a dark surface soil more than 20 inches thick. Meadin and O'Neill soils are in landscape positions similar to those of the Simeon soil. They have gravelly coarse sand at a depth of 8 to 40 inches. Thurman and Valentine soils are higher on the landscape than the Simeon soil. Also, they contain less medium and coarse sand. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Simeon soil. The available water capacity is low. The water intake rate is very high. Runoff is very slow. Organic matter content and natural fertility are low. The soil can be easily tilled throughout a wide range in moisture content.

About half of the acreage of this soil supports native range. The remaining acreage is cultivated. Some of these areas are irrigated by sprinklers.

If dry-farmed, this soil is suited to alfalfa, wheat, oats, rye, vetch, and tame grasses. It is poorly suited to corn, grain sorghum, and soybeans. Soil blowing is a moderate hazard in areas where the surface is not adequately protected. Stripcropping and planting narrow rows of trees along fields help to control soil blowing. A system of conservation tillage, such as no-till planting, that leaves crop residue on the surface helps to control soil blowing and conserves moisture. Water erosion is a hazard in some steep areas, and gully erosion is a severe hazard near drainageways.

If this soil is irrigated, sprinkler systems are the most suitable methods. Frequent applications of water help to prevent leaching of fertilizers and herbicides. The soil is particularly well suited to center-pivot sprinkler systems. Controlling soil blowing and maintaining productivity are the principal management concerns. Alfalfa, tame grasses, and small grain are the most suitable irrigated crops. If good management practices are used, corn and grain sorghum can also be grown. Maintaining a high amount of crop residue on the surface during the winter and after tillage and planting green manure crops help to control soil blowing and maintain fertility. Planting single rows of trees along the edge of irrigated fields also helps to control soil blowing.

This soil is suited to introduced grasses or legumes

for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Soil blowing is a severe hazard affecting young seedlings. The species selected for planting should be those that are tolerant of drought. Trees should be planted in a shallow furrow with as little disturbance of the soil as possible. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides or by cultivating between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IVe-3, dryland, and IVe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 7.

SvF—Simeon-Thurman complex, 6 to 30 percent slopes. These very deep, strongly sloping to steep soils are on ridgetops and side slopes in the uplands. The Simeon soil is excessively drained, and the Thurman soil is somewhat excessively drained. The Simeon soil is on narrow ridgetops and the lower side slopes. The Thurman soil is on the upper side slopes. The Simeon soil formed in sandy alluvial outwash material. The Thurman soil formed in sandy eolian material. Areas of these soils range from 5 to 500 acres in size. They are 50 to 60 percent Simeon soil and 30 to 40 percent Thurman soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the surface layer of the Simeon soil is dark grayish brown, very friable loamy sand about 7 inches thick. Below this is a transitional layer of grayish brown, loose sand about 6 inches thick. The underlying material to a depth of more than 60 inches is very pale brown sand. A few pebbles are on the surface and throughout the profile. In some places the surface layer is sand or sandy loam. In other places a few glacial cobbles are on the surface of the soil and throughout the profile.

Typically, the surface layer of the Thurman soil is dark grayish brown, very friable fine sandy loam about 10 inches thick. Below this is a transitional layer of brown, very friable fine sandy loam about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown loamy fine sand in the upper part and very pale brown sand in the lower part. In a few places the surface layer is loamy fine sand.

Included with these soils in mapping are small areas of Betts, Brunswick, Meadin, and Paka soils. Betts, Brunswick, and Paka soils are lower on the landscape than the Simeon and Thurman soils. Betts soils are calcareous. They formed in loamy glacial till. Brunswick and Paka soils formed in loamy material weathered from soft sandstone or siltstone bedrock. Meadin soils are in landscape positions similar to those of the Simeon and Thurman soils. They have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 10 to 20 percent of the unit.

Permeability is rapid in the Simeon and Thurman soils. The available water capacity is low. Runoff is very slow or medium. Organic matter content is low in the Simeon soil and moderately low in the Thurman soil.

Most areas of these soils support native grasses and are used for grazing. A few small areas are mowed for hay or used for cultivated crops. Some areas that were once farmed have been reseeded to grass.

These soils are not suited to cultivated crops or introduced grasses used for pasture because most areas are too droughty, erodible, and steep.

If the Simeon soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total annual forage. Blue grama, sand dropseed, sand lovegrass, sedges, and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and prairie sandreed decrease in abundance

and are replaced by needleandthread, sedges, blue grama, Scribner panicum, sand dropseed, and forbs.

If the Simeon soil is used as range, the climax vegetation is dominantly sand bluestem, needleandthread, little bluestem, and prairie sandreed. These species make up 65 percent or more of the total annual forage. Sand dropseed, blue grama, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem and little bluestem decrease in abundance and are replaced by prairie sandreed, blue grama, sand dropseed, needleandthread, sedges, annual grasses, and forbs. If overgrazing continues for many years, hairy grama, blue grama, sedges, common pricklypear, brittle pricklypear, small soapweed, and numerous annual and perennial weeds dominate the site.

If the Thurman soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 75 percent or more of the total annual forage. Switchgrass, blue grama, sand dropseed, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, sand dropseed, blue grama, sedges, annual grasses, and forbs. If overgrazing continues for many years, blue grama, Scribner panicum, sand dropseed, needleandthread, and numerous annual and perennial grasses and weeds dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly locating fences and watering and salting facilities can result in a more uniform distribution of grazing. Proper grazing use helps to control soil blowing and water erosion. Because of the low available water capacity, the soils are droughty. The amount of forage produced depends on the frequency and amount of rainfall. Areas used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

Most areas of these soils are too droughty and steep for the trees and shrubs commonly grown as windbreaks. Excessive water erosion can be controlled by planting trees on the contour and by maintaining strips of sod between the tree rows. Areas of the Thurman soil can be used for plantings that enhance recreational areas or wildlife habitat and for forests if trees and shrubs are hand planted or if other special practices are applied.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. A suitable alternative site should be selected in areas where slopes are more than 15 percent. Sealing the bottom of sewage lagoons helps to prevent seepage. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land, or the site can be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. Cutting and filling are needed to provide a suitable grade for roads.

The capability classification of the Simeon soil is VIs-4. The range site is Sands, and the windbreak suitability group is 10. The capability classification of the Thurman soil is VIe-3. The range site is Sandy, and the windbreak suitability group is 7.

Sw—Solomon silty clay, 0 to 2 percent slopes. This very deep, nearly level, poorly drained soil is on bottom land. It formed in calcareous, clayey alluvium. It is subject to occasional flooding, except in areas of bottom land along the Missouri River where large dams upstream have reduced the hazard of flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very firm, calcareous silty clay about 6 inches thick. The subsurface layer is dark gray, mottled, very firm, calcareous silty clay about 14 inches thick. The subsoil is grayish brown, mottled, very firm, calcareous silty clay about 20 inches thick. The underlying material to a depth of more than 60 inches is grayish brown, mottled, calcareous silty clay. In places the underlying material is silt loam or fine sand within a depth of 60 inches. In some areas the soil is moderately well drained or somewhat poorly drained. In a few places the water table is below a depth of 6 feet.

Included with this soil in mapping are small areas of Blyburg and Inavale soils. These soils are higher on the landscape than the Solomon soil. Blyburg soils are loamy throughout. They are well drained. Inavale soils are sandy throughout. They are excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is very slow in the Solomon soil. The available water capacity is moderate. The water intake rate is very low. Runoff is very slow. Organic matter content is moderate. Natural fertility is medium. The soil is difficult to work, and good tilth is difficult to maintain. The soil is sticky when wet and very hard when dry.

The water table is at the surface during wet years. It recedes to a depth of about 2 feet during dry years. The shrink-swell potential is high.

Most of the acreage of this soil is dry-farmed. Smaller acreages are irrigated, are seeded to introduced grasses, or support native grasses and are used for pasture or hayland.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, wheat, oats, and alfalfa. Spring planting is delayed in some years because of wetness. Maintaining good tilth is a major management concern. Wetness and soil blowing are hazards. The plow layer dries slowly in spring and stays wet during periods of heavy rainfall. If tilled when wet, the soil becomes cloddy and very hard. As it dries, large cracks form. These cracks can injure the roots of plants and can cause an excessive loss of moisture. Fall plowing or disking when moisture conditions are more favorable helps to maintain tilth. Soil blowing can be controlled by leaving unplowed strips in the field. Using a system of conservation tillage that leaves part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure, and including legumes in the cropping system help to maintain or improve organic matter content, fertility, and tilth and increase the rate of water intake. Alfalfa yields are high in areas of this soil because the deep taproot reaches beneficial moisture in the water table.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, and alfalfa. Land leveling may be needed in areas where gravity systems are used. Installing reuse systems at the lower end of fields helps to recycle runoff water. The soil is suited to sprinkler irrigation systems. The rate of water application should be adjusted to the very low intake rate of the soil. A system of conservation tillage that leaves part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, and applying feedlot manure help to maintain or improve organic matter content, fertility, and tilth and increase the rate of water intake.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass or orchardgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing when the soil is wet can result in surface compaction and poor tilth. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers can improve the growth and vigor of the grasses.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival rates of adapted species are good. Establishing seedlings may be difficult during wet years. Cracks can form in summer because of the high shrink-swell potential. The weeds and grasses that compete with the trees for moisture are a management concern. Irrigation may be needed during the first few years after seedlings are planted. Weeds and grasses can be controlled by proper site preparation prior to planting, by timely cultivation between rows, and by applications of appropriate herbicides.

This soil is not suitable for building site development because of the flooding, the wetness, and the high shrink-swell potential. It is not suited to septic tank absorption fields because of the flooding, the wetness, and the very slow permeability. A suitable alternate site should be selected. Diking sewage lagoons helps to prevent the damage caused by flooding. Constructing roads on suitable, compacted fill material and providing adequate roadside ditches and culverts help to prevent the damage caused by flooding and wetness. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability classification is IIIw-1, dryland and irrigated. The range site is Clayey Overflow, and the windbreak suitability group is 2W.

TfB—Thurman fine sand, 0 to 3 percent slopes. This very deep, nearly level or very gently sloping, somewhat excessively drained soil is on flats or low ridges on uplands and stream terraces. It formed in sandy eolian material. It is on flats or low ridges that have plane to concave slopes. Areas range from 5 to 200 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. The subsurface layer also is grayish brown, loose fine sand. It is about 9 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is pale brown and very pale brown sand. In some places the surface soil is 20 to 30 inches thick. In a few areas a loamy layer is below a depth of 40 inches. In other areas the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Bazile, Simeon, and Valentine soils. Bazile soils are slightly lower on the landscape than the Thurman soil.

Also, they contain more silt and clay. Simeon soils are in the lower positions on the landscape. They contain more medium and coarse sand throughout than the Thurman soil. Valentine soils are higher on the landscape than the Thurman soil. They are excessively drained. They have a thinner dark surface soil than the Thurman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil is loose and difficult to till when dry, but it is easy to work when moist.

About 60 percent of the acreage of this soil is used for cultivated crops. Most of the remaining acreage supports native grasses and is used for range. A small acreage is seeded to introduced grasses for pasture.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, oats, and alfalfa. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and cover crops sown in the fall can help to control soil blowing in the winter and spring. Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate and the uneven slopes. It is well suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. If irrigated, the soil is suited to corn, grain sorghum, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields can help to control soil blowing and protect livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Overgrazing can result in a severe hazard of soil blowing and the formation of small blowouts. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IVe-5, dryland, and IVe-12, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

TfC—Thurman fine sand, 3 to 6 percent slopes. This very deep, gently sloping, somewhat excessively drained soil is on low ridges and plane to concave side slopes in the uplands. It formed in sandy eolian material. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 6 inches thick. The subsurface layer is dark grayish brown, loose fine sand about 7 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 5 inches thick. The

underlying material to a depth of more than 60 inches is very pale brown fine sand. In places the surface soil is 20 to 30 inches thick. In some areas a loamy layer is below a depth of 40 inches. In other areas the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Bazile, Loretto, Ortello, Simeon, and Valentine soils. Bazile, Loretto, and Ortello soils contain more silt and clay than the Thurman soil. Also, they are slightly lower on the landscape. Simeon soils are in the lower landscape positions. They contain more medium and coarse sand throughout than the Thurman soil. Valentine soils generally are on the higher convex ridges. They have a thinner dark surface soil than the Thurman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil is loose and difficult to till when dry, but it is easy to work when moist.

About 55 percent of the acreage of this soil is cultivated. Most areas are used for dryland crops, but some areas where adequate water is available from wells or streams are irrigated. Most of the remaining acreage supports native grasses and is used for range. A small acreage is seeded to introduced grasses for pasture.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, rye, oats, and alfalfa. Soil blowing is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate and the uneven slopes. It is well suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizer. If irrigated, the soil is suited to corn, grain sorghum, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and corners of irrigated fields can help to control soil blowing and protect livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can increase the hazard of soil blowing and cause the formation of small blowouts. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Range seeding may be needed to stabilize eroded cropland.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons with impervious material helps to prevent seepage.

The capability classification is IVe-5, dryland, and IVe-12, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

ThB—Thurman loamy fine sand, 0 to 3 percent slopes. This very deep, nearly level or very gently sloping, somewhat excessively drained soil is on uplands and stream terraces. It formed in sandy eolian material. It is on flats or low ridges that have plane to concave slopes. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. Below this is a transitional layer of grayish brown, very friable loamy fine sand about 4 inches thick. The underlying material to a depth of more than 60 inches is fine sand. It is pale brown in the upper part and very pale brown in the lower part. In places the surface layer is fine sand or sand. In some small areas the surface soil is 20 to 30 inches thick. In other areas a loamy layer is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bazile, Ortello, Simeon, and Valentine soils. Bazile and Ortello soils have more silt and clay than the Thurman soil. Also, they are slightly lower on the landscape. Simeon soils contain more medium and coarse sand than the Thurman soil. Also, they are lower on the landscape. Valentine soils are in the higher positions on ridges. They have a thinner dark surface soil than the Thurman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil can be tilled throughout a wide range in moisture content.

About 70 percent of the acreage of this soil is used for cultivated crops. Most areas are dry-farmed, but some areas are irrigated by sprinklers if sufficient water is available from wells or streams. Most of the remaining acreage supports native grasses and is used for range. A small acreage is seeded to introduced grasses for pasture.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. Soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring (fig. 8). Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate. It is well suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. If irrigated, this soil is best suited to corn, grain sorghum, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields helps to control soil blowing and protects livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can increase the hazard of soil blowing and can cause the formation of small blowouts. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between

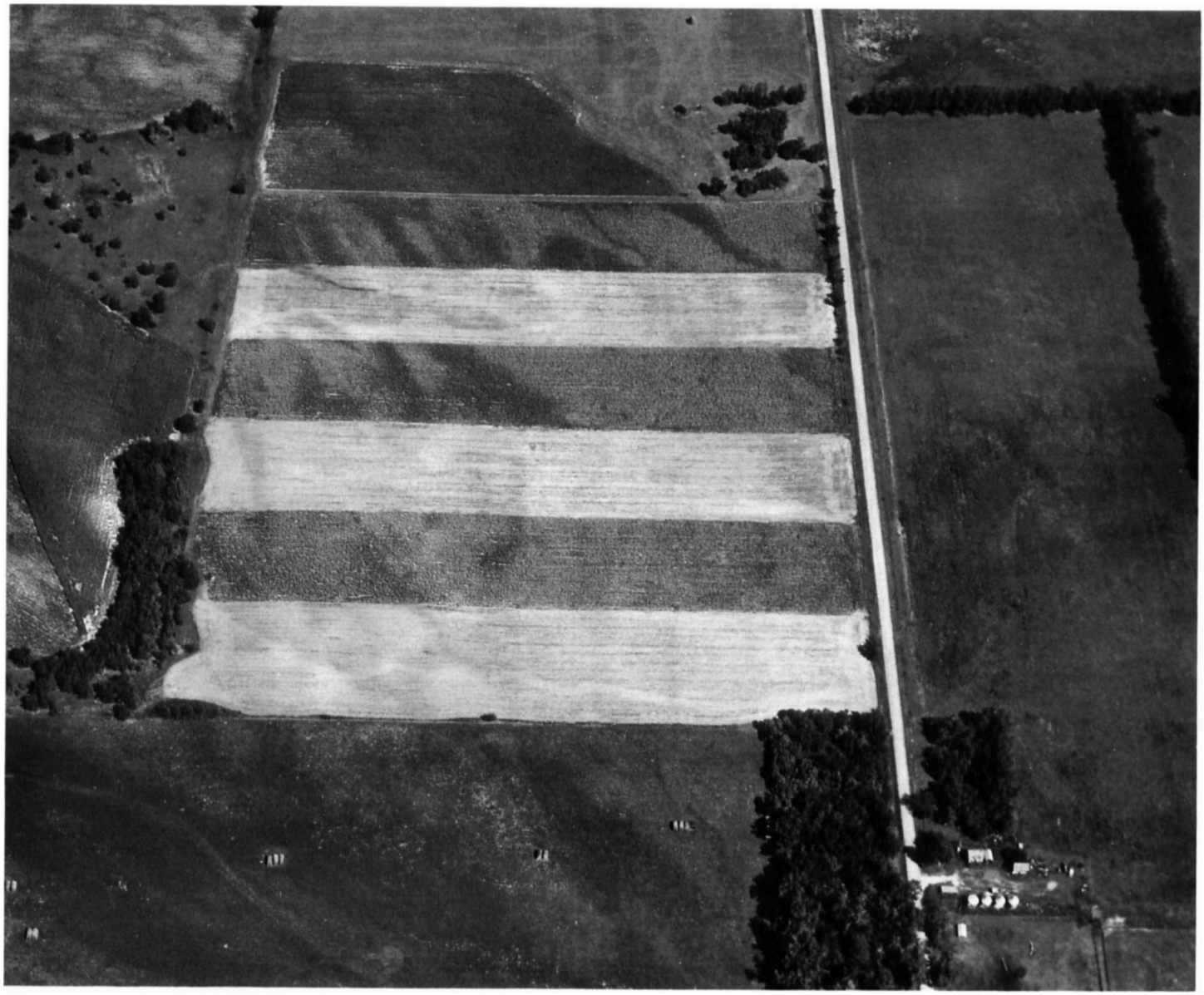

Figure 8.—Stripcropping of corn and rye/vetch in an area of Thurman loamy fine sand, 0 to 3 percent slopes.

the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IIIe-5, dryland, and IIIe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

ThC—Thurman loamy fine sand, 3 to 6 percent slopes. This very deep, gently sloping, somewhat excessively drained soil is on low, convex ridges and plane to concave side slopes in the uplands. It formed in sandy eolian material. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 8 inches thick. Below this is a transitional layer of grayish brown, loose fine sand about 4 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown fine sand in the upper part and very pale brown sand in the lower part. In some places the surface layer is fine sand or sand. In other places the surface soil is 20 to 30 inches thick. In some areas a loamy layer is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bazile, Loretto, Ortello, Simeon, and Valentine soils. Bazile, Loretto, and Ortello soils contain more silt and clay in the profile than the Thurman soil. Also, they are slightly lower on the landscape. Simeon soils are in the lower landscape positions. They contain more medium and coarse sand throughout than the Thurman soil. Valentine soils generally are on the higher convex ridges. They have a thinner dark surface soil than the Thurman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil can be tilled throughout a wide range in moisture content.

More than half of the acreage of this soil is cultivated. Most areas are used for dryland crops, but some areas where adequate water is available from wells or streams are irrigated by sprinklers. Most of the remaining acreage supports native grasses and is used for range. A small acreage is seeded to introduced grasses for pasture.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, rye, oats, and alfalfa. Soil blowing is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate and the uneven slopes. It is well suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. If irrigated, this soil is suited to corn, grain sorghum, oats, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields helps to control soil blowing and protects livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can increase the hazard of soil blowing and can cause the formation of small blowouts. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Range seeding may be needed to stabilize eroded cropland.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter

the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IVe-5, dryland, and IVe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

ToB—Thurman fine sandy loam, 0 to 3 percent slopes. This very deep, nearly level or very gently sloping, somewhat excessively drained soil is on uplands and stream terraces. It formed in sandy eolian material. It is on flats or low ridges that have plane to concave slopes. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown, very friable fine sandy loam about 7 inches thick. Below this is a transitional layer of brown, very friable loamy fine sand about 8 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown loamy fine sand in the upper part and very pale brown fine sand in the lower part. In some places the surface layer is loamy fine sand or fine sand. In other places the surface soil is 20 to 30 inches thick. In a few areas a loamy layer is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bazile, Loretto, Ortello, Simeon, and Valentine soils. Bazile, Loretto, and Ortello soils contain more silt and clay than the Thurman soil. Also, they are slightly lower on the landscape. Simeon soils contain more medium and coarse sand throughout than the Thurman soil. Also, they are lower on the landscape. Valentine soils are in the higher landscape positions on ridges. They have a thinner dark surface soil than the Thurman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil is easy to till.

Most of the acreage of this soil is dry-farmed. Some areas where adequate water is available from wells or streams are irrigated. A few areas support native grasses or are seeded to introduced grasses for pasture or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, soybeans, oats, and alfalfa. Soil blowing is a moderate hazard in areas where the surface is not adequately protected by crops or crop residue. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate and the uneven slopes. It is well suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. If irrigated, this soil is best suited to corn, grain sorghum, soybeans, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields helps to control soil blowing and protects livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of the native plant community and thus can increase the hazard of soil blowing. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. Sealing sewage lagoons helps to prevent seepage.

The capability classification is IIIe-3, dryland, and IIIe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 5.

ToD—Thurman fine sandy loam, 3 to 11 percent slopes. This very deep, gently sloping to strongly sloping, somewhat excessively drained soil is on ridges and side slopes in the uplands. It formed in sandy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer also is grayish brown, very friable fine sandy loam. It is about 7 inches thick. Below this is a transitional layer of brown, very friable fine sandy loam about 4 inches thick. The underlying material to a depth of more than 60 inches is light yellowish brown loamy sand. In a few areas the surface soil is 20 to 30 inches thick. In some places the surface layer is loamy fine sand or fine sand. In other places the surface soil is less than 5 inches thick. In a few areas a loamy layer is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Crofton, Ortello, Simeon, and Valentine soils. Crofton soils formed in silty, calcareous loess. They are generally in the slightly higher landscape positions. Ortello soils contain more silt and clay than the Thurman soil. Also, they are slightly lower on the landscape. Simeon soils contain more medium and coarse sand than the Thurman soil. Also, they are lower on the landscape. Valentine soils have a thinner dark surface soil than the Thurman soil. They are in the higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content is moderately low. Natural fertility is low. The soil is easy to till.

About 60 percent of the acreage of this soil is used as cropland. Most areas are dry-farmed, but some areas are irrigated. Most of the remaining acreage supports native grasses and is used as range. A small acreage is seeded to introduced grasses for pasture.

If dry-farmed, this soil is poorly suited to alfalfa, corn, grain sorghum, oats, and soybeans. Soil blowing is a moderate or severe hazard in areas where the surface is not adequately protected by crops or crop residue. Water erosion is a hazard on some long slopes, especially near waterways. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees in field windbreaks helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure help to maintain or improve organic matter content and fertility. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited only to sprinkler systems because of the very high water intake rate and the slope. It is suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. If irrigated, the soil is poorly suited to corn, grain sorghum, alfalfa, and introduced grasses. Soil blowing is a hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields helps to control soil blowing and protects livestock from the wind. If alfalfa is grown, applications of lime are needed.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates

help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants and thus can increase the hazard of soil blowing and can cause the formation of small blowouts. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides, by cultivating in a timely manner, and by mowing between the tree rows.

This soil is generally suited to building site development and roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. The sides of shallow excavations can slough or cave unless they are shored. Buildings and dwellings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. Cutting and filling may be needed to provide a suitable grade for roads.

The capability classification is IVe-3, dryland, and IVe-11, irrigated. The range site is Sandy, and the windbreak suitability group is 7.

ToF—Thurman fine sandy loam, 11 to 30 percent slopes. This very deep, moderately steep or steep, somewhat excessively drained soil is on upland side slopes. It formed in sandy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 10 inches thick. Below this is a transitional layer of grayish brown, very friable loamy sand about 8 inches thick. The underlying material to a depth of more than 60 inches is pale brown sand. In places the surface soil is 20 to 30 inches thick. In some areas on the upper slopes, the dark surface layer is less than 5 inches thick. In a few places the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Betts, Brunswick, Crofton, and Simeon soils. Betts and Brunswick soils are lower on the landscape than the Thurman soil. Betts soils formed in loamy glacial till. Brunswick soils formed in material weathered from sandstone bedrock. Crofton soils are in landscape positions similar to those of the Thurman soil. They formed in silty, calcareous loess. Simeon soils contain more coarse sand than the Thurman soil. They are in the lower landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Thurman soil. The available water capacity is low. Runoff is medium. Organic matter content is moderately low. Natural fertility is low.

This soil supports native grasses and is used as range. Areas of this soil are too steep and erodible to be used as cropland.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and prairie sandreed decrease in abundance and are replaced by needleandthread, blue grama, Scribner panicum, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to trees and shrubs grown as windbreaks and to plantings that enhance recreational

areas or wildlife habitat. The species selected for planting should be those that are tolerant of moderately droughty conditions and that will grow in sandy soil. The survival rate of seedlings can be increased if competing vegetation is controlled by proper site preparation, by cultivation, or by applications of appropriate herbicides. Soil blowing can be controlled by maintaining strips of sod or an annual cover crop between the tree rows. A drip system or another method of irrigation may be needed during periods of insufficient rainfall.

Because of the slope, this soil is limited as a site for buildings and sanitary facilities. The steeper areas are not suitable as sites for sanitary facilities. An alternative site should be selected. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage. The sides of shallow excavations can slough or cave unless they are shored. Cutting and filling can provide a suitable grade for roads and streets.

The capability classification is VIe-3, dryland. The range site is Sandy, and the windbreak suitability group is 7.

Tr—Trent silt loam, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on uplands. It formed in silty sediments. Areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer also is dark grayish brown, friable silt loam. It is about 12 inches thick. The subsoil is firm silty clay loam about 34 inches thick. The upper part is dark grayish brown, and the lower part is brown. The underlying material to a depth of more than 60 inches is pale brown, calcareous silty clay loam. In some areas the underlying material is loamy sand. In other areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bazile, Butler, Fillmore, and Moody soils. Bazile and Moody soils have a dark surface soil less than 20 inches thick. They are higher on the landscape than the Trent soil. Butler soils are in landscape positions similar to those of the Trent soil. Butler and Fillmore soils have more clay in the subsoil than the Trent soil. They are somewhat poorly drained. Fillmore soils are lower on the landscape than the Trent soil. They are ponded for short periods. Also included are small areas of alkaline soils. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Trent soil. The available water capacity is high. The water intake rate is moderately low. Runoff is slow. Organic matter content and natural fertility are high. Tilth is good.

Most areas of this soil are dry-farmed. Some areas are irrigated. The remaining areas support native or introduced grasses and are used for grazing or haying.

If dry-farmed, this soil is suited to corn, soybeans, sorghum, small grain, and legumes. Row crops can be grown year after year if proper amounts of fertilizer are applied and if weeds, diseases, and insects are controlled. A system of conservation tillage, such as disking, chiseling, and no-till planting, helps to maintain tilth. Leaving crop residue on the surface conserves moisture.

If irrigated, this soil is suited to corn, soybeans, and alfalfa. It is suited to sprinkler and gravity systems. Land leveling may be needed in areas where gravity systems are used. A system of conservation tillage, such as disking or no-till planting, that leaves crop residue on the surface conserves moisture and helps to maintain the content of organic matter. Maintaining fertility is a management concern.

This soil is suited to pastures of introduced grasses. Cool-season grasses, such as smooth bromegrass, orchardgrass, and tall fescue, can be seeded in a mixture with alfalfa. The soil is also suited to warm-season grasses. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Pasture grasses can be used as part of the cropping system. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition. Applications of nitrogen fertilizer can be beneficial in pastures that are irrigated.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are good. The weeds and grasses that compete with the trees for moisture can be controlled by cultivation between the rows with conventional equipment and by careful use of appropriate herbicides in the row. Areas near the trees can be hoed by hand.

The moderate permeability is a limitation on sites for septic tank absorption fields. This limitation generally can be overcome by increasing the size of the absorption field. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage.

Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. The damage to roads caused by frost action can be minimized by providing a surface drainage system. Crowning the road by grading and establishing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is I-1, dryland, and I-4, irrigated. The range site is Silty, and the windbreak suitability group is 3.

Tx—Trent silt loam, moderately wet, 0 to 2 percent slopes. This very deep, nearly level, moderately well drained soil is on flats near the head of upland drainageways or in swales on uplands. It formed in silty sediments. Areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 10 inches thick. The subsoil is firm silty clay loam about 31 inches thick. The upper part is grayish brown, the next part is light brownish gray, and the lower part is mottled and light brownish gray and is calcareous. The underlying material to a depth of more than 60 inches is light gray, mottled, calcareous silty clay loam. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Butler and Fillmore soils. These soils have more clay in the subsoil than the Trent soil. Butler soils are somewhat poorly drained. They are in landscape positions similar to those of the Trent soil. Fillmore soils are poorly drained. They are slightly lower on the landscape than the Trent soil. Also included are small areas of alkaline soils. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Trent soil. The available water capacity is high. The water intake rate is moderately low. Runoff is slow. Organic matter content and natural fertility are high. A perched seasonal high water table ranges from about 3.5 feet below the surface during wet years to 6.0 feet below the surface during dry years. In places runoff from adjacent higher areas may occur. Tilth is good.

Most areas of this soil are farmed. Some areas are irrigated. The remaining areas support native or introduced grasses and are used for grazing or hay.

If dry-farmed, this soil is suited to corn, soybeans, sorghum, small grain, and legumes. Row crops can be grown year after year if proper amounts of fertilizer are applied and if weeds, disease, and insects are controlled. Tillage is delayed in the spring of wet years and during extended wet periods because of the wetness caused by the perched high water table. During extended dry periods, however, crops can benefit from the additional moisture. A system of conservation tillage, such as disking, chiseling, and no-till planting, helps to maintain tilth. Leaving crop residue on the surface conserves moisture.

If irrigated, this soil is suited to sprinkler and gravity systems. Adjusting the rate of water application to the intake rate of the soil can minimize wetness and help to control runoff. Corn, soybeans, and alfalfa can be grown. Land leveling may be needed in areas where gravity systems are used. A system of conservation tillage, such as disking or no-till planting, that leaves crop residue on the surface conserves moisture and helps to maintain the content of organic matter. Maintaining fertility is a management concern.

This soil is suited to pastures of introduced grasses. Cool-season grasses, such as smooth bromegrass, orchardgrass, and tall fescue, can be seeded in a mixture with alfalfa. The soil also is suited to warm-season grasses. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Overgrazing reduces the amount of protective plant cover and the quality of the desired grasses. Proper stocking rates and rotation grazing help to keep the grasses in good condition.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are good. Undesirable weeds and grasses can be controlled by cultivation between the rows with conventional equipment and by careful use of appropriate herbicides in the row. Areas near the trees can be hoed by hand.

If this soil is used as a site for sanitary facilities or buildings, the perched water table and rare periods of flooding are management concerns. Septic tank absorption fields should be constructed on fill material so that the drain tiles are above the seasonal high water table. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by flooding and helps to overcome the wetness caused by the water table. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. The damage to roads caused by

frost action can be minimized by providing a good surface drainage system and a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate roadside ditches help to prevent the damage caused by wetness.

The capability classification is I-1, dryland, and I-4, irrigated. The range site is Silty Lowland, and the windbreak suitability group is 1.

UbF—Urban land, 3 to 30 percent slopes. This map unit consists of gently sloping to steep areas on uplands. These areas have been shaped and graded.

Urban land consists of areas ranging from gravelly loamy sand to silty clay that were intermixed during grading operations. Areas of Urban land are covered by building sites and streets. They are in the town of Niobrara.

Included in mapping are small areas of Simeon and Labu soils. These soils make up 5 to 15 percent of the unit.

No capability classification, range site, or windbreak suitability group is assigned.

VaD—Valentine fine sand, 3 to 9 percent slopes. This very deep, gently sloping to strongly sloping, excessively drained soil is on uplands. It formed in sandy eolian material. Areas range from 5 to 800 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 6 inches thick. Below this is a transitional layer of light brownish gray, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is very pale brown fine sand. In some places the surface layer is dark sand that is more than 6 inches thick.

Included with this soil in mapping are small areas of Simeon and Thurman soils. Simeon and Thurman soils are lower on the landscape than the Valentine soil. Simeon soils contain more medium and coarse sand than the Valentine soil, and Thurman soils have a thicker dark surface soil. Also included are a few small areas of blowouts and some areas where slopes are more than 9 percent. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. The available water capacity is low. The water intake rate is very high. Runoff is slow. Organic matter content and natural fertility are low.

Most of the acreage of this soil supports native grasses and is used as range or hayland. A small acreage is used for dryland crops. Some areas where adequate water is available from wells or streams are irrigated. A small acreage is seeded to introduced grasses for grazing or haying.

This soil is not suited to dryland farming because of drought and soil blowing. In areas that have been cultivated, range can be reestablished by planting warm-season native grasses.

If irrigated, this soil is poorly suited to corn, grain sorghum, rye, oats, and alfalfa.

This soil is suited only to sprinkler irrigation systems because of the very high water intake rate and the uneven slopes. It is suited to center-pivot systems. Enough water should be applied to meet the needs of the crop, but overwatering can cause deep leaching of fertilizers. Soil blowing is a severe hazard. A system of conservation tillage, such as no-till planting or disking, that leaves all or part of the crop residue on the surface helps to control soil blowing and conserves moisture. Returning crop residue to the soil, growing green manure crops, and applying barnyard manure improve organic matter content and fertility. Stripcropping and cover crops sown in the fall help to control soil blowing in the winter and spring. Planting single rows of trees on the edges and in corners of irrigated fields helps to control soil blowing and protects livestock from the wind. If alfalfa is grown, applications of lime are needed.

If irrigated, this soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are occasionally rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with legumes, such as alfalfa and milkvetch. Overgrazing reduces the amount of protective plant cover and the quality of the stands and thus can increase the hazard of soil blowing. The grazing season can be extended by managing cool-season grasses along with pastures of warm-season grasses. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage. Blue grama, needleandthread, sand lovegrass, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and other grasses and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to trees and shrubs grown as windbreaks. Soil blowing is a severe hazard affecting young seedlings. The species selected for planting should be those that are tolerant of drought. Trees should be planted in a shallow furrow with as little disturbance of the soil as possible. Drought and the weeds and grasses that compete with the trees for moisture affect the rate of seedling survival. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted. Weeds and grasses can be controlled by applying herbicides and by mowing between the tree rows.

This soil is suited to use as a site for dwellings or local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of underground water supplies. The sides of shallow excavations can cave in unless they are shored. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage.

The capability classification is VIe-5, dryland, and IVe-12, irrigated. The range site is Sands, and the windbreak suitability group is 7.

VaE—Valentine fine sand, 9 to 24 percent slopes. This very deep, strongly sloping to steep, excessively drained soil is on uplands. It formed in sandy eolian material. It is on rolling sandhills and a few steep side slopes along drainageways. Areas range from 5 to 400 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. Below this is a transitional layer of brown, loose fine sand about 3 inches thick. The underlying material to a depth of more than 60 inches is pale brown fine sand. In some places the surface soil is thicker and darker.

Included with this soil in mapping are small areas of Simeon and Thurman soils. These soils are lower on the landscape than the Valentine soil. Simeon soils have more medium and coarse sand than the Valentine soil, and Thurman soils have a thicker, darker surface soil. Also included are a few small areas of blowouts and some areas where slopes are more than 24 percent. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Valentine soil. The available water capacity is low. Runoff is slow. Organic matter content and natural fertility are low.

This soil supports native grasses and is used for grazing or hay. It is not suited to dryland or irrigated cultivated crops because of the slope, the droughtiness, and the hazard of soil blowing.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and switchgrass. These species make up 75 percent or more of the total annual forage. Blue grama, needleandthread, sand lovegrass, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and other grasses and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to trees and shrubs grown as windbreaks. It is better suited to drought-tolerant conifers than to other trees. Because the soil is loose, trees should be planted in a shallow furrow with as little disturbance of the soil as possible. Young seedlings can be damaged by windblown sand or can be covered by drifting sand. Drip irrigation systems can provide the moisture needed during the first few years after the trees are planted.

This soil is suited to septic tank absorption fields,

dwellings, and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. Seepage can result in the pollution of underground water supplies. In areas where the slope is 15 percent or less, tiles should be installed on the contour. In areas where the slope is more than 15 percent, absorption fields are not suitable because of lateral seepage. Dwellings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. Because of a severe hazard of soil blowing, mulching is needed in areas used for roads. Cutting and filling can provide a suitable grade for roads. The sides of shallow excavations can cave in unless they are shored. On sites for sewage lagoons, lining or sealing the lagoon helps to prevent seepage.

The capability classification is VIe-5, dryland. The range site is Sands, and the windbreak suitability group is 7.

Ve—Verdel silty clay, 0 to 2 percent slopes. This very deep, nearly level, well drained soil is on stream terraces. It formed in clayey alluvium. Areas range from 5 to 150 acres in size.

Typically, the surface layer is dark gray, very firm silty clay about 6 inches thick. The subsurface layer also is dark gray, very firm silty clay. It is about 10 inches thick. The subsoil is very firm, calcareous silty clay about 30 inches thick. It is dark gray in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The underlying material to a depth of more than 60 inches is grayish brown, calcareous silty clay. In a few places the surface layer is silty clay loam. In some areas carbonates are below a depth of 35 inches.

Included with this soil in mapping are small areas of Solomon and Trent soils. Solomon soils are poorly drained. They are lower on the landscape than the Verdel soil. Trent soils contain less clay than the Verdel soil. Also, they are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Verdel soil. The available water capacity is moderate. The water intake rate is very low. Runoff is slow. Organic matter content is moderate. Natural fertility is medium. Because of the fine texture of the soil, water is released slowly to plants and the soil is somewhat droughty. Working or trampling the soil during wet periods can result in surface compaction. The soil is difficult to work, and good tilth is difficult to maintain. Cracks can form during dry periods. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated. Some cultivated areas are irrigated. A few small, narrow areas near drainageways support introduced or native grasses and are used for grazing.

If dry-farmed, this soil is suited to oats, wheat, corn, grain sorghum, soybeans, and alfalfa. It is best suited to small grain and alfalfa, which grow and mature in spring and early summer when the amount of rainfall is highest. It is better suited to grain sorghum than to corn. Conserving moisture and maintaining good tilth and a high level of fertility are the main management needs. Returning crop residue to the soil improves the content of organic matter and conserves moisture. Leaving crops or crop residue on the surface helps to control soil blowing.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, alfalfa, small grain, and introduced grasses. The rate of water application should be adjusted to the very low intake rate of the soil. The soil is suited to gravity and sprinkler systems. Land leveling may be needed in areas where gravity systems are used. Diversion terraces may be needed to intercept runoff from the steeper adjacent areas. Planting deep-rooted crops and returning crop residue to the soil increase the water intake rate and maintain the content of organic matter. Adding barnyard manure increases the content of organic matter and improves fertility.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Proper site preparation and timely cultivation can increase the seedling survival rate. Because the soil has a high content of clay, it is somewhat droughty. The soil should be worked when it is moist but not wet. The weeds and undesirable grasses that compete with the trees for moisture are the main concerns. Competing vegetation can be controlled by cultivation or with appropriate herbicides. The species selected for planting should be those that are

tolerant of drought. Irrigation can provide additional water during periods of low rainfall.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. The soil should be worked when it is moist but not wet. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is IIs-2, dryland, and IIs-1, irrigated. The range site is Clayey, and the windbreak suitability group is 4C.

VeC—Verdel silty clay, 2 to 6 percent slopes. This very deep, gently sloping, well drained soil is on foot slopes and stream terraces. It formed in clayey alluvium. Areas range from 5 to 200 acres in size.

The surface layer is dark grayish brown, firm silty clay about 6 inches thick. The subsurface layer also is dark grayish brown, firm silty clay. It is about 12 inches thick. The subsoil is grayish brown, very firm silty clay about 27 inches thick. It is calcareous in the lower part. The underlying material to a depth of more than 60 inches is light brownish gray, calcareous silty clay. In some places the surface layer is silty clay loam. In other places the dark surface soil is less than 20 inches thick.

Included with this soil in mapping are small areas of Labu, Lynch, and Trent soils. Labu and Lynch soils are in the higher landscape positions in gently sloping, convex areas. They have shale bedrock at a depth of 20 to 40 inches. Trent soils are higher on the landscape than the Verdel soil. Also, they contain less clay. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Verdel soil. The available water capacity is moderate. The water intake rate is very low. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. Ponding occurs if the soil is worked or trampled when wet. Because of the fine texture of the soil, water is released slowly to plants. Cracks 1 to 3 inches wide can form during dry periods. The shrink-swell potential is high.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated. A small acreage supports introduced or native grasses and is used for grazing or hay.

If dry-farmed, this soil is suited to wheat, oats, grain sorghum, corn, and alfalfa. Small grain and the first cutting of alfalfa are generally the most suitable crops because they grow and mature in spring when the amount of rainfall is highest. The soil is better suited to grain sorghum than to corn. Conserving moisture and maintaining good tilth and a high level of fertility are the main management needs in cultivated areas. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface increases the rate of water intake and reduces the evaporation rate. Soil blowing and water erosion are slight or moderate hazards. Terraces, contour farming, and grassed waterways conserve moisture and help to control water erosion.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, alfalfa, wheat, and introduced grasses. If gravity systems are used in gently sloping areas, erosion is excessive. Water should be applied slowly if sprinkler systems are used because of the very low water intake rate. Planting deep-rooted crops and returning crop residue to the soil increase the water intake rate and maintain the content of organic matter.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Droughtiness and the high content of clay affect newly planted seedlings. The weeds and grasses that compete with the trees for moisture are management concerns. Proper site preparation and timely cultivation can increase the seedling survival rate. The species selected for planting should be those that are tolerant of drought. Irrigation can provide additional water during periods of low rainfall.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Strengthening the foundation of buildings and

backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is IIIe-4, dryland, and IIIe-1, irrigated. The range site is Clayey, and the windbreak suitability group is 4C.

VeD—Verdel silty clay, 6 to 11 percent slopes. This very deep, strongly sloping, well drained soil is on foot slopes along drainageways. It formed in clayey alluvium. Areas range from 5 to 50 acres in size.

Typically, the surface layer is dark grayish brown, very firm silty clay about 6 inches thick. The subsurface layer also is dark grayish brown, very firm silty clay. It is about 4 inches thick. The subsoil is dark grayish brown, very firm silty clay about 26 inches thick. It is calcareous in the lower part. The underlying material to a depth of more than 60 inches is grayish brown, calcareous silty clay. In some small areas the surface layer is lighter colored. In places the dark surface soil is less than 20 inches thick.

Included with this soil in mapping are small areas of Labu and Lynch soils. These soils have a thinner dark surface layer than the Verdel soil and have shale bedrock at a depth of 20 to 40 inches. They are in the higher landscape positions. They make up 5 to 15 percent of the unit.

Permeability is slow in the Verdel soil. The available water capacity is moderate. The water intake rate is very low. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. Ponding occurs if the soil is worked or trampled when wet. Because of the fine texture of the soil, water is released slowly to plants. Cracks 1 to 3 inches wide can form during dry periods. The shrink-swell potential is high.

More than half of the acreage of this soil is dry-farmed. Small areas are irrigated. The remaining acreage supports mainly native or introduced grasses and is used for grazing or hayland.

If dry-farmed, this soil is poorly suited to wheat, oats, grain sorghum, corn, and alfalfa. It is best suited to alfalfa. It is generally suited to small grain, which matures before hot, dry weather occurs. The soil is better suited to grain sorghum than to corn. Controlling water erosion, conserving moisture, improving the content of organic matter, and maintaining good tilth and a high level of fertility are the main management needs in cultivated areas. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface increases the rate of water intake and reduces the evaporation rate. Sheet erosion is a hazard, and gully erosion is a severe hazard. Terraces, contour farming, and grassed waterways conserve moisture and help to control water erosion.

If irrigated, this soil is poorly suited to corn, grain sorghum, wheat, oats, alfalfa, and introduced grasses. Because of the slope, the soil is suited only to sprinkler systems. Water should be applied slowly because of the very low water intake rate. Planting deep-rooted crops and returning crop residue to the soil increase the water intake rate and maintain the content of organic matter. A system of conservation tillage helps to control water erosion in sloping areas.

This soil is suited to introduced grasses or legumes for pasture or hayland. Grasses or legumes are commonly rotated with other crops. Cool-season grasses, such as smooth bromegrass and intermediate wheatgrass, are suitable species. They can be seeded alone or in a mixture with a legume, such as alfalfa. Rotation grazing and proper stocking rates help to keep the grasses in good condition. Applying nitrogen and phosphate fertilizers improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate herbicides are applied.

This soil is suited to native grasses used for range. Overgrazing and improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, a planned grazing system, and timely deferment of grazing and haying help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Survival and growth rates of adapted species are fair. Proper site preparation and timely cultivation can increase the seedling survival rate. Droughtiness and the high content of clay affect newly planted seedlings. The soil should be worked when it is moist but not too wet. The weeds and undesirable grasses that compete with the trees for moisture are a management concern. Competing vegetation can be controlled by cultivation or applications of the appropriate herbicides. Irrigation can provide additional water during periods of low rainfall.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the

low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Slides are a potential hazard on sites for roads. Tile drains can intercept runoff from the steeper areas. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability classification is IVe-4, dryland, and IVe-1, irrigated. The range site is Clayey, and the windbreak suitability group is 4C.

VfC—Verdigre fine sandy loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 10 inches thick. The subsoil is about 25 inches thick. The upper part is brown, friable clay loam, and the lower part is light brownish gray, very firm, calcareous clay. The underlying material is light brownish gray, calcareous clay about 14 inches thick. Light brownish gray, calcareous shale bedrock is at a depth of about 54 inches. In some places the shale bedrock is at a depth of less than 40 or more than 60 inches.

Included with this soil in mapping are small areas of Labu, Simeon, Thurman, and Valentine soils. Labu soils are clayey throughout. They have shale bedrock at a depth of 20 to 40 inches. They are in landscape positions similar to those of the Verdigre soil. Simeon, Thurman, and Valentine soils are sandy. They are higher on the landscape than the Verdigre soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the loamy upper part of the Verdigre soil and slow in the lower part. The available water capacity is moderate. The water intake rate also is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

A large acreage of this soil is used for cultivated crops. The remaining acreage supports introduced or native grasses. Most areas are dry-farmed. A small area is irrigated. A small acreage supports pastures of introduced grasses and is used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, alfalfa, soybeans, oats, and wheat. Soil blowing and water erosion are the main hazards. In areas where outcrops of shale are at or near the surface, cultivation is difficult. Terraces, contour farming, stripcropping, and grassed waterways help to control water erosion. Tillage should be kept to a minimum. Including grasses and legumes in the cropping sequence can maintain organic matter content and fertility and helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface conserves moisture and helps to control soil blowing. Planting single rows of trees in field windbreaks helps to control soil blowing and provides protection for livestock in the winter.

If irrigated, this soil is suited to corn, grain sorghum, and alfalfa. Soybeans, small grain, and introduced grasses also are suitable species. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Terraces, contour farming, stripcropping, and grassed waterways help to control water erosion and soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing. Most gently sloping areas are not suited to gravity irrigation because of the hazard of erosion.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control soil blowing and water erosion. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of the potential plant community. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition and keep the soil in good condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Trees and shrubs grow more slowly in areas of this soil because of the high content of clay in the subsoil and underlying material. The species selected for planting should be those that are tolerant of drought.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. Grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Strengthening the foundation of buildings and backfilling with coarse

textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-3, dryland, and IIIe-5, irrigated. The range site is Silty, and the windbreak suitability group is 4C.

VfD—Verdigre fine sandy loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is brown, very friable fine sandy loam about 11 inches thick. The subsoil is about 20 inches thick. The upper part is light brownish gray, friable clay loam, and the lower part is light brownish gray, very firm, calcareous silty clay. The underlying material is light brownish gray, calcareous clay about 15 inches thick. Light gray, calcareous shale bedrock is at a depth of about 53 inches. In some places the shale bedrock is at a depth of less than 40 or more than 60 inches. In a few places the surface soil is loamy fine sand.

Included with this soil in mapping are small areas of Labu, Simeon, Thurman, and Valentine soils. Labu soils are clayey throughout. They are in landscape positions similar to those of the Verdigre soil. Simeon, Thurman, and Valentine soils are sandy. They are higher on the landscape than the Verdigre soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the loamy upper part of the Verdigre soil and slow in the lower part. The available water capacity is moderate. The water intake rate also is moderate. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

About half of the acreage of this soil is used for cultivated crops. The remaining acreage supports introduced or native grasses. Most areas are dry-farmed. A small area is irrigated. The areas of introduced and native grasses are used for grazing or hay.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, alfalfa, soybeans, oats, and wheat. Soil blowing and water erosion are the main hazards. Gully erosion is a hazard in drainageways. In areas where outcrops of shale are at or near the surface, cultivation is difficult. Terraces, contour farming, stripcropping, and grassed waterways help to control water erosion. Tillage should be kept to a minimum. Including grasses and legumes in the cropping sequence can maintain organic matter content and fertility and helps to control soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface conserves moisture and helps to control soil blowing.

If irrigated, this soil is poorly suited to corn, grain sorghum, alfalfa, small grain, and introduced grasses. Adjusting the rate of water application to the moderate intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Terraces, contour farming, stripcropping, and grassed waterways help to control water erosion and soil blowing. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface helps to control soil blowing.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to range. Using areas of this soil as range can help to control soil blowing and water erosion. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of the potential plant community. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year can maintain or improve the range condition and help to keep the soil in good condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Trees and shrubs grow more slowly in areas of this soil because of the high content of clay in the subsoil and underlying material. The species selected for planting should be those that are tolerant of drought.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Because of the slope, working the soil is difficult. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites

should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IVe-3, dryland, and IVe-5, irrigated. The range site is Silty, and the windbreak suitability group is 4C.

VfF—Verdigre fine sandy loam, 11 to 30 percent slopes. This deep, moderately steep and steep, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 10 to 150 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 10 inches thick. The subsoil is about 21 inches thick. The upper part is brown, friable clay loam, and the lower part is grayish brown, very firm, calcareous silty clay. The underlying material is grayish brown, calcareous clay about 17 inches thick. Light gray, calcareous shale bedrock is at a depth of about 55 inches. In some places the shale bedrock is within a depth of 40 inches or below a depth of 60 inches. In a few places the surface soil is loamy fine sand.

Included with this soil in mapping are small areas of Labu, Sansarc, Simeon, Thurman, and Valentine soils. Labu and Sansarc soils are clayey throughout. They are in landscape positions similar to those of the Verdigre soil. They have shale bedrock at a depth of 6 to 40 inches. Simeon, Thurman, and Valentine soils are sandy. They are higher on the landscape than the Verdigre soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the loamy upper part of the Verdigre soil and slow in the clayey lower part. The available water capacity is moderate. Runoff is medium or rapid. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

Most of the acreage of this soil is used for range. Areas of this soil are too erodible and steep to support cultivated crops.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 80 percent or more of the total annual forage. Blue grama, indiangrass, switchgrass, sand lovegrass, and annual grasses and forbs make up the rest. If continuous heavy grazing is allowed, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion is excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is too steep for the trees and shrubs commonly grown as windbreaks. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted.

This soil is generally not suited to sanitary facilities because of the slope and the slow permeability. A suitable alternative site should be selected. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling can provide a suitable grade for roads.

The capability classification is VIe-3, dryland. The range site is Silty, and the windbreak suitability group is 10.

VgC—Verdigre loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is grayish brown, friable loam about 4 inches thick. The

subsoil is about 32 inches thick. The upper part is brown, firm clay loam; the next part is pale brown, firm clay loam; and the lower part is light gray and olive yellow, very firm, calcareous silty clay. The underlying material is light gray and olive yellow, calcareous silty clay about 14 inches thick. Light gray and yellowish brown, calcareous shale bedrock is at a depth of about 56 inches. In some places the depth to shale bedrock is less than 40 or more than 60 inches.

Included with this soil in mapping are small areas of Labu, Moody, and Paka soils. Labu soils are clayey throughout. They have shale bedrock at a depth of 20 to 40 inches. They are in landscape positions similar to those of the Verdigre soil. Moody and Paka soils have more silt and less sand throughout than the Verdigre soil. They do not have shale bedrock below a depth of 40 inches. They are higher on the landscape than the Verdigre soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Verdigre soil and slow in the lower part. The available water capacity is moderate. The water intake rate is low. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

Most of the acreage of this soil is used for cultivated crops. The remaining acreage supports introduced or native grasses. Most areas are dry-farmed. A small acreage is irrigated. The areas of introduced and native grasses are used for grazing or hay.

If dry-farmed, this soil is suited to corn, grain sorghum, alfalfa, soybeans, oats, and wheat. Water erosion is a slight or moderate hazard. In areas where outcrops of shale are at or near the surface, cultivation is difficult. Terraces, contour farming, and grassed waterways help to control water erosion. Including grasses and legumes in the cropping sequence helps to maintain organic matter content and fertility. A system of conservation tillage that leaves most of the crop residue on the surface conserves moisture and helps to control water erosion.

If irrigated, this soil is suited to corn, grain sorghum, alfalfa, soybeans, small grain, and introduced grasses. Adjusting the rate of water application to the low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Where slopes are suitable, terraces, contour farming, and grassed waterways help to control water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control erosion. Most gently sloping areas are not suited to gravity irrigation systems because of the hazard of erosion.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of fertilizer, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

Using areas of this soil as range is very effective in controlling water erosion. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a planned grazing system maintain or improve the range condition and help to keep the soil in good condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Trees and shrubs grow more slowly in areas of this soil because of the high content of clay in the subsoil and underlying material. The species selected for planting should be those that are tolerant of drought.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IIIe-2, dryland and irrigated. The range site is Silty, and the windbreak suitability group is 4C.

VgD—Verdigre loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, friable loam about 6 inches thick. The subsurface layer also is grayish brown, friable loam. It is about 3 inches thick. The subsoil is about 31 inches thick. The upper part is pale brown, firm clay loam; the next part is grayish brown, very firm, calcareous clay; and the lower part is light olive gray, very firm, calcareous clay. The underlying material is light olive gray, calcareous clay about 14 inches thick. Light gray, calcareous shale bedrock is at a depth of about 54 inches. In some places the shale bedrock is within a depth of 40 inches or below a depth of 60 inches.

Included with this soil in mapping are small areas of Crofton, Labu, Nora, and Paka soils. Crofton, Nora, and Paka soils have more silt and less sand throughout than the Verdigre soil. They do not have shale bedrock below a depth of 40 inches. They are higher on the landscape than the Verdigre soil. Labu soils are clayey throughout. They have shale bedrock at a depth of 20 to 40 inches. They are in landscape positions similar to those of the Verdigre soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Verdigre soil and slow in the lower part. The available water capacity is moderate. The water intake rate is low. Runoff is medium. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

About half of the acreage of this soil is used for cultivated crops. The remaining acreage supports introduced or native grasses. Most areas are dry-farmed. A small acreage is irrigated. The areas of introduced and native grasses are used for grazing or hay.

If dry-farmed, this soil is poorly suited to corn, grain sorghum, alfalfa, soybeans, oats, and wheat. Water erosion is a moderate or severe hazard. In areas where outcrops of shale are at or near the surface, cultivation is difficult. Terraces, contour farming, and grassed waterways help to control water erosion. Including grasses and legumes in the cropping sequence helps to maintain organic matter content and fertility. A system of conservation tillage, such as no-till planting or disking, that leaves most of the crop residue on the surface conserves moisture and helps to control water erosion.

If irrigated, this soil is poorly suited to corn, alfalfa, small grain, grain sorghum, and introduced grasses. The major hazard is water erosion. Adjusting the rate of water application to the low intake rate of the soil minimizes the amount of water that runs off and helps to control erosion. Terraces, contour farming, and grassed waterways help to control water erosion. A system of conservation tillage, such as no-till planting or disking, that leaves crop residue on the surface helps to control water erosion.

This soil is suited to pastures. Pastures are mainly bromegrass or, in some areas, a mixture of bromegrass and alfalfa and other cool-season grasses. Applications of nitrogen fertilizers, rotation grazing, and proper stocking rates help to keep the grasses in good condition.

Using areas of this soil as range is very effective in controlling water erosion. Overgrazing or improper haying methods reduce the amount of protective plant cover and the quality of native plants. Proper grazing use, timely deferment of grazing and haying, and a grazing system in which two or more pastures are alternately grazed and rested and the order of the grazing and rest periods is changed each year help to maintain or improve the range condition and keep the soil in good condition.

This soil is poorly suited to trees and shrubs grown as windbreaks. Seedlings generally survive and grow if competing vegetation is controlled by proper site preparation, timely cultivation, or applications of appropriate herbicides. Trees and shrubs grow more slowly in areas of this soil because of the high content of clay in the subsoil and underlying material. The species selected for planting should be those that are tolerant of drought.

This soil is not suited to septic tank absorption fields because of the slow permeability. A suitable alternative site should be selected. On sites for sewage lagoons, grading is needed to modify the slope and to shape the lagoon. The soil should be worked when moist but not wet. Because of the slope, working the soil is difficult. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The capability classification is IVe-2, dryland and irrigated. The range site is Silty, and the windbreak suitability group is 4C.

VgF—Verdigre loam, 11 to 30 percent slopes. This deep, moderately steep and steep, well drained soil is on uplands. It formed in loamy eolian material deposited over material weathered from clayey shale bedrock. Areas range from 10 to 150 acres in size.

Typically, the surface layer is grayish brown, friable loam about 9 inches thick. The subsurface layer also is grayish brown, friable loam. It is about 3 inches thick. The subsoil is about 21 inches thick. The upper part is light brownish gray, firm clay loam, and the lower part is light olive gray, very firm, calcareous clay. The underlying material is light gray, calcareous clay about 12 inches thick. Light gray, calcareous shale bedrock is at a depth of about 45 inches. In some places the depth to shale bedrock is less than 40 or more than 60 inches.

Included with this soil in mapping are small areas of Crofton, Labu, Nora, and Sansarc soils. Crofton and

Nora soils have more silt and less sand throughout than the Verdigre soil. They do not have shale bedrock below a depth of 40 inches. They are higher on the landscape than the Verdigre soil. Labu and Sansarc soils are clayey throughout. They are in landscape positions similar to those of the Verdigre soil. They have shale bedrock at a depth of 6 to 40 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Verdigre soil and slow in the lower part. The available water capacity is moderate. Runoff is medium or rapid. Organic matter content is moderate. Natural fertility is medium. The shrink-swell potential is high in the lower part of the profile.

Most of the acreage of this soil is used as range. Areas of this soil are too erodible and steep to support cultivated crops.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, sideoats grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Needleandthread, switchgrass, indiangrass, green needlegrass, blue grama, sedges, and other annual and perennial grasses and forbs make up the rest. If continuous heavy grazing is allowed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and are replaced by blue grama, needleandthread, plains muhly, sand dropseed, western wheatgrass, sedges, and other perennial and annual grasses and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferment of grazing and haying can help to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If this soil is used as hayland, the forage should be harvested only every other year. During the year in which the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is too steep for the trees and shrubs commonly grown as windbreaks. Some areas can be used for plantings that enhance recreational areas and wildlife habitat or for forests if trees and shrubs are hand planted.

This soil is generally not suited to sanitary facilities because of the slope and the slow permeability. A suitable alternative site should be selected. Strengthening the foundation of buildings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the building sites should be graded to a suitable gradient. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Cutting and filling can provide a suitable grade for roads.

The capability classification is VIe-2, dryland. The range site is Silty, and the windbreak suitability group is 10.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly

from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 235,000 acres in the survey area, or nearly 32 percent of the total acreage, meets the soil requirements for prime farmland.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Prepared by William E. Reinsch, conservation agronomist, Natural Resources Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Natural Resources Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Cropland makes up about 58 percent of the total acreage on farms in Knox County. Nearly 13 percent of the cultivated cropland is irrigated. Corn, small grain, and alfalfa hay are the main crops. Other crops grown are soybeans and grain sorghum.

Management of Dryland Crops

Although dryland crops are grown in scattered areas throughout the county, the greatest concentration of areas used for dryland and irrigated crops is in the eastern and east-central parts of the county. Dryland crops are grown mainly in areas of the Moody-Bazile-Trent, Crofton-Nora-Alcester, Betts-Crofton-Alcester, Thurman-Bazile-Ortello, and Labu-Lynch-Sansarc associations, which are described under the heading "General Soil Map Units." Dryland crops are mostly used as feed for livestock. More than 36 percent of the dry-farmed cropland is used for the production of hay and small grain.

Insufficient rainfall commonly is a limiting factor affecting crop production in the county. Water erosion and soil blowing can prevent maximum crop production. Good management of the areas used for dryland crops reduces the runoff rate, helps to control erosion, conserves moisture, and improves tilth.

Terraces, contour farming, contour stripcropping, and a conservation tillage system that keeps crop residue on the surface help to control water erosion. Keeping crop residue on the surface or establishing a protective plant cover minimizes crusting during and after heavy rains. In winter the stubble holds snow on the field and

Figure 9.—Terraces in an area of Crofton-Nora complex, 6 to 11 percent slopes, eroded.

thus increases the moisture supply. Terraces reduce the length of slopes and thus reduce the runoff rate and help to control erosion. Broad-base terraces are practical on moderately sloping upland soils where slopes are long and rather smooth. Grassed-backslope or narrow-base terraces are best suited to slopes that are more than 10 percent because these terraces do not increase the steepness of the slope (fig. 9).

In Knox County, erosion is the major problem on nearly all soils used as cropland and in areas of pasture that have been overgrazed. Soils that have slopes of more than 4 percent and are loamy sand are the most susceptible to soil blowing and water erosion.

Soil blowing is a major problem in areas of the Valentine-Simeon-Thurman and Thurman-Bazile-Ortello associations. Keeping crop residue on the surface until spring planting helps to control soil blowing. A system of conservation tillage that leaves crop residue on the surface also helps to control soil blowing. Using the more productive soils for row crops and the steeper, more erodible soils for close-growing crops, such as small grain, or for hay and pasture helps to control erosion.

Contour stripcropping and conservation tillage help to control soil blowing and water erosion. Contour stripcropping helps to control erosion by maintaining short-term rotations of contoured strips of meadow crops. The areas between the strips are cultivated, and row crops are planted on the contour. The strips of grasses or grasses and legumes are generally used for hay. Contour stripcropping is best suited to soils that have short slopes, such as those in the Labu-Lynch-Sansarc association.

Erosion is damaging because productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Also, erosion can result in the sedimentation of streams, lakes, and ponds. Erosion control minimizes this pollution and improves the quality of water for municipal and recreational uses and for fish and wildlife.

The cropping system and the management practices that help to control erosion should be planned so that

they are effective on the soil in each field. This planned management is known as a resource management system. Resource management systems in areas of dryland crops help to maintain soil tilth and fertility, maintain a cover of vegetation that protects the soil from erosion, and control weeds, insects, and diseases.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils that have good tilth are granular and porous. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth. Growing legumes, such as alfalfa, improves tilth and provides nitrogen for the next crop in the rotation.

Systems for managing cropland resources vary according to the soils on which they are used. For example, a resource management system in an area of Moody silty clay loam, 2 to 6 percent slopes, should include management and vegetative practices. A resource management system in an area of Crofton silt loam, 6 to 11 percent slopes, eroded, should include management, vegetative, and mechanical practices.

Occasionally, tillage is needed to prepare a seedbed, control weeds, and provide a favorable place for plants to grow. Excessive tillage, however, reduces the extent of the plant cover and thus increases the hazard of erosion. Tillage practices should be limited to those that are essential. Various tillage practices can be used in Knox County. No-till planting, till planting, disking, and chiseling are practices that are well suited to row crops. Grasses and legumes can be established without further seedbed preparation by drilling into a cover of stubble.

Soil fertility in most of the eroded soils in the county is naturally lower than in the uneroded soils. All of the soils, however, require additional plant nutrients for optimum production. The kind and amount of fertilizer to be applied to the soils used for dryland crops should be based on the results of soil tests. Nitrogen and phosphorus are the elements added to most cultivated areas. In some areas trace elements are needed.

Management of Irrigated Crops

About 13 percent of the cultivated cropland in Knox County is irrigated. Corn is the main crop grown in irrigated areas. A smaller percentage of the acreage is used for alfalfa or soybeans. The irrigation water is obtained from wells. Gravity or sprinkler systems are suited to the areas used for row crops. Alfalfa is generally irrigated by sprinkler systems.

The cropping sequence on soils that are well suited to irrigation consists mostly of row crops. A crop rotation that includes different crops, such as corn and soybeans, helps to control the diseases and insects that are common if the same crop is grown year after year.

Gently sloping soils, such as Moody silty clay loam, 2 to 6 percent slopes, are subject to water erosion if they are furrow irrigated down the slope. These soils should be contour bench leveled if furrow irrigated, or contour furrows and a ridge-till conservation tillage system should be used. Land leveling increases the efficiency of irrigation because it results in an even distribution of water.

Contour farming and conservation tillage practices that keep crop residue on the surface help to control water erosion on soils irrigated by a sprinkler system. When water is applied by the sprinklers at a controlled rate, it is absorbed by the soil and does not run off the surface. Sprinklers can be used on the more sloping soils and in nearly level areas. Some soils, such as Valentine fine sand, 3 to 9 percent slopes, are suited to sprinkler irrigation only if erosion is controlled. Because the application of water can be carefully regulated, sprinklers can be used for special purposes, such as establishing a new pasture on moderately steep soils. The most common types of sprinkler irrigation in Knox County are center-pivot and towline systems.

Furrow irrigation is most efficient if it is started after the plants have used about half of the available water in the soil. Thus, if a soil holds 8 inches of available water, irrigation should be started when about 4 inches has been removed by the crop.

A tailwater recovery pit can be installed to trap excess irrigation tailwater. This water can then be pumped back onto the field and used again. This practice increases the efficiency of the irrigation system and conserves the water supply.

All of the soils in Nebraska are assigned to irrigation design groups *(6)*. If applicable, an irrigated capability classification is specified at the end of the map unit descriptions under the heading "Detailed Soil Map Units." The Arabic numeral at the end of the irrigated capability classification indicates the irrigation design group to which the soil is assigned.

Assistance in planning and designing an irrigation system can be obtained at the local office of the Natural Resources Conservation Service. Estimates of the cost of irrigation equipment can be obtained from local dealers and manufacturers.

Weed Control

A suitable cropping sequence or appropriate herbicides help to control weeds. Rotating different crops in a planned sequence not only helps to control weeds but also increases the productivity of the soil and the content of organic matter. The kind and amount of herbicide applied to the soil should be carefully controlled. The colloidal clay and humus fractions of the soil are responsible for most of the chemical activity in

the soil. Applications of some herbicides on sandy soils that have a low content of colloidal clay, such as Thurman soils, and on soils that have a low content of organic matter, such as the eroded Crofton soils, can cause crop damage.

Management of Pasture and Hayland

Hayland or pasture should be managed for maximum forage production. After a pasture is established, the grasses should be kept productive. In Knox County, pastures of introduced grasses consist mainly of smooth bromegrass. This grass starts to grow early in spring and reaches its peak growth in May and June. It is dormant during July and August unless the pasture is irrigated. For this reason, it should be managed in a planned grazing system along with pastures of warm-season grasses or with temporary pastures of sudangrass, which reaches its peak growth during July and August. This rotation provides green plants during the entire growing season.

Including rotation grazing in the management of pastures allows for plant regrowth. A planned grazing system that rotates pastures of cool-season grasses with warm-season grasses can extend the grazing season and increase production. The most commonly grown introduced grasses for cool-season pastures are smooth bromegrass and intermediate wheatgrass. Other cool-season grasses and legumes that are adapted to the soils in Knox County are orchardgrass, creeping foxtail, meadow bromegrass, reed canarygrass, alfalfa, and cicer milkvetch. Some native warm-season grasses, if planted as a single species in nonirrigated areas, are compatible with cool-season pastures and improve forage quality during the grazing season. Switchgrass, indiangrass, and big bluestem are native warm-season grasses that can provide high-quality forage during the summer.

Introduced pasture grasses are more productive if grazing is delayed in spring and fall until after the grasses have reached a height of 5 or 6 inches. Until the plants reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in the spring or too late in the fall reduces the vigor of the plants.

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 6. 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. The land capability classification also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; 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 residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

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 as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil 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 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The

numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas 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 hazard is the 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 very cold or very 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. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 and IIIe-6.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of the map units in this county is given in the section "Detailed Soil Map Units" and in the yields table.

Rangeland

Prepared by Kenneth L. Hladek, range conservationist, Natural Resources Conservation Service.

Rangeland makes up approximately 39 percent of the agricultural land in Knox County. It is in scattered areas throughout the county. The largest acreages, however, are in the Brunswick-Paka-Simeon and Labu-Lynch-Sansarc associations, which are described under the heading "General Soil Map Units." Farms in these associations are typically smaller livestock and cash-grain operations. Larger ranches are dominant in the Valentine-Simeon-Thurman association in the west-central part of the county.

The rangeland throughout the county is primarily used for grazing by livestock, but a small acreage is used for the production of native hay. The Inavale-Barney-Orwet association in the north-central part of the county is mainly used as hayland. Native hay is also harvested in areas of the Thurman-Bazile-Ortello association, although these areas generally are not highly productive.

The raising of livestock, mainly cow-calf herds from which calves are sold in the fall as feeders, is one of the most important agricultural industries in the county. Cattle generally graze in areas of range from late spring to early fall. Livestock graze the regrowth on native meadows and the corn residue on irrigated cropland in the fall. They are fed alfalfa and native hay during the winter and early spring. The forage produced on rangeland is often supplemented with protein during the fall and winter.

Much of the rangeland in Knox County produces well below its potential because it has been continuously overgrazed in the past. Stocking rates are commonly related to the amount of crop residue available for grazing in the fall. Many formerly terraced fields of cropland in the county were reseeded to smooth bromegrass. These fields generally are intermingled with the rangeland and used for grazing. These areas should be managed separately as pasture or reseeded to a native grass mixture that is compatible with the surrounding rangeland. Poor grazing distribution and brush encroachment in upland areas have also reduced the production of forage.

The main goal of range management is excellent range condition. Proper management of rangeland is one of the most important factors affecting the conservation of soil, water, and plants in the county. Proper range management and improvement practices, such as proper grazing use, planned grazing systems, range seeding, and brush control, increase the productivity of the range. Besides improving the yields of desirable forage plants, these practices minimize soil

losses, improve wildlife habitat, and increase the potential for livestock production.

This section can assist ranchers and conservationists in planning the management of range. It defines range sites, explains the evaluation of range condition, and describes planned grazing systems and other aspects of range and hayland management.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 8 shows, for most of the soils, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 8 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply 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 is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. 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 make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. 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. Range condition is an ecological rating only.

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 optimum production of vegetation, control of undesirable brush species, 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.

Range Condition

The range condition for any range site is the existing state of the vegetation compared to its potential, or climax vegetation. Climax vegetation is a stable plant community that represents the furthest point of plant succession. It is generally the most productive combination of native forage plants and represents the highest potential in kind and amount of vegetation for a given range site. It reproduces itself and changes little as long as the climate and soil remain stable.

Determining the range condition provides an approximate measure of the overall health of the plant community. More importantly, it provides a basis for predicting the degree of improvement possible under different kinds of management. Four range condition classes express the degree to which the composition of the present plant community differs from that of the climax vegetation. These classes are excellent, good, fair, and poor.

All food that green plants use for growth, maintenance, and reproduction is manufactured in their leaves. The excessive removal of leaves during the growing season drastically affects the growth of both roots and shoots. Livestock graze selectively, removing more leaves from some plants than from others. This selective grazing varies according to the season and the degree of use. Various plants respond to heavy continuous grazing in different ways. Some plants

decrease in abundance, some increase, and others invade. These plant responses are used to classify range condition.

The *decreaser species* on a site are those in the original plant community that decrease in abundance when grazed closely and continuously during the growing season. The *increaser species* are those in the original plant community that normally increase in abundance under continuous heavy grazing. They decrease in abundance if the pasture is severely overgrazed. *Invader species* are not part of the original plant community. They begin growing in an area after the decreasers and increasers have been weakened or eliminated.

Once range condition has been determined, it is important to know whether it is improving or deteriorating in order to plan adjustments in grazing use and management. Important factors affecting trends in the plant community are the vigor and reproductive capacities of both the desirable and undesirable species.

The goal of range management is excellent range condition. The greatest forage yields may be obtained on a sustained basis when the range is in excellent condition and is not deteriorating. Under these circumstances, soil blowing and water erosion are reduced to an acceptable level and plants can make optimum use of precipitation.

The range sites given at the end of each map unit description are determined by the kind and amount of vegetation that can be expected when the sites are in excellent condition.

Proper Grazing Use

Proper grazing use involves grazing at an intensity that maintains sufficient plant cover to protect the soil and that maintains or improves both the quantity and quality of desirable vegetation. It is the first and most important step in successful range management. It increases the vigor and reproductive capacity of desirable plants, leaves enough accumulated litter and mulch on the surface to help control erosion, and increases forage production. The proper intensity of grazing used on rangeland during the entire growing season removes no more than half of the current year's growth, by weight.

Proper grazing use is determined by the degree to which desirable species are grazed in key areas. It is affected by stocking rates, distribution of livestock, the kinds and classes of livestock, and the length of the grazing season.

The stocking rate is the number of grazing animals in a particular pasture. It is based on animal units and animal unit months. An *animal unit* is a measurement of livestock numbers based on the equivalent of one mature cow, weighing approximately 1,000 pounds, and a calf that is at least 4 months of age or the equivalent of the cow and calf. An *animal unit month* is the amount of forage or feed necessary to sustain an animal unit for 1 month. The range site and range condition are used to determine animal unit months for each pasture. The suggested initial stocking rate for range sites in excellent condition are given for many of the soils under the heading "Detailed Soil Map Units." The rates are lower for range sites in less than excellent condition.

The suggested initial stocking rate for rangeland is relatively easy to calculate for any given soil or range site. For example, in an area of Valentine fine sand, 9 to 24 percent slopes, the suggested initial stocking rate is 0.9 animal unit month per acre if the range is in excellent condition. Thus, a 640-acre pasture in excellent condition can carry about 576 animal units for 1 month. If the pasture is to be grazed for 5 months, the suggested initial stocking rate would be about 115 animal units. The initial suggested stocking rate is based on the condition of the existing plant community and the average annual forage production of each range site. Because of weather conditions, forage production varies. The suggested rate is intended as an initial stocking rate and should be adjusted to changes in forage production or the management system.

The proper distribution of livestock throughout a pasture requires planning. Livestock tend to graze most heavily in areas near livestock watering facilities, in areas near roads and trails, and in gently sloping areas. Distant corners of pastures and areas of steep terrain are typically undergrazed. Poor grazing distribution can result from too few watering facilities or from poorly distributed salting and watering facilities, shade, and supplemental feed. A continued concentration of livestock in an area results in severe overuse of that area and a hazard of erosion while the other areas are left underused. Carefully locating fences and salting and watering facilities and applying a planned grazing system help to achieve a uniform distribution of grazing.

Fences help to distribute grazing in a more uniform pattern. Also, they divide pastures into sections to be used in a planned grazing system and keep livestock out of blowouts and reseeded areas. Cross fences should be located so that they follow natural land features and range sites as much as possible. The potential stocking rate should be similar for all pastures. Generally, the smaller pastures are used more efficiently by livestock than the larger pastures. This efficiency in forage use should be considered in addition to the convenience in operation when the pasture size is determined.

Properly locating salt and mineral facilities is one of

the easiest and most economical means of achieving a uniform distribution of grazing in a pasture. The salt and mineral facilities should be placed away from water facilities. They can be easily moved to areas that are undergrazed and can be relocated at different times throughout the grazing season. In areas of Valentine soils, relocating the salting and mineral stations each time salt and minerals are provided reduces the hazard of soil blowing.

Properly located watering facilities also can improve the distribution of grazing. In Knox County, most livestock water is obtained from wells that are pumped by windmills and from perennial streams, particularly in areas of the Valentine-Simeon-Thurman association. Watering facilities should be spaced at varying distances, depending on the terrain. In rough or hilly areas, the distance between facilities should not be more than 0.5 mile. In the more level areas, it should be no more than 1.0 mile. If the distance is too far, the areas near water sources will be overgrazed (fig. 10).

Range management is also dependent on the kinds and classes of livestock grazing the pasture. Cattle, sheep, and horses have different grazing habits and nutritional needs that affect the way range can best be managed for proper grazing use. Cattle are the main livestock raised in the county. Their grazing habits are well suited to the characteristics of the major range sites. Grazing habits also differ among classes of cattle. Yearlings graze in more areas of a pasture than cows with calves. Their tendency to trail along fence lines can sometimes result in erosion. Yearlings also graze in the steeper areas and generally graze a pasture more uniformly than cows with calves. Cow-calf pairs tend to graze more on the gentler slopes and stay closer to watering facilities than yearlings. As a result, poor grazing distribution may be more of a problem in pastures stocked with cows and calves than in those stocked with yearlings. Only a few horses and sheep are raised in the county.

General management techniques outlined in this section and under the heading "Detailed Soil Map Units" apply principally to cattle production. Management techniques may need adjustment if other livestock are grazed.

Planned Grazing Systems

Planned grazing systems are effective in achieving maximum forage production and livestock performance and in controlling erosion and improving wildlife habitat (fig. 11). In a planned grazing system, two or more pastures are alternately rested and grazed in a planned sequence over a period of years. The rest periods are planned for sometime during the growing season. All livestock should be removed from the pasture being rested. These pastures are grazed in a different sequence each year. By not grazing the same pasture at the same time each year, the plants are not close-cropped by livestock at the same stage of development every year. Planned grazing systems increase plant vigor and forage production and allow the plant community to improve, thus improving range condition. Planned grazing systems permit maximum and uniform use of forage and maintain rangeland productivity over a period of years. They also help to overcome the adverse effects of drought and other climatic conditions.

An effective planned grazing system must be flexible and should be adapted to the needs of an individual rancher. Fences, watering facilities, range condition, range sites, kinds or classes of grazing animals, and economic factors are all important considerations in determining the best system for a particular ranch. Grazing systems should be modified over a period of time because of improved plant vigor, increased forage production, or changes in management needs.

Planned grazing systems can increase stocking rates through an increase in forage production and improved forage quality. They also minimize the formation of blowouts and may reduce the number of parasites and minimize the likelihood of diseases among cattle since the pastures are generally cleaner than those that are continuously grazed.

Deferred Grazing

Deferred grazing is the resting of grazing land for a prescribed period. The need for deferment is based on the range condition and range trends. Deferment should be for a minimum of 3 consecutive months and should coincide with the critical growth period of the desirable plants. The maximum benefit from deferment coincides with the food storage period. For native warm-season grasses, this period occurs from late July to early October. On some sites a short deferment of 3 months is all that is needed, but on other sites a deferment of two complete growing seasons of continuous rest may be needed. Generally, some grazing throughout the year is more beneficial than a complete year-long deferment. Following the periods of deferment, the pasture can be grazed after the first heavy frost in the fall or early in the spring before the warm-season grasses begin to grow. If the pastures are grazed in winter, protein supplements are needed to meet the nutritional needs of cattle.

Deferred grazing allows plants a rest period during critical times in their growth stages. This period allows grasses to become vigorous and to produce a mulch at the surface, thus increasing the rate of water infiltration. This mulch also reduces the susceptibility of the soil to erosion. Deferred grazing also promotes natural grass

Figure 10.—Livestock water dams and artesian wells provide water for livestock.

reseeding by allowing the desirable species to set seed and, more importantly, to spread vegetatively.

Where overgrazing has eliminated the native grasses, reseeding the range to adapted native grasses is the best method of restoration. Native range should be reseeded only after careful evaluation.

Range Seeding

In some areas, such as formerly cultivated fields and abandoned farmsteads, range management alone cannot restore a satisfactory cover of native vegetation. Range seeding may be needed in these areas. It may also be needed in severely overgrazed areas where the

Figure 11.—An area of Lynch-Bristow complex, 11 to 30 percent slopes. The area to the left of the fence has been overgrazed. Good range management practices have been applied in the area to the right of the fence.

native vegetation has deteriorated so much that it will not respond to management practices.

Good stands of native grasses can be reestablished if the seedbed is properly prepared, adapted species of native grasses are selected for planting, the correct seeding methods are used, and careful management is applied after seeding.

Range seeding is most successful when the seedbed is firm and has a cover of mulch. A firm seedbed helps to ensure good soil-seed contact, which is essential for seedling development. The cover of mulch helps to keep the soil moist, lowers the temperature of the surface soil, and helps to control erosion. It can be provided by planting a temporary crop, such as sudangrass or grain sorghum. Tillage should be avoided because a firm seedbed is needed. The grass should be seeded directly into the stubble the following fall, winter, or spring. On soils that have a coarser textured surface layer and are subject to soil blowing, preparing the seedbed and seeding in narrow strips over a period of several years help to control soil blowing.

Seeding mixtures should consist of adapted native

grasses that are on the site when the range is in excellent condition. Consequently, they vary according to the soils and range sites. Using a grassland drill with depth bands ensures the proper placement of seeds at a uniform depth. If the soils are tilled during seedbed preparation, a range interseeder should be used in areas where the hazard of soil blowing is severe. This system places seeds in the center of a shallow furrow without disturbing the vegetation between the furrows.

Controlling weeds is important in obtaining a good, viable stand. Mowing, spraying, and controlled, light grazing of broadleaf species and weedy grasses help to ensure a good stand of grasses.

Newly seeded areas should not be fully grazed until after the grass is well established. Establishment may take 2 or 3 years, depending on the grass species, the range site, the method of planting, and the weather. Initial grazing of these areas should be light. Limited grazing in spring or during late fall and winter helps to control weeds until the grass is established. Proper grazing use and a planned grazing system help to keep the range productive after the grass is established.

Additional information about appropriate grass mixtures, grassland drills, and planting times can be obtained at the local office of the Natural Resources Conservation Service.

Control of Blowouts

Blowouts occur on sandy soils, mainly in areas of the Valentine-Simeon-Thurman association, where the vegetation has been removed. Many blowouts form in areas of the sandhills that have been subject to continuous heavy grazing. Larger blowouts generally form in areas near wells where livestock tend to concentrate. Smaller blowouts commonly occur along trails and fence lines. Drought increases the likelihood that blowouts will form.

Unless they are stabilized, blowouts are likely to become larger. The wind blows the sand to bordering areas, where the windblown sand smothers the vegetation. The result is an expanding area that is subject to severe soil blowing.

A planned system can stabilize and control many blowouts within a period of 4 or 5 years. Locating salt and mineral facilities away from the blowouts helps to prevent the concentration of livestock in the area. Feeding livestock native hay with seed over winter in areas of blowouts has also proven to be effective in stabilizing the blowouts. This method should be tried before a full-fledged reseeding program is undertaken.

If a planned grazing system is not feasible or if hay cannot be fed in winter, reseeding may be necessary. If blowouts are reseeded, steep banks around the edge of the blowouts generally should be reshaped into a stable slope. If a quick-growing cover crop is planted in the spring, a mixture of adapted native grasses can be drilled into the stubble left from the crop. The cover crop helps to protect the surface from soil blowing, lowers the soil temperature, and creates a firm seedbed. If a cover crop is not practical, a mulch of native hay can be spread over the surface and anchored into the sand after seeding. Mulching helps to prevent the damage caused by windblown sand while the grasses become established. Fencing blowout areas after seeding helps to keep livestock out until a desirable stand is established. Proper grazing use and a planned grazing system help to prevent the reactivation of stabilized blowouts after the grasses are established.

Brush Control

Small soapweed, western snowberry, eastern redcedar, and smooth sumac are the main brush species in the county. Although they are not a major problem, these plants encroach on the land and reduce forage production and carrying capacity.

Small soapweed and yucca are mainly a problem in the Valentine-Simeon-Thurman association. Yucca can generally be controlled by winter grazing. Feeding cottonseed cake as a protein supplement increases the amount of yucca that cattle consume and causes the yucca to lose vigor. Applications of approved herbicide may not be effective.

Western snowberry, smooth sumac, skunkbush sumac, and eastern redcedar are a problem in areas of the Brunswick-Paka-Simeon and Labu-Lynch-Sansarc associations. These species invade prairie uplands in fairly large numbers, particularly adjacent to steep canyon areas where seed sources are abundant. Western snowberry, smooth sumac, and skunkbush sumac can best be controlled with applications of approved herbicides. Applications may need to be repeated for several consecutive years to control western snowberry. Herbicide recommendations can be obtained from the county extension agent or the local office of the Natural Resources Conservation Service. Eastern redcedar can be easily controlled by cutting the trees at ground level. Cutting can be done by hand or with earthmoving equipment in areas where the slope and terrain are suitable. Additional treatment is not necessary if no green branches are left. Applications of an appropriate herbicide can also help to control eastern redcedar. If adequate fuel materials are available, prescribed burning also can be used to control eastern redcedar.

Management of Native Hayland

A small acreage of rangeland in the county is used

for the production of native hay. Most of the hay is cut in areas of soils that have a high water table. These soils are associated with the Wet Subirrigated and Subirrigated range sites in the Inavale-Barney-Orwet association. Proper management can maintain or improve the production of hay. Timely mowing is needed to maintain plant vigor and the quality and quantity of forage. Mowing the grasses between the boot stage and the emergence of the seed heads allows for adequate regrowth and carbohydrate storage in the plant roots before the first frost. A mowing height of 3 inches or more helps to maintain plant vigor and promotes rapid regrowth. Large meadows can be divided into three sections and mowed in rotation. One-third of the meadow should be mowed about 2 weeks before plants reach the boot stage, one-third at the boot stage, and one-third in the early flowering period. The order in which the sections are mowed should be rotated in succeeding years.

Meadows should not be grazed or harvested for hay when the surface is wet or the water table is within a depth of 6 inches. Grazing or using machinery at these times results in the formation of small depressions, ruts, and mounds, which can hinder mowing in later years. After the soil is frozen, meadows can be grazed without damage.

The Valentine-Simeon-Thurman association is also used for native hay on upland sites. The range sites in areas of this association are generally the Sandy Lowland, Sands, and Sandy range sites.

Hay grown in these areas should be harvested only every other year. During the following year, grazing only in the fall or winter allows the warm-season grasses to regain vigor and suppresses the cool-season grasses and weeds. As on wet sites, the best time for mowing is between the boot stage and the emergence of seed heads. Regulating mowing allows the desirable grasses to remain vigorous and healthy. Early mowing and cutting at the proper height allow for adequate plant regrowth. The regrowth helps to hold snow on the surface and increases the supply of soil moisture.

Technical assistance in managing range and hayland can be obtained from the local office of the Natural Resources Conservation Service.

Windbreaks and Environmental Plantings

Prepared by Keith A. Ticknor, forester, Natural Resources Conservation Service.

Windbreaks and environmental plantings have been planted at various times on most farmsteads and ranch headquarters in Knox County (fig. 12). Field windbreaks, shelterbelts, and windbreaks that provide protection to livestock also are numerous. Siberian elm and eastern redcedar are the predominant species in farmstead windbreaks. Other species include green ash, hackberry, silver maple, mulberry, honeylocust, Russian-olive, ponderosa pine, lilac, boxelder, American elm, and eastern cottonwood.

Planting trees and shrubs is a continual process because short-lived trees, such as Siberian elm, pass maturity and deteriorate; some trees are destroyed by insects, diseases, and storms; and new plantings are needed for expanding ranches. In areas where Siberian elm is the main species, supplemental plantings of evergreen trees and shrubs are needed to provide high-quality protection from the wind.

Field windbreaks and shelterbelts are numerous. These windbreaks are in scattered areas throughout the county, but the greatest concentration is in the western half of the county on the sandy soils of the Valentine-Simeon-Thurman and Thurman-Bazile-Ortello associations (fig. 13). Eastern redcedar is the most common species in windbreaks that are planted in single rows. Eastern cottonwood, Russian-olive, and green ash are also planted in field windbreaks.

Shelterbelts have 8 to 10 rows of trees and shrubs. Many of these shelterbelts were planted during the Prairie States Forestry Project from 1935 to 1942. Species in the shelterbelts consist of Siberian peashrub, eastern redcedar, ponderosa pine, green ash, hackberry, honeylocust, Siberian elm, American elm, Russian mulberry, eastern cottonwood, black walnut, and American plum. Many of these shelterbelts have reached maturity and are now deteriorating. Thinning the trees, removing some of the trees, and replanting are needed to maintain the value and effectiveness of the shelterbelts.

Windbreaks that protect livestock are sometimes used in livestock operations. They generally consist of multiple rows of trees. Eastern redcedar is the predominant species.

The species of trees and shrubs grown as windbreaks should be those that are suited to the soils in the selected site. Selecting suitable species is the first step toward ensuring survival and a maximum growth rate. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate of trees and shrubs.

Generally, trees and shrubs are easily established in the county. The main limitation is competition from weeds and grasses. Proper site preparation before planting and control of competing vegetation after planting are the major management objectives when windbreaks are established. In sandy areas, supplemental watering and cover crops between the tree rows may be needed.

Windbreaks protect livestock, buildings, and yards

Figure 12.—Farmstead windbreaks in an area of Thurman loamy fine sand, 0 to 3 percent slopes.

from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs 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 depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep 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. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Figure 13.—Field windbreaks in an area of the Thurman-Bazile-Ortello association.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Natural Resources Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Native Woodland

Prepared by Keith A. Ticknor, forester, Natural Resources Conservation Service.

In Knox County native woody vegetation grows on steep slopes and breaks, along streams and rivers, and in tributaries and upland drainageways. Approximately 28,000 acres, or 4 percent of the county, is woodland. Wooded areas are mostly in narrow bands or strips along drainageways, but some fairly large areas of woodland are on steep breaks in the northern part of the county. The lumber industry is small, but it is an important local resource.

Much of the woodland is on the least productive soils; therefore, it takes an extremely long time before trees reach a harvestable size. Management is difficult because of the low productivity and the small size of the trees. Also, the acreage that supports woodland has been declining for many years because the land has been cleared and converted to cropland. The areas of woodland could be improved by proper harvesting, thinning, and controlled grazing.

The greatest concentration of woodland is in areas of shale soils in the Labu-Lynch-Sansarc association, which is described under the heading "General Soil Map Units." The areas of woodland are most prevalent on the north- and east-facing slopes. Bur oak is the predominant species. It occurs in nearly pure stands in some areas and in mixed hardwood forests in other areas. Other species include green ash, hackberry, eastern redcedar, American elm, slippery elm, boxelder, gray dogwood, smooth sumac, common chokecherry, American plum, gooseberry, western snowberry, and common pricklyash. Willow and cottonwood trees grow in the bottom of draws.

Bottom-land areas along the major streams, such as the Niobrara River, Verdigris Creek, and Bazile Creek, support a variety of species. Eastern cottonwood, boxelder, green ash, bur oak, American elm, black willow, peachleaf willow, and sandbar willow are the predominant species. Other species include black walnut, eastern redcedar, mulberry, hackberry, Russian-olive, American basswood, common chokecherry, American plum, smooth sumac, gooseberry, common pricklyash, western snowberry, indigobush, and red raspberry.

Areas along upland drainageways are generally heavily wooded with species similar to those in the breaks.

Recreation

Gerald E. Jasmer, wildlife biologist, Natural Resources Conservation Service, helped prepare this section.

Some of the finest recreational opportunities in Nebraska are in Knox County. Opportunities for picnicking, hiking, swimming, fishing, hunting, water skiing, boating, sailing, canoeing, and camping are plentiful. Many natural, scenic, and historical sites are available for sightseeing.

Many of the recreational activities in the county center around Lewis and Clark Lake. Lewis and Clark Lake is the last reservoir on the Missouri River. Nebraska, South Dakota, and the U.S. Army Corps of Engineers operate excellent recreational facilities around the lake. The lake covers approximately 33,000 acres. More than 7,300 acres is in the Lewis and Clark State Recreation Area in Nebraska.

The Lewis and Clark State Recreation Area provides many recreational facilities. Boat ramps, camping sites, picnic shelters, drinking water, restrooms, showers, dump stations, electrical hookups, fish cleaning stations, beaches, and snowmobile trails are available. Boat ramps are also located at the Ferry Landing State Recreation Area, at the Old Niobrara Townsite, and at Verdel.

The Niobrara State Park is at the confluence of the Missouri and Niobrara Rivers and near the headwaters of Lewis and Clark Lake. The park consists of more than 1,200 acres of the most scenic country in Nebraska (fig. 14). It includes horseback riding trails, hiking trails, a swimming pool, fishing areas, picnic shelters, barbecue grills, restrooms, cabins, camp sites, electrical hookups, showers, stables, and a trailer dump station.

The Bazile Creek Wildlife Management Area is at the confluence of Bazile Creek and the Missouri River. It provides good opportunities for hunting, hiking, nature photography, bird watching, and canoeing. This 4,500-acre area provides excellent opportunities for hunting waterfowl, pheasant, deer, woodcock, and squirrel. A public boat ramp on the Missouri River provides access to opportunities for hunting waterfowl and for fishing. Hunting is permitted in wildlife management areas during regular hunting seasons. Limited hunting is permitted at certain State parks and recreational areas.

Fishing is one of the most popular recreational activities in Nebraska. Lewis and Clark Lake offers fishing opportunities for walleye, sauger, smallmouth bass, channel catfish, and northern pike. The Niobrara River provides good fishing opportunities for flathead and channel catfish. The lower areas of Verdigris and Ponca Creeks provide fishing opportunities for catfish. Although not commonly sought, bullfrogs can be found around many rivers, streams, and ponds. Excellent fishing opportunities for largemouth bass, bluegill, perch, and crappie are available in many privately owned ponds in the county. Landowner permission must be obtained before fishing on private land.

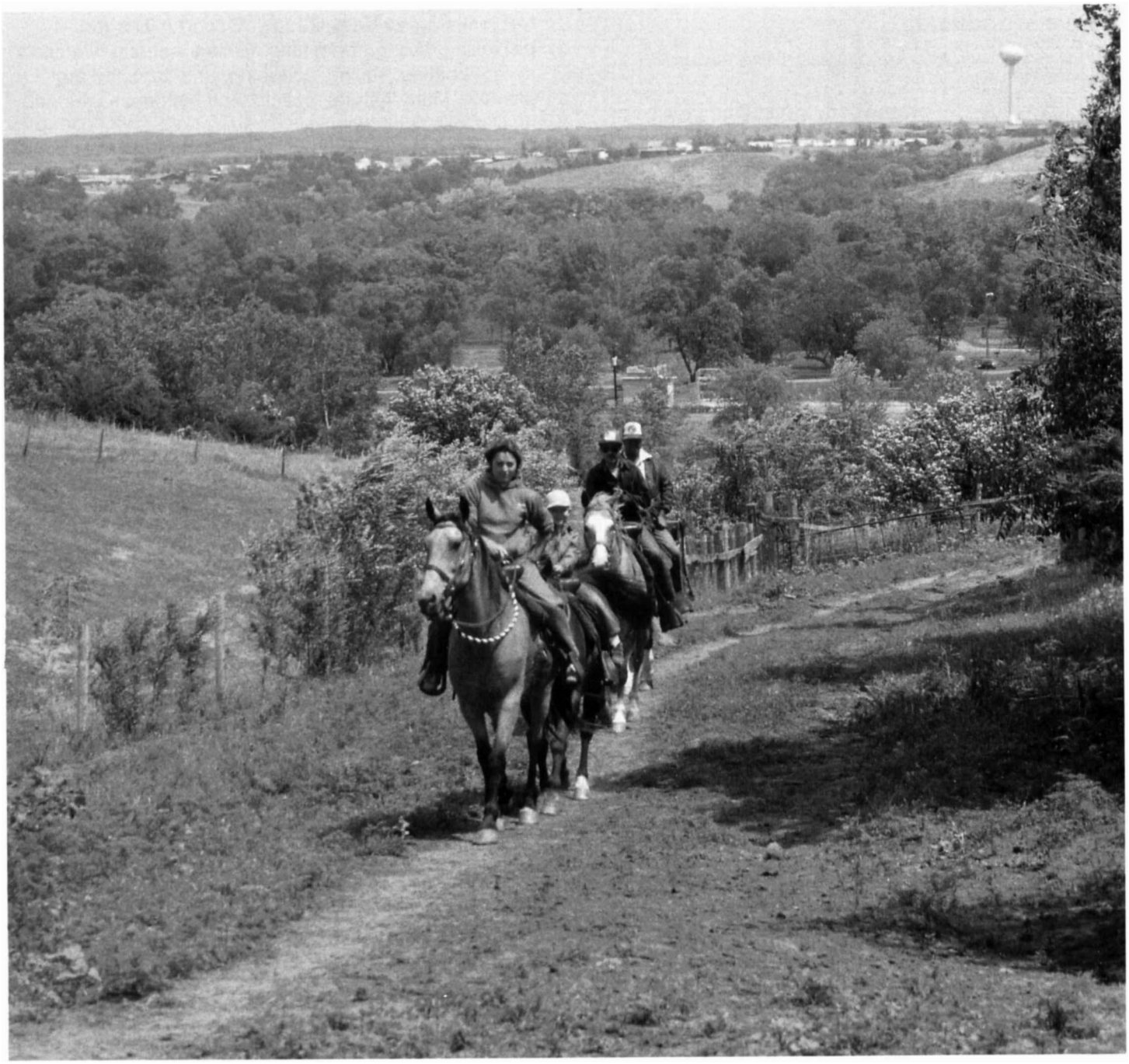

Figure 14.—The Niobrara State Park provides opportunities for recreational activities, such as trail rides.

Hunting for small game, big game, and waterfowl is popular in Knox County. Small game species that are hunted include prairie chicken, sharp-tailed grouse, ring-necked pheasant, gray partridge, cottontail rabbit, coyote, raccoon, and fox squirrel. Mourning doves are common throughout the county and are hunted in early fall. Big game species that are hunted include whitetail deer, mule deer, and wild turkey. Numerous species of ducks and geese are hunted. The trapping of furbearers, such as beaver, raccoon, mink, and coyote, is common in the county but is less popular than hunting. Hunting and trapping occur during regular seasons in public areas open to hunting and on private land. Hunting on private land is by permission of the

landowner. Privately owned game farms and the 15,000-acre Santee Sioux Reservation provide additional opportunities for hunting.

Knox County has 126 acres of municipal recreational facilities *(4)*. Several private businesses in the county charge a fee for recreational activities, including fishing, waterfowl and upland game hunting, and camping. Additional information about these activities can be obtained from the Upper Missouri United Chamber of Commerce.

Additional information on improving fish and wildlife habitat and designing recreational facilities can be obtained from local offices of the Natural Resources Conservation Service.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that 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 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation, such as shaping and leveling the 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 are gently sloping 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 campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for 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 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 and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Gerald E. Jasmer, wildlife biologist, Natural Resources Conservation Service, helped prepare this section.

Knox County has a wide variety of wildlife habitat types for openland, wetland, woodland, and rangeland species. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. The kind and amount of vegetation that is available to wildlife as food and cover, the availability of natural water sources, and the potential for construction of water impoundments are affected by the soils.

The associations in the county, which are described under the heading "General Soil Map Units," generally have quite different potential for wildlife production. Many of these associations can be grouped according to the wildlife habitat and wildlife species they support. The relationship of the soils in each association to wildlife habitat is described in the following paragraphs.

The Moody-Bazile-Trent, Crofton-Nora-Alcester, and Betts-Crofton-Alcester associations make up most of the cropland in the county. These associations consist of areas of dry cropland, irrigated cropland, native rangeland, pasture, and hayland. The primary crops include corn, oats, soybeans, alfalfa, millet, and rye. Maintaining good cover in areas of cropland during winter can provide wildlife with cover and food and help to control soil blowing and water erosion. Applying a

system of conservation tillage, returning crop residue to the soil, and rotating crops can significantly benefit wildlife in these associations. The Aowa-Shell-Kezan association is on bottom land along small drainageways. In well drained, rarely flooded areas, crop production is similar to the crop production in the Moody-Bazile-Trent, Crofton-Nora-Alcester, and Betts-Crofton-Alcester associations. Areas that are less well drained are primarily used for grazing or for the production of hay:

The Aowa-Shell-Kezan, Moody-Bazile-Trent, Crofton-Nora-Alcester, and Betts-Crofton-Alcester associations provide habitat for a variety of openland wildlife, such as pheasant, gray partridge, cottontail rabbit, and mourning dove. The crops grown in areas of this association provide a good source of food and cover. Shallow wetland basins and constructed ponds are in scattered areas and are used by migrating waterfowl and shore birds for feeding and resting. The trees and shrubs used for protection on many farmsteads and fields provide wildlife with critical winter cover. Renovation of many of the older windbreaks, however, is needed to provide continued protection of dwellings, livestock, cropland, and wildlife. Overgrazed range and pastures provide poor areas for nesting and rearing broods. The number of game birds is limited by this widespread problem. Suitable areas for nesting can be provided through proper grazing management of pasture and range, maintenance of grassy field borders, and planting and maintenance of additional field windbreaks.

The Brunswick-Paka-Simeon association consists predominantly of rangeland used for grazing. The high-quality rangeland habitat in this association is composed of native grasses, forbs, and a few scattered woody plants. Some areas produce small grain and alfalfa. Small stands of bur oak, eastern redcedar, and various shrubs provide woodland habitat on steep slopes and along drainageways. Woody plants dramatically improve the overall quality of wildlife habitat in areas of this association by increasing the diversity of food and cover types. Good woodland habitat is critical during the winter. Sharp-tailed grouse, prairie chicken, coyote, mule deer, whitetail deer, jackrabbit, badger, small rodents, meadowlark, turkey, and horned lark are wildlife species in areas of this association. Most wildlife species would benefit from additional water development, such as small dams, dugouts, and springs. Proper grazing management and maintenance of scattered areas of woodland habitat are critical to wildlife in areas of this association.

The northern part of the county includes areas of uplands along the Missouri and Niobrara Rivers, Ponca Creek, and Verdigris and Bazile Creeks. Sandy and gravelly soils make up the Thurman-Bazile-Ortello, Valentine-Simeon-Thurman, and Simeon-Meadin-O'Neill associations. These areas are predominantly native range, but some areas are used for production of dryland or irrigated crops. The Labu-Lynch-Sansarc association also is predominantly range. The soils in this area are generally strongly sloping and clayey. This area supports scattered stands of trees and shrubs, which provide good woodland habitat. The wildlife that frequently inhabit rangeland areas include mule deer, coyote, prairie grouse, small rodents, and reptiles, such as bullsnake, prairie skink, hognose snake, and six-lined racerunner. Whitetail deer, bobcat, turkey, and great horned owl inhabit the woodland and adjacent areas. Rangeland and woodland habitat can be improved and maintained through proper grazing use and rotation grazing. Developing additional water facilities can increase the number of wildlife.

The Fluvaquents-Albaton-Solomon, Aowa-Shell-Kezan, and Inavale-Barney-Orwet associations are in areas of bottom land near major streams and rivers. These areas are used as rangeland, hayland, or cropland. They may provide habitat for openland, rangeland, woodland, or wetland wildlife, depending on the slope and the degree of wetness. Because of the permanent water supply and good density of shrubs and trees on streambanks and islands, excellent habitat is provided throughout the year. Species of plants commonly found in these areas include chokecherry, American plum, indigobush, wild grape, cottonwood, willow, and green ash. The wildlife species that inhabit these areas include waterfowl, herons, shore birds, woodcock, bobwhite quail, muskrat, mink, raccoon, bobcat, beaver, opossum, skunk, squirrel, red fox, and songbirds. Areas of these associations and adjacent areas of water provide habitat for several threatened and endangered species of fish and wildlife. These species include bald eagle, least tern, piping plover, pallid sturgeon, lake sturgeon, and daces. Conservation practices that increase streambank stability and water quality can be beneficial to both common and rare species of fish and wildlife. Providing wildlife food plots can be particularly useful. Small food plots may be heavily used by many wildlife species if there is little or no cropland nearby. Sweetclover, alfalfa, milo, oats, and sunflowers are good crops for food plots.

Additional information on establishing food plots and on many other conservation practices that benefit fish and wildlife can be obtained from local offices of the Natural Resources Conservation Service.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and

distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in 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* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features 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 flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features 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, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, smooth bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features 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 flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are switchgrass, little bluestem, goldenrod, sunflower, ragweed, and sideoats grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are hackberry, cottonwood, willow, green ash, Russian-olive, and honeylocust.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, blue spruce, eastern redcedar, and Rocky Mountain juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are American plum, skunkbush sumac, chokecherry, silver buffaloberry, and crabapple.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, prairie cordgrass, rushes, sedges, cattails, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, shallow dugouts, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife 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. Wildlife attracted to these areas include ring-necked quail, pheasant, mourning dove, meadowlark, killdeer, badger, and skunk.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild

turkey, porcupines, woodpeckers, squirrels, raccoon, deer, and songbirds.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include pronghorn antelope, mule deer, coyote, prairie dog, and prairie grouse.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is

affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the 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.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of groundwater pollution. Ease of excavation and revegetation should be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications

for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the

soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, and sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts and sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

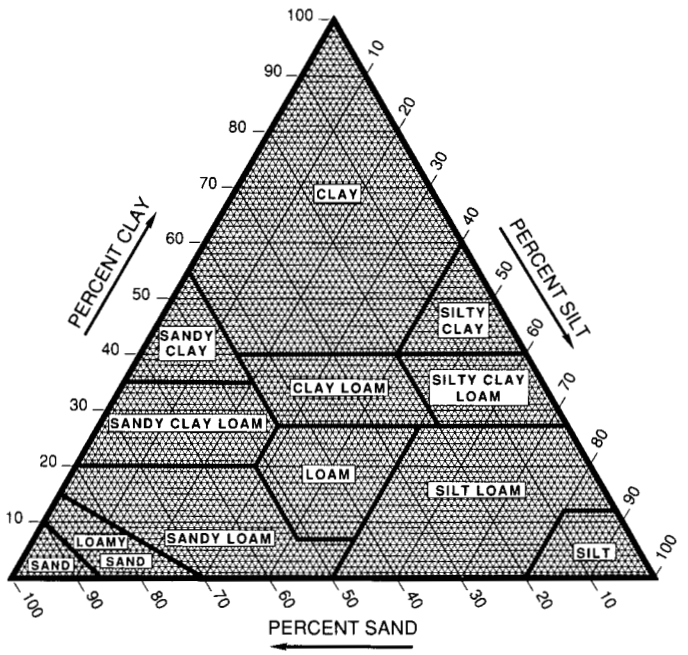

Figure 15.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given 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 the fraction of the soil that is less than 2 millimeters in diameter (fig. 15). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(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 and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and

highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups 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 (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 19.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓-bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops

and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It 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 nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive 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 mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of 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 clays 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.

If a soil is assigned to two hydrologic groups in table 18, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

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 (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the

freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); and Specific gravity—T 100 (AASHTO), D 854 (ASTM).

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