APPENDIX D-7

SOILS

REYNOLDS RANCH AMENDMENT AREA
CONVERSE COUNTY WYOMING

1.0 General

The impact to the topsoil resource at the Reynolds Ranch amendment area is relatively minor when compared to typical surface mining operations as the in-situ mining process results in very limited topsoil disturbance. Accordingly, most of the required topsoil salvage is restricted to major roads and building sites. Topsoil is not regularly salvaged and stockpiled from wellfield sites as disturbance is minimal and the wellfield sites are revegetated shortly after wellfield construction is complete.

2.0 Soil Baseline Studies

Baseline soil studies performed for the amendment area include an Order 3 soil survey conducted by the U.S. Soil Conservation Service (SCS) in 1982 and an Order 1-2 soil assessment conducted by BKS Environmental Associates, Inc. in 1997 for Rio Algom Mining Corporation.

The soil survey conducted by the SCS included all of Converse County, including the Reynolds Ranch amendment area. Applicable portions of this survey are contained in Addendum D7-1 and includes detailed SCS map unit descriptions, typical SCS soil profile descriptions of each series, engineering index properties, and physical and chemical properties. Plate D7-1 shows the delineation of the SCS soil unit boundaries for the Reynolds Ranch amendment area.

The 1997 soil assessment is contained in Addendum D7-2. This assessment was a higher intensity Order 1-2 survey and includes mechanical and chemical analysis of several sampling locations throughout the amendment area, additional soil unit descriptions, and reclamation suitability analysis. An area soils map was also developed during this survey utilizing previous mapping and soil unit information and information gained during the 1997 survey. However, PRI has been unable to locate and obtain a copy of this map. Therefore, mapping of soil unit boundaries developed previously by the SCS will be utilized for mapping of baseline soil unit boundaries at the Reynolds Ranch amendment area.

ADDENDUM D7-1

SOIL SURVEY OF CONVERSE COUNTY, WYOMING,
NORTHERN PART .

U.S. SOIL CONSERVATION SERVICE

Detailed Soil Map Units

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

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have characteristic variability of all natural phenomena. 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 other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties 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, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavior divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the landscape was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes 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 if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit 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 layers, 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 layers. They also can differ in 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, Shingle loam, thin solum, is one of several phases in the Shingle series.

Most map units are made up of two or more major soils or miscellaneous areas. These map units are complexes or associations.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Ulm-Renohill complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or

miscellaneous areas are somewhat similar. Zigweid-ambria association, 0 to 6 percent slopes, is an example.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 3 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 or miscellaneous areas.

Map Unit Descriptions

101—Absted-Arvada-Bone complex, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on toe slopes, alluvial flats, and stream terraces. Slopes are medium in length and are plane. The native vegetation is mainly salt tolerant grasses, shrubs, and woody plants.

This unit is 40 percent Absted fine sandy loam, 25 percent Arvada loam, and 20 percent Bone clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam, Lohmiller clay loam, Haverdad fine sandy loam, and Bahl clay. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Absted soil is deep and well drained. It formed in clayey alluvium derived dominantly from sedimentary rock. Typically, the surface layer is pale brown fine sandy loam about 3 inches thick. The upper 23 inches of the subsoil is brown and grayish brown clay, and the lower 34 inches or more is light brownish gray clay. In a few areas soft bedrock is at a depth of 20 to 60 inches.

Permeability of the Absted soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. Excess sodium or soluble salts are at an average depth of 15 inches.

The Arvada soil is deep and well drained. It formed in clayey alluvium derived dominantly from sedimentary rock. Typically, the surface layer is light brownish gray loam about 3 inches thick. The subsoil is pale brown and light brownish gray clay about 19 inches thick. The substratum to a depth of 60 inches or more is pale brown clay.

Permeability of the Arvada soil is very slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. Excess sodium or soluble salts are in the upper part of the subsoil.

The Bone soil is deep and well drained. It formed in clayey alluvium derived dominantly from sedimentary rock. Typically, the surface layer is pale brown clay loam about 2 inches thick. The upper 3 inches of the subsoil is light brownish gray clay loam, and the lower 5 inches is light gray clay loam. The substratum to a depth of 60 inches or more is very pale brown clay loam and clay.

Permeability of the Bone soil is very slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. Excess sodium or soluble salts occur throughout the profile.

Most areas of this unit are used for livestock grazing and wildlife habitat. A few areas are used for hay production.

The potential plant community on this unit is mainly inland saltgrass, western wheatgrass, Indian ricegrass, and Gardner saltbush. The Bone soil commonly does not support any significant amount of vegetation. As the range condition deteriorates, greasewood increases. As the range condition further deteriorates, annuals invade. The potential plant community produces about 500 pounds of air-dry vegetation in normal years. Production varies from 650 pounds in favorable years to 250 pounds in unfavorable years.

Some areas of this unit east of Wyoming Highway 59, immediately adjacent to the Cheyenne River, support different species and significantly higher levels of plant production than is typical for this unit. Alkali sacaton and western wheatgrass dominate these areas, and yields may range from 1,200 to 2,000 pounds of air-dry vegetation per year. These sites are on the lower parts of stream terraces and receive runoff from river tributaries.

The production of forage in most areas is limited by salinity or alkalinity and low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

Range seeding is suitable if the range is in poor condition. The main limitations are salinity or alkalinity and lack of suitable adapted species for use in reclamation. The areas of this unit on the lower parts of stream terraces have fair suitability for seeding. These areas also can be improved by mechanical or chemical treatment if heavily infested with undesirable plants.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slow and very slow permeability, and slow runoff. Backfilling excavations with coarser textured material reduces the shrink-swell potential. Constructing a larger absorption

field or using selected material will help compensate for the slow and very slow permeability.

This map unit is in capability subclass VIs. Most of the unit is in the Saline Upland, 10- to 14-inch ppt., Northern Plains range site. The areas on the lower parts of stream terraces adjacent to the Cheyenne River are in Saline Lowland, 10- to 14-inch ppt., Northern Plains range site.

102—Aeric Haplaquepts, 0 to 3 percent slopes. These deep, poorly drained soils are in areas of centripetal drainage in playas. The soils formed in clayey local alluvium derived dominantly from sedimentary rock. Slopes are concave and are short or medium in length. Areas are generally oval in shape and are 1 to 100 acres in size. The native vegetation is mainly grasses.

Included in this unit are small areas of Silhouette clay loam, Savageton clay loam, and Bahl clay. Also included are small intermittent ponds. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

No single profile of Aeric Haplaquepts is typical, but one commonly observed in the survey area has a surface layer of light gray and light brownish gray clay loam about 8 inches thick. The underlying material to a depth of 48 inches or more is light gray and pale brown clay with yellow and yellowish red mottles. In some of the smaller areas of these soils, soft sedimentary bedrock is at a depth of 20 to 60 inches.

Permeability of the Aeric Haplaquepts is very slow. Available water capacity is high. Effective rooting depth is 60 inches for water-tolerant plants but is limited to depths between 0 and 12 inches for non-water-tolerant plants. Runoff is very slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight. A seasonal high water table fluctuates between depths of 0 and 24 inches from March through July. Some areas of this unit are covered by water from snowmelt, intense rain showers, and runoff from adjacent areas.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly basin wildrye, green needlegrass, western wheatgrass, and Canada wildrye. As the range condition deteriorates, needleleaf sedge and Sandberg bluegrass increase. As the range condition further deteriorates, annual forbs invade. The potential plant community produces about 2,300 pounds of air-dry vegetation in normal years. Production varies from 2,800 pounds in favorable years to 1,900 pounds in unfavorable years. The types of vegetation in the larger playas also include those of wetland and subirrigated range sites in the lower positions and no vegetation in the lowest positions because of intermittent ponding.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds. Larger areas of this unit are used temporarily by migratory shore birds.

This unit is not suited to homesite development because of ponding.

This map unit is in capability subclass VIw. °Most of this unit is in the Clayey Overflow, 10- to 14-inch ppt., Northern Plains range site.

103—Bahl-Savageton complex, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on toe slopes and alluvial flats. Slopes are medium in length and are plane to slightly concave. The native vegetation is mainly grasses.

This unit is 40 percent Bahl clay and 35 percent Savageton clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam and Zigweid clay loam. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Bahl soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcare shale. Typically, the surface layer is pale olive clay at 4 inches thick. The underlying material to a depth of 60 inches or more is pale olive clay.

Permeability of the Bahl soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Savageton soil is moderately deep and well drained. It formed in clayey local alluvium and residuum derived dominantly from calcareous shale. Typically, the surface layer is gray clay loam about 2 inches thick. The subsoil is light brownish gray and grayish brown clay about 30 inches thick. Platy shale is at a depth of 32 inches.

Permeability of the Savageton soil is very slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cactus and broom

snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slow and very slow permeability, and the depth of the the Savageton soil to soft bedrock. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Constructing a larger absorption field or using selected material helps to overcome the slow permeability of the Bahl soil. Areas of the Savageton soil are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass IVe. It is in the Clayey, 10- to 14-inch ppt., Northern Plains range site.

104—Cambria-Cushman complex, 0 to 6 percent slopes. This map unit is on toe slopes and ridge crests of rolling uplands. Slopes are medium in length and are slightly convex to plane. The native vegetation is mainly grasses and shrubs.

This unit is 60 percent Cambria fine sandy loam and 30 percent Cushman loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam and Renohill sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from sedimentary rock. Typically, the surface layer is grayish brown fine sandy loam about 2 inches thick. The upper 8 inches of the subsoil is brown sandy clay loam, and the lower part to a depth of 60 inches or more is pale brown loam. In some areas soft bedrock is at a depth of 40 to 60 inches.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is brown loam about 4 inches thick. The upper 11 inches of the subsoil is yellowish brown and light yellowish brown clay loam, and the lower 18 inches is pale brown clay loam and very pale brown sandy clay loam. Interbedded shale and sandstone are at a depth of 33 inches.

Permeability of the Cushman soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are moderate shrink-swell potential and the depth of the Cushman soil to soft bedrock. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Areas of the Cushman soil are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

105—Cambria-Cushman complex, 6 to 15 percent slopes. This map unit is on back slopes of rolling uplands and on adjacent foot slopes. Slopes are short and are mostly convex. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Cambria sandy loam and 30 percent Cushman loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Renohill clay loam and Worf fine sandy loam. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from sedimentary rock. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 4 inches of the subsoil is yellowish brown loam, and the lower part to a depth of 60 inches or more is pale brown loam. In some areas soft bedrock is between depths of 40 and 60 inches.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is pale brown loam about 3 inches thick. The upper 14 inches of the subsoil is pale brown and light gray clay loam, and the lower 8 inches is pale yellow loam. Interbedded shale and sandstone are at a depth of 25 inches.

Permeability of the Cushman soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are moderate shrink-swell potential, slope, and the depth of the Cushman soil to soft bedrock. Backfilling with coarser textured material reduces the limitation of shrink-swell potential. Areas of the Cushman soil are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

106—Cambria Variant-Forkwood Variant complex, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on toe slopes and alluvial flats. Slopes are long and plane. The native vegetation is mainly grasses and shrubs.

This unit is 45 percent Cambria Variant fine sandy loam and 35 percent Forkwood Variant clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Hiland sandy loam and Ulm loam. Also included are small areas of soils that have a stratified substratum. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Cambria Variant soil is deep and well drained. It formed in loamy alluvium derived dominantly from interbedded sandstone and shale. Typically, the surface layer is light gray fine sandy loam about 2 inches thick. The upper 14 inches of the subsoil is light brownish gray clay loam and loam, and the lower 32 inches is light brownish gray stratified loam, clay loam, and sandy clay loam to a depth of 60 inches or more.

Permeability of the Cambria Variant soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Forkwood Variant soil is deep and well drained. It formed in loamy alluvium derived dominantly from interbedded sandstone and shale. Typically, the surface layer is light gray clay loam about 3 inches thick. The upper 13 inches of the subsoil is pale brown clay loam, and the lower part to a depth of 60 inches or more is light gray stratified loam, clay loam, and fine sandy loam.

Permeability of the Forkwood Variant soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitation is moderate shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome this limitation.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. There are inclusions of Clayey Overflow, 10- to 14-inch ppt., Northern Plains range site in areas where runoff water collects.

107—Clarkelen-Draknab complex, 0 to 3 percent slopes. This map unit is on flood plains. Slopes are long and plane. The native vegetation is mainly grasses and woody plants.

This unit is 50 percent Clarkelen sandy loam and 35 percent Draknab loamy sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Keeline sandy loam, Haverdad fine sandy loam, and Bigwin fine sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Clarkelen soil is deep and somewhat excessively drained. It formed in loamy recently deposited alluvium derived dominantly from sedimentary rock. Typically, the surface layer is pale brown and grayish brown sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is highly stratified light brownish gray sand, sandy loam, sandy clay loam, and silt loam.

Permeability of the Clarkelen soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition occur along streambanks.

The Draknab soil is deep and excessively drained. It formed in sandy recently deposited alluvium derived dominantly from sandstone. Typically, the surface layer is yellowish brown loamy sand about 2 inches thick. The underlying material to a depth of 60 inches or more is pale brown and very pale brown, stratified sand, coarse sand, loamy sand, and loamy coarse sand.

Permeability of the Draknab soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition occur along streambanks.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, slender wheatgrass, needleandthread, and cottonwood trees. As the range condition deteriorates, silver sagebrush, rubber rabbitbrush, and snowberry increase. As the range condition further deteriorates, annual forbs and cheatgrass invade. The potential plant community produces about 2,500 pounds of air-dry vegetation in normal years. Production varies from 3,000 pounds in favorable years to 2,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation and the hazard of flooding. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds. Cottonwood trees commonly provide important riparian habitat for birds and small mammals.

This unit is poorly suited to homesite development. The main limitations are the hazard of excavations caving in and the hazard of flooding. Constructing dikes reduces the risk of flooding. Use of septic tank

absorption fields could create a hazard of polluting ground water.

This map unit is in capability subclass IVe. It is in the Lowland, 10- to 14-inch ppt., Northern Plains range site.

108—Clarkelen-Dwyer-Orpha association, 0 to 10 percent slopes. This map unit is in gently sloping areas on flood plains and in undulating to gently rolling areas on dunes that are superimposed on stream terraces. The Clarkelen soil is on flood plains, and the Dwyer and Orpha soils are on terrace dunes. Slopes are medium in length and are plane, or they are short and convex. The native vegetation is mainly grasses and woody plants.

This unit is 40 percent Clarkelen sandy loam, 25 percent Dwyer loamy sand, and 20 percent Orpha loamy sand.

Included in this unit are small areas of Haverdad fine sandy loam, Draknab loamy sand, Keeline sandy loam, and Kishona loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Clarkelen soil is deep and somewhat excessively drained. It formed in loamy recently deposited alluvium derived dominantly from sedimentary rock. Typically, the surface layer is pale brown and grayish brown sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is highly stratified, light brownish gray sand, sandy loam, sandy clay loam, and silt loam that contain carbonates.

Permeability of the Clarkelen soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is severe. The hazard of wind erosion is moderate. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

The Dwyer soil is deep and excessively drained. It formed in eolian sand derived from mixed sources. Typically, the surface layer is brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is pale brown loamy sand that contains carbonates within a depth of 40 inches.

Permeability of the Dwyer soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Orpha soil is deep and excessively drained. It formed in eolian sand derived from mixed sources. Typically, the surface layer is pale brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy sand.

Permeability of the Orpha soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Clarkelen soil is mainly needleandthread, slender wheatgrass, western wheatgrass, and cottonwood trees. As the range condition deteriorates, silver sagebrush, rubber rabbitbrush, and snowberry increase. As the range condition further deteriorates, annual forbs and cheatgrass invade. The potential plant community produces about 2,500 pounds of air-dry vegetation in normal years. Production varies from 3,000 pounds in favorable years to 2,000 pounds in unfavorable years.

The production of forage on the Clarkelen soil is limited by low annual precipitation and the hazard of flooding. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community. The suitability of this soil for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. This soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Dwyer and Orpha soils is mainly prairie sandreed, sand bluestem, needleandthread, and Indian ricegrass. As the range condition deteriorates, sageworts increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 2,000 pounds of air-dry vegetation in normal years. Production varies from 2,500 pounds in favorable years to 1,400 pounds in unfavorable years.

The production of forage on the Dwyer and Orpha soils is limited by droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community. The suitability of these soils for rangeland seeding is poor. The main limitations are the hazard of wind erosion and droughtiness. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. These soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds. Cottonwood trees commonly provide important riparian habitat for birds and small mammals.

The Clarkelen soil is poorly suited to homesite development. The main limitation is the hazard of flooding. Use of septic tank absorption fields could

create a hazard of polluting ground water. If the Dwyer and Orpha soils are used for homesite development, the main limitations are slope, the hazard of excavations caving in, and sand blowing.

The Clarkelen soil is in capability subclass IVe. The Dwyer and Orpha soils are in capability subclass VIe. The Clarkelen soil is in the Lowland, 10- to 14-inch ppt., Northern Plains range site. The Dwyer and Orpha soils are in the Sands, 10- to 14-inch ppt., Northern Plains range site.

109—Clarkelen-Haverdad-Bigwinder complex, 0 to 3 percent slopes. This map unit is on flood plains and low terraces of major streams. Slopes are medium in length and are plane. The native vegetation is mainly grasses, sedges, and woody plants.

This unit is 35 percent Clarkelen sandy loam, 25 percent Haverdad fine sandy loam, and 25 percent Bigwinder fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Draknab loamy sand, Keeline sandy loam, and Dwyer loamy sand. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Clarkelen soil is deep and somewhat excessively drained. It formed in loamy recently deposited alluvium derived dominantly from sedimentary rock. Typically, the surface layer is pale brown and grayish brown sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is highly stratified, light brownish gray sand, sandy loam, sandy clay loam, and silt loam.

Permeability of the Clarkelen soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

The Haverdad soil is deep and well drained. It formed in loamy recently deposited alluvium derived dominantly from sedimentary rock. Typically, the surface layer is grayish brown fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray loam with lenses of clay loam and fine sandy loam.

Permeability of the Haverdad soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition occur along streambanks.

The Bigwinder soil is deep and poorly drained. It formed in loamy alluvium derived dominantly from sedimentary rock. Typically, the surface layer is light brownish gray fine sandy loam about 3 inches thick. It has strong brown mottles. The upper 21 inches of the underlying material is stratified, light gray loam, sandy loam, and loamy sand, and the lower part to a depth of 60 inches or more is stratified, light gray and reddish yellow loamy sand and sand.

Permeability of the Bigwinder soil is moderate to moderately rapid to a depth of 24 inches and is rapid below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate. This soil is subject to flooding during prolonged, high-intensity storms. Channeling and deposition occur along streambanks.

This unit is used mainly for livestock grazing and wildlife habitat. It is also used as hayland.

The potential plant community on the Clarkelen and Haverdad soils is mainly needleandthread, slender wheatgrass, green needlegrass, and cottonwood trees (fig. 2). As the range condition deteriorates, silver sagebrush, rubber rabbitbrush, and snowberry increase. As the range condition further deteriorates, annual forbs and cheatgrass invade. The potential plant community produces about 2,500 pounds of air-dry vegetation in normal years. Production varies from 3,000 pounds in favorable years to 2,000 pounds in unfavorable years.

The production of forage on these soils is limited by low annual precipitation and the hazard of flooding. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase.

The potential plant community on the Bigwinder soil is mainly Nebraska sedge, basin wildrye, slender wheatgrass, and willows. As the range condition deteriorates, western wheatgrass, mat muhly, and spike sedge increase. As the range condition further deteriorates, annual forbs invade. The potential plant community produces about 4,000 pounds of air-dry vegetation in normal years. Production varies from 4,500 pounds in favorable years to 3,500 pounds in unfavorable years.

The production of forage on this soil is limited by wetness and the hazard of flooding. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

Figure 2.—Area of Clarkelen-Haverdad-Bigwinder complex, 0 to 3 percent slope, along Box Creek. This area supports scattered cottonwood trees.

The suitability of this soil for rangeland seeding is good. The main limitations are wetness and the hazard of flooding.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds. Cottonwood trees commonly provide important riparian habitat for birds and small mammals.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and wetness. Construction of dikes reduces the risk of flooding. Use of septic tank absorption fields could create a hazard of polluting ground water.

This map unit is in capability subclass IVe. The Clarkelen and Haverdad soils are in the Lowland, 10- to 14-inch ppt., Northern Plains range site. The Bigwinder soil is in the Subirrigated, 10- to 14-inch ppt., Northern Plains range site.

110—Cushman-Terro complex, 0 to 6 percent slopes. This map unit is on pediment slopes of nearly level to undulating dissected uplands. Slopes are medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 45 percent Cushman loam and 40 percent Terro sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shingle clay loam in the more highly dissected areas. Also included are small areas of Hiland sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is brown loam about 4 inches thick. The upper 11 inches of the subsoil is yellowish brown and light yellowish brown clay loam, and the lower 18 inches

is pale brown clay loam and very pale brown loam. ...added sandstone and shale are at a depth of 33 ...

Permeability of the Cushman soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 19 inches of the subsoil is brown and pale brown sandy loam, and the lower 11 inches is light gray sandy loam. Soft sandstone is at a depth of 34 inches. In some areas soft bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Cushman soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom ...eweed invade. The potential plant community ...ices about 1,500 pounds of air-dry vegetation in ...rmal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The potential plant community on the Terro soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. The main limitation is the hazard of wind erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are depth to soft bedrock and shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome the problem of shrink-swell potential. It may be necessary to construct a mounded absorption field to compensate for the restricted depth to bedrock.

This map unit is in capability subclass IVe. The Cushman soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Terro soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site.

111—Cushman-Terro complex, 6 to 15 percent slopes. This map unit is on shoulder slopes and back slopes of rolling uplands. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 55 percent Cushman loam and 30 percent Terro sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shingle clay loam and Worf fine sandy loam on shoulder slopes. Also included are small areas of Hiland sandy loam on back slopes. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is pale brown loam about 3 inches thick. The upper 14 inches of the subsoil is pale brown and light gray clay loam, and the lower 8 inches is pale yellow loam. Interbedded sandstone and shale are at a depth of 25 inches. In some areas soft bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Cushman soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Terro soil is somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 19 inches of the subsoil is brown and pale brown sandy loam, and the lower 11 inches is light gray sandy loam. Soft sandstone is at a depth of 34 inches. In some areas soft bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water

erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Cushman soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The potential plant community on the Terro soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitations are the hazards of wind and water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are depth to soft bedrock, slope, and the moderate shrink-swell potential of the Cushman soil, which can be overcome by backfilling with coarser textured material. It may be necessary to construct a mounded absorption field to compensate for the limited depth to bedrock.

This map unit is in capability subclass VIe. The Cushman soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Terro soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site.

112—Cushman-Worf association, 6 to 15 percent slopes. This map unit is on ridges, shoulder slopes, and back slopes of rolling uplands. Slopes are convex and are medium in length. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Cushman loam, 6 to 10 percent slopes, and 35 percent Worf fine sandy loam, 10 to 15 percent slopes. The Cushman soil is on back slopes, and the Worf soil is on ridges and shoulder slopes.

Included in this unit are small areas of Worfka fine sandy loam and Shingle loam intermingled with areas of the Worf soil. Also included are small areas of Forkwood sandy loam on concave slopes bordering areas of the Cushman soil. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from interbedded sandstone and shale. Typically, the surface layer is pale brown loam about 3 inches thick. The upper 14 inches of the subsoil is pale brown and light gray clay loam, and the lower 8 inches is pale yellow loam. Interbedded shale and sandstone are at a depth of 25 inches.

Permeability of the Cushman soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium to rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Worf soil is shallow and well drained. It formed in residuum derived dominantly from calcareous shale. Typically, the surface layer is grayish brown fine sandy loam about 2 inches thick. The subsoil is brown and light yellowish brown sandy clay loam about 16 inches thick. Soft, calcareous shale is at a depth of 18 inches.

Permeability of the Worf soil is moderate. Available water capacity is low. Effective rooting depth is 8 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Cushman soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years. The production of forage is limited by low annual precipitation. The suitability of this soil for rangeland seeding is good.

The potential plant community on the Worf soil is mainly western wheatgrass, green needlegrass, and bluebunch wheatgrass. As the range condition deteriorates, birdfoot sagebrush and big sagebrush increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200

pounds in favorable years to 450 pounds in unfavorable
irs.

The production of forage on this unit is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are the limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are slope, depth to soft bedrock, and moderate shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome the limitation of moderate shrink-swell potential. Construction of a mounded absorption field may be needed to compensate for the depth to rock.

This map unit is in capability subclass VIe. The Cushman soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Worf soil is in the Shallow Clayey, 10- to 14-inch ppt., Northern Plains range site.

113—Dwyer-Orpha loamy sands, 3 to 15 percent slopes. This map unit is on undulating to rolling dunes superimposed on stream terraces and alluvial flats. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Dwyer loamy sand and 30 percent Orpha loamy sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Keeline sandy loam, Vonalee loamy sand, and Hiland sandy loam in swales and other depressional areas. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Dwyer soil is deep and excessively drained. It formed in sandy eolian material derived from mixed sources. Typically, the surface layer is brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is pale brown loamy sand. Carbonates are within 40 inches of the surface. In some areas buried loamy strata are at a depth of 40 inches or more. In a few areas calcareous sandstone is at a depth of 20 to 60 inches.

Permeability of the Dwyer soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Orpha soil is deep and excessively drained. It formed in sandy eolian material derived from mixed sources. Typically, the surface layer is grayish brown loamy sand about 6 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray sand. Carbonates are below a depth of 40 inches. In some areas buried loamy strata are at a depth of 40 inches or more.

Permeability of the Orpha soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly prairie sandreed, Indian ricegrass, needleandthread, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. If the vegetation further deteriorates, annuals and snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitations are the hazards of erosion by wind and water. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are the hazard of excavations caving in, slope, and sand blowing.

This map unit is in capability subclass VIIe. It is in the Sandy, 10- to 14-inch ppt., Northern Plains range site. In some of the steeper areas are inclusions of Sands, 10- to 14-inch ppt., Northern Plains range site.

114—Forkwood-Cambria fine sandy loams, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas of foot slopes and toe slopes of rolling

uplands. Slopes are long and plane. The native vegetation is mainly grasses and shrubs.

This unit is 55 percent Forkwood fine sandy loam and 30 percent Cambria fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam and Zigweid clay loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Forkwood soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown fine sandy loam about 7 inches thick. The upper 7 inches of the subsoil is pale brown clay loam, and the lower part to a depth of 60 inches or more is light brownish gray and light gray clay loam. In some areas bedrock is at a depth of 20 to 60 inches.

Permeability of the Forkwood soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from sedimentary rock. Typically, the surface layer is grayish brown fine sandy loam about 2 inches thick. The upper 8 inches of the subsoil is brown sandy clay loam, and the lower part to a depth of 60 inches or more is pale brown loam.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is well suited to homesite development. It has few limitations. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Septic tank absorption fields operate most effectively if placed deep in the subsoil.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

115—Forkwood-Cambria-Cushman complex, 6 to 15 percent slopes. This map unit is on ridge crests, back slopes, and foot slopes of rolling uplands. Slopes are short and are mostly convex. The native vegetation is mainly grasses and shrubs.

This unit is 30 percent Forkwood fine sandy loam, 30 percent Cambria sandy loam, and 30 percent Cushman loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam and Worf fine sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Forkwood soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown fine sandy loam about 5 inches thick. The upper 13 inches of the subsoil is light yellowish brown clay loam, and the lower part to a depth of 60 inches or more is pale yellow and light gray loam.

Permeability of the Forkwood soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from sedimentary rock. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 4 inches of the subsoil is yellowish brown loam, and the lower part to a depth of 60 inches or more is pale brown loam.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Cushman soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 3 inches thick. The upper 14 inches of the subsoil is pale brown and light gray clay loam, and the lower 8 inches is pale yellow loam over

interbedded shale and sandstone. Soft bedrock is at a depth of 25 inches.

Permeability of the Cushman soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are moderate shrink-swell potential and the depth of the Cushman soil to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of moderate shrink-swell potential. Septic tank absorption fields operate most effectively if placed deep in the subsoil of the Cambria and Forkwood soils; areas of the Cushman soil are not suitable for this use.

This map unit is in capability subclass VIe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

116—Forkwood-Ulm complex, 0 to 6 percent slopes. This map unit is on foot slopes and toe slopes. Slopes are plane and are medium to long. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Forkwood fine sandy loam and 40 percent Ulm loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bidman sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Forkwood soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown fine sandy loam about 7 inches thick. The upper 7 inches of the subsoil is pale brown clay loam, and the lower part to a depth of 60 inches or more is light brownish gray and light gray clay loam. In some areas the subsoil is sandy clay loam.

Permeability of the Forkwood soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

The Ulm soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is brown loam about 5 inches thick. The upper 16 inches of the subsoil is brown clay loam and clay, and the lower part to a depth of 60 inches or more is pale brown clay loam and light yellowish brown sandy clay loam.

Permeability of the Ulm soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are high shrink-swell potential and the slow permeability of the Ulm soil. Backfilling excavations with coarser textured material helps to overcome the

limitation of shrink-swell potential. Constructing a larger septic tank absorption field helps to compensate for the slow permeability of the Ulm soil. Absorption lines operate most effectively if they are placed deep in the subsoil.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

117—Forkwood-Ulm-Renohill complex, 6 to 15 percent slopes. This map unit is on foot slopes, back slopes, and ridges of rolling uplands. Slopes are short and are convex to plane. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Forkwood fine sandy loam, 30 percent Ulm clay loam, and 20 percent Renohill clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Cushman loam, Bidman sandy loam, and Worfka fine sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Forkwood soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown fine sandy loam about 7 inches thick. The upper 7 inches of the subsoil is pale brown clay loam, and the lower part to a depth of 60 inches or more is light brownish gray and light gray clay loam.

Permeability of the Forkwood soil is moderate. Available water capacity is high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. The hazard of wind erosion is moderate.

The Ulm soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower part to a depth of 60 inches or more is light gray clay loam.

Permeability of the Ulm soil is slow. Available water capacity is high to very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Renohill soil is moderately deep and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 5 inches thick. The subsoil is light brownish gray clay loam about 20 inches thick. Calcareous gritty shale is at a depth of 25 inches.

Permeability of the Renohill soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Forkwood s mainly western wheatgrass, thickspike wheatgrass, a needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The potential plant community on the Ulm and Renohill soils is mainly western wheatgrass, thickspike wheatgrass, and green needlegrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to im areas of deteriorated rangeland. Such practices incre water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slope, slow permeability of the Ulm and Renohill soils, and the depth of the Renohill soil to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Constructing a larger absorption field helps to compensate for the slow permeability of the Ulm and Renohill soils. Absorption fields are most effective if they are placed deep in the subsoil of the Forkwood soil; the Renohill soil is not suitable for use as absorption fields.

This map unit is in capability subclass VIe. The Forkwood soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Ulm and Renohill soils are in the Clayey, 10- to 14-inch ppt., Northern Plains range site.

118—Gateson Variant-Tassel Variant association, 10 to 45 percent slopes. This map unit is on upland

ridges, shoulder slopes, and back slopes on the northern end of Pine Ridge. Slopes are convex and are medium in length. The native vegetation in the steeper areas is mainly conifers with an understory of grasses, and in the less sloping areas it is mainly grasses with scattered conifers. Sandstone and ironstone channery fragments and flagstones cover as much as 50 percent of the surface in some areas.

This unit is 45 percent Gateson Variant loamy sand and 35 percent Tassel Variant very fine sandy loam. The Gateson Variant soil is on steep back slopes, and the Tassel Variant soil is on ridges.

Included in this unit are small areas of Worf fine sandy loam, Tullock loamy sand, and Terro loamy fine sand. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Gateson Variant soil is shallow and well drained. It formed in loamy residuum derived dominantly from noncalcareous sandstone. Typically, the surface is covered with a mat of pine needles and other forest litter about 2 inches thick. The surface layer is pinkish gray loamy sand about 4 inches thick. The subsoil is reddish yellow sandy clay loam about 7 inches thick. The substratum is pinkish gray clay about 5 inches thick over soft, noncalcareous, interbedded sandstone and shale. Soft bedrock is at a depth of 15 to 24 inches.

Permeability of the Gateson Variant soil is moderate. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Tassel Variant soil is very shallow and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is light yellowish brown very fine sandy loam about 4 inches thick. The underlying material to a depth of 9 inches is gray loam. Soft, calcareous sandstone is at a depth of 9 inches.

Permeability of the Tassel Variant soil is moderate. Available water capacity is very low. Effective rooting depth is 5 to 10 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

Most areas of this unit are used for livestock grazing and wildlife habitat. A few areas are used as a source of wood products.

The Gateson Variant soil is poorly suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 35 to 50. This soil can produce 12 cords per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The main concerns in producing and harvesting timber are shallow soil depth, slow regeneration of trees, the hazard of erosion, and difficulty of harvesting on the steeper slopes. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. The very low available water capacity generally influences seedling survival in areas where understory plants are numerous. Conventional methods of harvesting timber are difficult to use because of slope.

The potential understory plant community on the Gateson Variant soil is mainly Idaho fescue and yarrow. The woodland understory produces about 650 pounds of air-dry vegetation in normal years. Production varies from 800 pounds in favorable years to 400 pounds in unfavorable years.

The potential plant community on the Tassel Variant soil is mainly needleandthread, prairie sandreed, little bluestem, and bluebunch wheatgrass. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,600 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on this soil is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Tassel Variant soil for rangeland seeding is poor. The main limitations are limited rooting depth and the hazards of erosion by wind and water. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are slope, shrink-swell potential, and depth to soft bedrock. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Absorption fields should be constructed of selected material.

This map unit is in capability subclass VIIe. The Gateson Variant soil is not placed in a range site. The Tassel Variant soil is in the Shallow Sandy, 15- to 17-inch ppt., Northern Plains range site.

119—Gullied land. This map unit is in rolling to steep areas where gullies have downcut into friable soil material. The remaining soil material is shallow to deep and is well drained. It was derived from sedimentary residuum and local alluvium. Slopes are short and convex. This unit is essentially barren.

Typically, the original surface layer and subsoil have been lost through erosion. The remaining soil material is

10 to 60 inches thick or more over bedrock. Texture ranges from sandy loam to clay loam.

Included in this unit are small areas of Shingle clay loam, Theedle loam, Samday clay loam, and Savageton clay loam. Also included are small areas of exposed sandstone and shale. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of the soil material in this unit is slow to moderate. Available water capacity is low to moderate. Effective rooting depth is 10 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used mainly for wildlife habitat. The included areas are also used for livestock grazing.

The vegetation on the included areas in this unit provides some food for antelope, deer, small mammals, and birds.

This map unit is in capability subclass VIIe. It is not placed in a range site.

120—Haverdad-Lohmiller complex, 0 to 6 percent slopes. This map unit is on flood plains. Slopes are short and plane. The native vegetation is mainly grasses, woody shrubs, and scattered cottonwood trees. This unit is subject to flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

This unit is 50 percent Haverdad fine sandy loam and 30 percent Lohmiller clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Draknab loamy sand on flood plains and small areas of Kishona loam and Bahl clay on alluvial flat remnants. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Haverdad soil is deep and well drained. It formed in loamy recently deposited alluvium derived dominantly from sedimentary rock. Typically, the surface layer is grayish brown fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray loam with lenses of clay loam and fine sandy loam.

Permeability of the Haverdad soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate. A slight accumulation of soluble salts is in the surface layer and the upper part of the subsoil in some areas.

The Lohmiller soil is deep and well drained. It formed in stratified, clayey, recently deposited alluvium derived dominantly from shale. Typically, the surface layer is grayish brown clay loam about 3 inches thick. The next layer is brown clay 13 inches thick. Below this to a depth of 60 inches or more is stratified, light yellowish brown and brown sandy clay loam, sandy loam, and sandy clay.

Permeability of the Lohmiller soil is slow to moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly green needlegrass, slender wheatgrass, needleandthread, and cottonwood trees. As the range condition deteriorates, woody plants such as snowberry, silver sagebrush, and rubber rabbitbrush increase. As the range condition further deteriorates, annual forbs and cheatgrass invade. The potential plant community produces about 2,500 pounds of air-dry vegetation in normal years. Production varies from 3,000 pounds in favorable years to 2,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation and the hazard of flooding. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds. Cottonwood trees commonly provide important riparian habitat for birds and small mammals.

This unit is poorly suited to homesite development. The main limitations are the hazard of flooding and shrink-swell potential. Construction of dikes reduces the risk of flooding. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential.

This map unit is in capability subclass IVw. It is in the Lowland, 10- to 14-inch ppt., Northern Plains range site. In some areas are inclusions of Clayey Overflow, 10- to 14-inch ppt., Northern Plains range site.

121—Hiland-Bowbac sandy loams, 0 to 6 percent slopes. This map unit is on foot slopes and pediment slopes. Slopes are convex and are medium in length. The native vegetation is mainly grasses and shrubs.

This unit is 70 percent Hiland sandy loam and 20 percent Bowbac sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ulm loam, Vonalee loamy sand, and Terro sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Hiland soil is deep and well drained. It formed in loamy residuum, local alluvium, and eolian material derived dominantly from calcareous sandstone. Typically, the surface layer is pale brown sandy loam about 5 inches thick. The upper 25 inches of the subsoil is pale brown and light yellowish brown sandy clay loam, and the lower part to a depth of 60 inches or more is very pale brown sandy loam. In some areas the subsoil is loam or light clay loam.

Permeability of the Hiland soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

The Bowbac soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 3 inches thick. The upper 15 inches of the subsoil is brown sandy clay loam, and the lower 18 inches is brown and light yellowish brown sandy loam. Soft, calcareous sandstone is at a depth of 36 inches. In some areas the subsoil is loam or light clay loam.

Permeability of the Bowbac soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

Most areas of this unit are used for livestock grazing and wildlife habitat. A few areas where water is available from small reservoirs are used for irrigated alfalfa.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. Alfalfa yields average about 2.0 to 2.5 tons per acre with a moderate level of management.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitation is depth to soft bedrock in the Bowbac soil. Areas of Hiland soil should be selected for absorption fields.

This map unit is in capability subclass IVe, irrigated and nonirrigated. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

122—Hiland-Bowbac complex, 6 to 15 percent slopes. This map unit is on ridges and back slopes of rolling uplands. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 60 percent Hiland sandy clay loam and 30 percent Bowbac sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Vonalee loamy sand, Renohill clay loam, Terro sandy loam, and Worf fine sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Hiland soil is deep and well drained. It formed in loamy residuum and eolian material derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy clay loam about 3 inches thick. The upper 21 inches of the subsoil is brown sandy loam and sandy clay loam, and the lower part to a depth of 60 inches or more is grayish brown and light brownish gray sandy loam and sandy clay loam. In some areas the subsoil is loam or light clay loam.

Permeability of the Hiland soil is moderate to moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Bowbac soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 11 inches of the subsoil is brown and dark yellowish brown sandy clay loam, and the lower 13 inches is light yellowish brown fine sandy loam. Soft calcareous sandstone is at a depth of 28 inches. In some areas the subsoil is loam or light clay loam.

Permeability of the Bowbac soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and

needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are slope and the depth of the Bowbac soil to soft bedrock. Areas of the Bowbac soil are not suitable for absorption fields.

This map unit is in capability subclass VIe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

123—Keeline-Tassel-Turnback complex, 6 to 15 percent slopes. This map unit is on rolling uplands. Slopes are short to medium in length and are mostly convex. The native vegetation is mainly grasses.

This unit is 35 percent Keeline sandy loam, 25 percent Tassel loamy fine sand, and 20 percent Turnback loamy fine sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Tullock loamy sand, Orpha loamy sand, and Dwyer loamy sand on ridge crests and on lee slopes where windblown sand collects. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Keeline soil is deep and somewhat excessively drained. It formed in loamy, wind-worked residuum derived dominantly from calcareous sandstone. Typically, the surface layer is yellowish brown sandy loam about 3 inches thick. The subsoil is pale brown sandy loam about 5 inches thick. The underlying material to a depth of 60 inches or more is very pale brown sandy loam.

Permeability of the Keeline soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

The Tassel soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is light brownish gray loamy fine sand 2 inches thick. The underlying material to a depth of 16 inches is pale brown fine sandy loam. Soft sandstone is at a depth of 16 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Turnback soil is moderately deep and well drained. It formed in loamy, wind-worked residuum derived dominantly from calcareous sandstone. Typically, the surface layer is pale brown loamy fine sand about 4 inches thick. The subsoil is light yellowish brown and pale yellow sandy loam about 26 inches thick. Soft sandstone is at a depth of 30 inches.

Permeability of the Turnback soil is moderately rapid. Available water capacity is very low to low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Keeline and Turnback soils is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As range condition deteriorates, sageworts and needle sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is fair. The main limitation is the hazard of wind erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

These soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Tassel soil is mainly needleandthread, prairie sandreed, Indian

ricegrass, and little bluestem. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,000 pounds of air-dry vegetation in normal years. Production varies from 1,400 pounds in favorable years to 600 pounds in unfavorable years.

The production of forage on this soil is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this soil for rangeland seeding is poor. The main limitations are limited rooting depth and the hazards of wind and water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If the Keeline soil is used for homesite development, the main limitation is slope. The Tassel and Turnback soils are limited by depth to soft bedrock. They are not suitable for absorption fields.

This map unit is in capability subclass VIe. The Keeline and Turnback soils are in the Sandy, 10- to 14-inch ppt., Northern Plains range site. The Tassel soil is in the Shallow Sandy, 10- to 14-inch ppt., Northern Plains range site.

124—Kishona-Dwyer-Orpha association, 0 to 10 percent slopes. This map unit is on nearly level to undulating alluvial flats and gently rolling dunes superimposed on stream terraces. Slopes are long and plane or short and convex. The Kishona soils are on alluvial flats, and the Dwyer and Orpha soils are on terrace dunes. The native vegetation is mainly grasses.

This unit is 35 percent Kishona loam, 25 percent Dwyer loamy sand, and 15 percent Orpha loamy sand.

Included in this unit are small areas of Draknab loamy sand and Haverdad fine sandy loam on flood plains and Bahl clay on alluvial flats. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Kishona soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is brown loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and light gray clay loam. Carbonates are disseminated throughout the soil.

Permeability of the Kishona soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Dwyer soil is deep and excessively drained. It formed in eolian sand derived dominantly from mixed sources. Typically, the surface layer is brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is pale brown loamy sand. Carbonates are at a depth of less than 40 inches.

Permeability of the Dwyer soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Orpha soil is deep and excessively drained. It formed in eolian sand derived from mixed sources. Typically, the surface layer is pale brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy sand. Depth to carbonates is less than 40 inches.

Permeability of the Orpha soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Kishona soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on the Kishona soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this soil for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The potential plant community on the Dwyer and Orpha soils is mainly prairie sandreed, sand bluestem, needleandthread, and Indian ricegrass. As the range condition deteriorates, sageworts increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 2,000 pounds of air-dry vegetation in

normal years. Production varies from 2,500 pounds in favorable years to 1,400 pounds in unfavorable years.

The production of forage is limited by droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is poor. The main limitations are the hazard of wind erosion and droughtiness. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

These soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If the Kishona soil is used for homesite development, the main limitation is moderate shrink-swell potential. If the Dwyer and Orpha soils are used for homesite development, the main limitations are the hazard of cutbanks caving in, sand blowing, and slope. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential in the Kishona soil.

The Kishona soil is in capability subclass IVe, and the Dwyer and Orpha soils are in capability subclass VIe. The Kishona soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Dwyer and Orpha soils are in the Sands, 10- to 14-inch ppt., Northern Plains range site.

125—Orella-Rock outcrop-Samday complex, 3 to 30 percent slopes. This map unit is on ridgetops, shoulders, and back slopes of undulating to steep uplands. Slopes are medium in length and are convex. The native vegetation is mainly grasses and forbs.

This unit is 35 percent Orella clay loam, 25 percent Rock outcrop, and 25 percent Samday clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shingle clay loam, Tassel sandy loam, and Theedle loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Orella soil is shallow and well drained. It formed in clayey residuum derived dominantly from sodic shale. The surface layer is light gray clay loam about 4 inches thick. The underlying material to a depth of 20 inches is light gray and light brownish gray clay. Fragmented shale is at a depth of 20 inches.

Permeability of the Orella soil is very slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

Rock outcrop is exposures of multicolored, calcareo and noncalcareous, soft and moderately hard shale a siltstone.

The Samday soil is shallow and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay. Soft shale is at a depth of 18 inches.

Permeability of the Samday soil is slow. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, green needlegrass, and bluebunch wheatgrass. As the range condition deteriorates, birdfoot sagebrush and big sagebrush increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so th the desired balance of preferred species is maintain the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slope, and depth to shale. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential.

This map unit is in capability subclass VIIe. The Orella and Samday soils are in the Shallow Clayey, 10- to 14-inch ppt., Northern Plains range site.

126—Pits, mine. This map unit consists of open pits and spoil material from small- and moderate-sized uranium operations. None of these areas are currently being mined, and reclamation plans have not been developed. These areas support little if any vegetation.

Open pits are vertical or very steep excavations into sedimentary rock consisting of rippable sandstone with some interbedded shale and coal seams. Physical and chemical properties of the pit wall and displaced spoil banks are highly variable. The spoil material is mixed, and it is extremely acid to moderately alkaline. The material commonly is sandy, but some layers are loamy and clayey.

Onsite investigation of individual areas is necessary to determine reclamation potential. Backfilling excavations and reshaping cut slopes reduce the risk of erosion. Backfilling with suitable topsoil aids revegetation.

127—Renohill-Worfka-Shingle complex, 0 to 6 percent slopes. This map unit is on upland summits and back slopes. Slopes are medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Renohill fine sandy loam, 30 percent Worfka fine sandy loam, and 20 percent Shingle clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Samday clay loam, Worf fine sandy loam, and Bidman sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Renohill soil is moderately deep and well drained. It formed in clayey residuum derived dominantly from soft shale. Typically, the surface layer is pale brown fine sandy loam about 5 inches thick. The upper 15 inches of the subsoil is brown clay, and the lower 16 inches is pale brown clay loam. Calcareous shale is at a depth of 36 inches. In some areas depth to soft bedrock ranges from 40 to 60 inches or more.

Permeability of the Renohill soil is slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Worfka soil is shallow and well drained. It formed in clayey residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is pale brown fine sandy loam about 6 inches thick. The upper 6 inches of the subsoil is light brownish gray clay, and the lower 6 inches is light yellowish brown clay loam. Soft interbedded shale and sandstone are at a depth of 18 inches.

Permeability of the Worfka soil is slow. Available water capacity is very low to low. Effective rooting depth is 7 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Available water capacity is low. Effective rooting depth is 4 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing, nonirrigated crops, and wildlife habitat.

The potential plant community on the Renohill soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and brown snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on the Renohill soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this soil for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The potential plant community on the Worfka and Shingle soils is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

A few small, nearly level areas of this unit have a higher percentage of Renohill soil than is typical; these areas are used for nonirrigated wheat. Yield averages about 15 to 20 bushels per acre every other year with a moderate level of management. Because precipitation is not sufficient for annual cropping, a cropping system that includes small grain and summer fallow is most suitable. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential and depth to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential.

This map unit is in capability subclass VIe. The Renohill soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Worfka and Shingle soils are in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

128—Renohill-Worfka-Shingle complex, 6 to 15 percent slopes. This map unit is on back slopes of rolling uplands. Slopes are short to medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Renohill clay loam, 30 percent Worfka fine sandy loam, and 20 percent Shingle clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Samday clay loam, Worf fine sandy loam, and Cushman loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Renohill soil is moderately deep and well drained. It formed in clayey residuum derived dominantly from soft shale. Typically, the surface layer is light brownish gray clay loam about 5 inches thick. The subsoil is light brownish gray clay loam 20 inches thick. Calcareous, gritty shale is at a depth of 25 inches. In some areas soft bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Renohill soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Worfka soil is shallow and well drained. It formed in clayey residuum derived dominantly from calcareous shale and sandstone. Typically, the surface layer is grayish brown fine sandy loam about 3 inches thick. The upper 5 inches of the subsoil is pale brown clay, and the lower 6 inches is light yellowish brown clay loam. Interbedded shale and sandstone are at a depth of 14 inches.

Permeability of the Worfka soil is slow. Available water capacity is very low. Effective rooting depth is 7 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Available water capacity is low. Effective rooting depth is 4 to 20 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Renohill soil is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage on the Renohill soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so th the desired balance of preferred species is maintain the plant community.

The suitability of this soil for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The potential plant community on the Worfka soil is mainly western wheatgrass, green needlegrass, and bluebunch wheatgrass. As the range condition deteriorates, birdfoot sagebrush and big sagebrush increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The potential plant community on the Shingle soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant

community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on the Worfka and Shingle soils is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slope, and depth to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential.

This map unit is in capability subclass VIIe. The Renohill soil is in the Clayey, 10- to 14-inch ppt., Northern Plains range site. The Worfka soil is in the Shallow Clayey, 10- to 14-inch ppt., Northern Plains range site. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

129—Samday-Shingle-Worf complex, 3 to 15 percent slopes. This map unit is on summits and ridges of undulating to rolling uplands. Slopes are short and convex. The native vegetation is mainly grasses and forbs.

This unit is 30 percent Samday clay loam, 25 percent Shingle clay loam, and 25 percent Worf fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Worfka fine sandy loam, Renohill clay loam, and Theedle loam. Also included are small areas of Rock outcrop. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Samday soil is shallow and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay. Soft shale is at a depth of 18 inches.

Permeability of the Samday soil is slow. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Available water capacity is low. Effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Worf soil is shallow and well drained. It formed in loamy residuum derived dominantly from interbedded shale and sandstone. Typically, the surface layer is grayish brown fine sandy loam about 2 inches thick. The subsoil is brown and light yellowish brown sandy clay loam about 16 inches thick. Soft shale is at a depth of 18 inches.

Permeability of the Worf soil is moderate. Available water capacity is low. Effective rooting depth is 8 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Samday and Worf soils is mainly western wheatgrass, green needlegrass, and bluebunch wheatgrass. As the range condition deteriorates, birdfoot sagebrush and big sagebrush increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The potential plant community on the Shingle soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on this unit is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily

infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slope, and depth to shale. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Absorption fields should be constructed using selected material.

This map unit is in capability subclass VIIe. The Samday and Worf soils are in the Shallow Clayey, 10- to 14-inch ppt., Northern Plains range site. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

130—Sear-Wibaux complex, 0 to 15 percent slopes. This map unit is in nearly level areas on the summit of buttes and in undulating to rolling areas on shale uplands. Slopes are short and are plane to convex. The native vegetation is mainly grasses and forbs.

This unit is 45 percent Sear loam and 35 percent Wibaux channery loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shingle loam, Samday clay loam, and Rock outcrop. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Sear soil is very shallow and well drained. It formed in channery loamy residuum derived dominantly from fragmented porcellanite. Typically, the surface layer is pinkish gray loam about 2 inches thick. The subsoil is brown channery loam about 7 inches thick. Fragmented porcellanite with soil material partially filling voids in it is between depths of 9 and 60 inches or more.

Permeability of the Sear soil is moderate to a depth of 9 inches and very rapid below this depth. Available water capacity is low. Effective rooting depth is 5 to 10 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Wibaux soil is shallow and somewhat excessively drained. It formed in channery loamy residuum derived dominantly from fragmented porcellanite. Typically, the surface layer is pinkish gray channery loam about 4 inches thick. The underlying material to a depth of 11 inches is light brown very channery loam. Fragmented porcellanite with soil material partially filling voids in it is between depths of 11 and 60 inches or more.

Permeability of the Wibaux soil is moderate to a depth of 11 inches and very rapid below this depth. Available water capacity is low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Sear soil is mainly bluebunch wheatgrass, little bluestem, westerr wheatgrass, and needleandthread. As the range condition deteriorates, woody plants increase. As the range condition further deteriorates, annuals invade. The potential plant community produces about 600 pounds of air-dry vegetation in normal years. Production varies from 600 pounds in favorable years to 400 pounds in unfavorable years.

The potential plant community on the Wibaux soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on this unit is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitation is depth to porcellanite fragments or soft bedrock. Absorption fields should be constructed using selected material.

This map unit is in capability subclass VIIe. The Sear soil is in the Very Shallow, 10- to 14-inch ppt., Northern Plains range site. The Wibaux soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

131—Shingle-Rock outcrop-Samday complex, 10 to 30 percent slopes. This map unit is on ridgetops, shoulders, and back slopes of rolling to steep uplands and on actively eroding escarpments. Slopes are medium in length and are convex. The native vegetation is mainly grasses and forbs.

This unit is 40 percent Shingle clay loam, 25 percent Rock outcrop, and 20 percent Samday clay loam. The components of this unit are so intricately intermingled

that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Theedle loam and Tassel sandy loam. Also included are small areas of Shingle, thin solum, soils and Tassel, thin solum, soils that formed in neutral, interbedded shale and sandstone. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown clay loam about 4 inches thick. The underlying material to a depth of 13 inches is light brownish gray clay loam. Interbedded shale and sandstone are at a depth of 13 inches.

Permeability of the Shingle soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

Rock outcrop is exposures of multicolored, calcareous and noncalcareous, soft to moderately hard shale and siltstone.

The Samday soil is shallow and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay. Interbedded shale and sandstone are at a depth of 18 inches.

Permeability of the Samday soil is slow. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Shingle soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The potential plant community on the Samday soil is mainly western wheatgrass, green needlegrass, and bluebunch wheatgrass. As the range condition deteriorates, birdfoot sagebrush and big sagebrush increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on these soils is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community. The suitability of these soils for rangeland seeding is poor. The main limitations are limited rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. The soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential, slope, and depth to soft bedrock. Backfilling excavations with coarser textured material reduces the shrink-swell potential. Absorption fields should be constructed using selected material.

This map unit is in capability subclass VIIe. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site. The Samday soil is in the Shallow Clayey, 10- to 14-inch ppt., Northern Plains range site. The included Tassel, thin solum, soil is a woodland soil.

132—Shingle, thin solum-Rock outcrop-Tassel, thin solum complex, cool, 6 to 45 percent slopes. This map unit is in rolling to steep areas on upland ridges, escarpments, and badlands along the eastern edge of the survey area. Slopes are medium in length and are convex. The native vegetation is mainly ponderosa pine and grasses with scattered junipers.

This unit is 35 percent Shingle loam, thin solum; 25 percent Rock outcrop; and 20 percent Tassel loamy fine sand, thin solum. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Samday clay loam, Tullock loamy sand, and Vonalee loamy sand. Also included are small areas of Samday soils that are less than 10 inches thick. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Shingle soil is very shallow and well drained. It formed in loamy residuum derived from interbedded, noncalcareous shale and sandstone. Typically, the surface layer is light gray loam about 2 inches thick. The underlying material to a depth of 9 inches is grayish brown clay loam.

Permeability of the Shingle soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 10 inches. Runoff is rapid, and the hazard of water

erosion is severe. The hazard of wind erosion is moderate.

Rock outcrop is soft, mostly noncalcareous shale and sandstone with seams of coal and ironstone.

The Tassel soil is very shallow and well drained. It formed in loamy residuum derived dominantly from noncalcareous sandstone. Typically, the surface layer is pale brown loamy fine sand about 2 inches thick. The underlying material to a depth of 8 inches is light yellowish brown and light olive brown sandy loam. Depth to noncalcareous sandstone ranges from 5 to 10 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 5 to 10 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The Shingle and Tassel soils are poorly suited to the production of timber. The site index for ponderosa pine ranges from 20 to 30. These soils can produce 6 cords per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The main concerns in producing and harvesting timber are the low density of the stands, the very shallow depth of the soils, slow regeneration, the hazard of erosion, and difficulty of harvesting. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Minimizing the risk of erosion is essential in harvesting timber. The very low available water capacity generally influences seedling survival in areas where understory plants are numerous. Conventional methods of harvesting timber are difficult to use because of slope.

The potential understory plant community on the Shingle and Tassel soils is mainly needleandthread, prairie sandreed, little bluestem, and bluebunch wheatgrass. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, annuals invade. The potential understory plant community produces about 600 pounds of air-dry vegetation in normal years. Production varies from 800 pounds in favorable years to 400 pounds in unfavorable years.

About 20 percent of this unit is scattered 5- to 10-acre clearings that support mainly range vegetation. The potential plant community in these clearings is mainly prairie sandreed, bluebunch wheatgrass, little bluestem, and western wheatgrass.

If the plant communities are overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community. Brush management improves deteriorated areas that are producing more woody shrubs than were present in the potential plant community. Livestock grazing should be managed to protect the soil from excessive erosion.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are slope and depth to soft bedrock. Mounded absorption fields should be constructed.

This map unit is in capability subclass VIIe. It is in woodland suitability group 2D1.

133—Shingle-Theedle-Cambria association, 6 to 30 percent slopes. This map unit is on ridge crests, back slopes, and pediment slopes of rolling to steep uplands. Slopes are medium in length and are convex. The native vegetation is mainly grasses and forbs.

This unit is 40 percent Shingle clay loam, 25 percent Theedle loam, and 25 percent Cambria sandy loam. The Shingle soil is in the more convex, moderately steep and steep areas. The Theedle and Cambria soils are in the less convex, moderately sloping areas.

Included in this unit are small areas of Samday clay loam and Rock outcrop. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Availab water capacity is low. Effective rooting depth is 4 to 2ι inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Theedle soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 5 inches thick. The underlying material to a depth of 23 inches is light gray loam and light brownish gray clay loam. Soft shale is at a depth of 28 inches. In some areas shale is at a depth of 40 to 60 inches or more.

Permeability of the Theedle soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from shale and sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 4 inches of the subsoil is yellowish brown loam, and the lower part to a depth of 60 inches or more is pale brown and brown loam. In a few areas, bedrock is at a depth of 40 to 60 inches.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60

inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Shingle soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on the Shingle soil is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this soil for rangeland seeding is poor. The main limitations are restricted rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Theedle and Cambria soils is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on Theedle and Cambria soils is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

The Shingle soil is poorly suited to homesite development. The main limitations are moderate shrink-swell potential, slope, and depth to soft bedrock. If the Theedle soil is used for homesite development, the main limitations are moderate shrink-swell potential, slope, and depth to soft bedrock. If the Cambria soil is used for homesite development, the main limitations are slope and moderate shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Septic tank absorption lines in the Cambria soil operate best if placed deep in the subsoil. Areas of the Shingle and Theedle soils are not suitable for use as absorption fields.

The Shingle soil is in capability subclass VIIe, and the Theedle and Cambria soils are in capability subclass VIe, nonirrigated. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site. The Theedle and Cambria soils are in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

134—Silhouette-Heldt association, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on alluvial flats, toe slopes, and foot slopes. Slopes are long and are plane to slightly concave. The Silhouette soils are on foot slopes and the outer margins of alluvial flats, and the Heldt soils are on toe slopes and at the center of alluvial flats. The native vegetation is mainly grasses.

This unit is 50 percent Silhouette clay loam and 35 percent Heldt clay loam.

Included in this unit are small areas of Bidman sandy loam, Ulm loam, and Zigweid loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Silhouette soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The upper part of the subsoil is pale brown clay about 20 inches thick, and the lower part to a depth of 48 inches or more is very pale brown clay and light gray clay loam. In a few areas, soft shale is at a depth of 20 to 40 inches.

Permeability of the Silhouette soil is slow. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Heldt soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is light gray clay loam about 1 inch thick. The subsoil is light brownish gray clay about 18 inches thick. The substratum to a depth of 60 inches or more is pale brown and very pale brown clay. Cracks as much as 0.5 inch wide extend to a depth of 20 inches when the soil is dry.

Permeability of the Heldt soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are high shrink-swell potential and slow permeability. Backfilling excavations with coarser textured material reduces the shrink-swell potential. Constructing a larger absorption field helps to compensate for the slow permeability.

This unit is in capability subclass IVe. It is in the Clayey, 10- to 14-inch ppt., Northern Plains range site.

135—Tassel-Shingle complex, 6 to 30 percent slopes. This map unit is on ridgetops and shoulder slopes in undulating to steep areas on uplands and on partially stabilized escarpments. Slopes are medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Tassel fine sandy loam and 30 percent Shingle clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Samday clay loam, Rock outcrop, Worf loamy sand, Worfka fine sandy loam, and Theedle loam. Also included are small areas of Gateson Variant and Tassel Variant soils along Pine Ridge and small areas of Shingle soils, thin solum, and Tassel soils, thin solum, along the eastern county line. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Tassel soil is shallow and well drained. It forme in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is pale brown fine sandy loam about 3 inches thick. The underlying material to a depth of 14 inches is pale brown and light yellowish brown fine sandy loam. Soft sandstone is at a depth of 14 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Available water capacity is low. Effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Tassel soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,000 pounds of air-dry vegetation in normal years. Production varies from 1,400 pounds in favorable years to 600 pounds in unfavorable years.

The potential plant community on the Shingle soil is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage on this unit is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are limited rooting depth and the hazards of wind and water erosion. Areas that are

heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are depth to soft bedrock and slope. Absorption fields should be constructed using selected material.

This map unit is in capability subclass VIIe. The Tassel soil is in the Shallow Sandy, 10- to 14-inch ppt., Northern Plains range site. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

136—Tassel-Terro-Rock outcrop complex, 15 to 30 percent slopes. This map unit is in hilly to steep areas on upland ridgetops, shoulder slopes, and back slopes. Slopes are convex and are medium in length. The native vegetation is mainly grasses and shrubs.

This unit is 40 percent Tassel loamy fine sand, 20 percent Terro sandy loam, and 20 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Tullock loamy sand and Turnback loamy fine sand on the upper part of hill slopes and Keeline sandy loam on the lower part of hill slopes. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Tassel soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is grayish brown loamy fine sand about 2 inches thick. The underlying material to a depth of 16 inches is pale brown fine sandy loam. Soft calcareous sandstone is at a depth of 16 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 6 inches of the subsoil is brown sandy loam, and the lower 24 inches is pale brown and light gray sandy loam. Soft sandstone is at a depth of 34 inches. A few areas have soft bedrock at a depth of 40 to 60 inches or more.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

Rock outcrop is exposures of mostly soft, calcareous sandstone on knolls and narrow ridges.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Tassel soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,000 pounds of air-dry vegetation in normal years. Production varies from 1,400 pounds in favorable years to 600 pounds in unfavorable years.

The potential plant community on the Terro soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation and limited rooting depth. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are the hazards of wind and water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are slope and depth to soft bedrock. Mounded septic tank absorption fields should be installed in the less sloping areas, and selected material should be used.

This map unit is in capability subclass VIIe. The Tassel soil is in the Shallow Sandy, 10- to 14-inch ppt., Northern Plains range site. The Terro soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site. Rock outcrop is not placed in a range site.

137—Tassel-Tullock-Vonalee association, 6 to 30 percent slopes. This map unit is on ridges and hill slopes in an area of rolling to steep uplands. Slopes are

medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 40 percent Tassel loamy fine sand, 20 percent Tullock loamy sand, and 20 percent Vonalee loamy sand. The Tassel soil has slopes of 6 to 30 percent, the Tullock soil has slopes of 6 to 20 percent, and the Vonalee soil has slopes of 6 to 15 percent.

Included in this unit are small areas of Bowbac sandy loam, Turnback sandy loam, and Keeline sandy loam and small areas of sandstone Rock outcrop. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Tassel soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is grayish brown loamy fine sand about 2 inches thick. The underlying material to a depth of 16 inches is pale brown fine sandy loam. Soft calcareous sandstone is at a depth of 16 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Tullock soil is moderately deep and excessively drained. It formed in sandy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown loamy sand about 5 inches thick. The upper 15 inches of the underlying material is brown sand, and the lower part to a depth of 31 inches is pale brown loamy sand. Soft sandstone is at a depth of 31 inches. In a few areas, bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Tullock soil is rapid. Available water capacity is very low to low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Vonalee soil is deep and somewhat excessively drained. It formed in loamy, wind-worked residuum derived dominantly from calcareous sandstone. Typically, the surface layer is dark grayish brown loamy sand about 3 inches thick. The upper 16 inches of the subsoil is light yellowish brown sandy loam, and the lower 5 inches is pale brown sandy loam. The substratum to a depth of 60 inches or more is pale brown loamy sand. In a few areas, soft bedrock is at a depth of 20 to 60 inches.

Permeability of the Vonalee soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Tassel soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,000 pounds of air vegetation in normal years. Production varies from 1,4 pounds in favorable years to 600 pounds in unfavorable years.

The production of forage on the Tassel soil is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Tassel soil for rangeland seeding is poor. The main limitations are limited rooting depth and the hazards of erosion by wind and water. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Tassel soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Tullock soil is mainly prairie sandreed, sand bluestem, needleandthread, and Indian ricegrass. As the range condition deteriorates, sageworts increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 2,000 pounds of air-dry vegetation in normal years. Production varies from 2,500 pounds in favorable years to 1,400 pounds in unfavorable years.

The production of forage on the Tullock soil is limit by droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Tullock soil for rangeland seeding is poor. The main limitations are the hazard of wind erosion, droughtiness, and slope. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Tullock soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Vonalee soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on the Vonalee soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and

the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Vonalee soil for rangeland seeding is fair. The main limitations are the hazards of wind and water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Vonalee soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

The Tassel and Tullock soils are poorly suited to homesite development. The main limitations are slope, depth to soft bedrock, and the hazard of sand blowing. If the Vonalee soil is used for homesite development, the main limitation is slope. Areas of the Vonalee soil are most suitable for use as septic tank absorption fields.

The Tassel soil is in capability subclass VIIe. The Tullock and Vonalee soils are in capability subclass VIe. The Tassel soil is in the Shallow Sandy, 10- to 14-inch ppt., Northern Plains range site. The Tullock soil is in the Sands, 10- to 14-inch ppt., Northern Plains range site. The Vonalee soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site.

138—Terro-Tullock-Orpha complex, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on upland summits and superimposed dunes. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Terro sandy loam, 30 percent Tullock loamy sand, and 20 percent Orpha loamy sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Turnback sandy loam, Keeline sandy loam, and Bowbac sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 6 inches of the subsoil is brown sandy loam, and the lower 24 inches is pale brown and light gray sandy loam. Soft sandstone is at a depth of 34 inches. In a few areas, soft bedrock is at a depth of 40 to 60 inches or more.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Tullock soil is moderately deep and excessively drained. It formed in sandy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown loamy sand about 5 inches thick. The upper 15 inches of the underlying material is brown sand, and the lower part to a depth of 31 inches is pale brown loamy sand. Soft sandstone is at a depth of 31 inches.

Permeability of the Tullock soil is rapid. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

The Orpha soil is deep and excessively drained. It formed in eolian sand derived from mixed sources. Typically, the surface layer is pale brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy sand. In some areas carbonates are above a depth of 40 inches.

Permeability of the Orpha soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Terro soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on the Terro soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Terro soil for rangeland seeding is good. The main limitation is the hazard of wind erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Terro soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Tullock and Orpha soils is mainly prairie sandreed, sand bluestem, needleandthread, and Indian ricegrass. As the range condition deteriorates, sageworts increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 2,000 pounds of air-dry vegetation in normal years. Production varies from 2,500 pounds in favorable years to 1,400 pounds in unfavorable years.

The production of forage on the Tullock and Orpha soils is limited by droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Tullock and Orpha soils for rangeland seeding is poor. The main limitations are the hazard of wind erosion and droughtiness. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Tullock and Orpha soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are depth to soft bedrock, the hazard of sand blowing, and the hazard of excavations caving in. Areas of the Orpha soil are most suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. The Terro soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site. The Tullock and Orpha soils are in the Sands, 10- to 14-inch ppt., Northern Plains range site.

139—Terro-Tullock-Orpha complex, 6 to 15 percent slopes. This map unit is on ridgetops, shoulders, and back slopes of rolling uplands and on superimposed dunes. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Terro sandy loam, 30 percent Tullock loamy sand, and 20 percent Orpha loamy sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Turnback sandy loam and Keeline sandy loam on ridges and shoulder slopes. Also included are small areas of Tassel loamy fine sand on ridgetops and Vonalee loamy sand on the lower part of hill slopes. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 6 inches of the subsoil is brown sandy loam, and the lower 24 inches is pale brown and light gray sandy loam. Soft sandstone is at a depth of 34 inches.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Tullock soil is moderately deep and excessively drained. It formed in sandy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown loamy sand about 5 inches thick. The upper 15 inches of the underlying material is brown sand, and the lower part to a depth of 31 inches is pale brown loamy sand. Soft sandstone is at a depth of 31 inches.

Permeability of the Tullock soil is rapid. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

The Orpha soil is deep and excessively drained. It formed in eolian sand derived from mixed sources. Typically, the surface layer is pale brown loamy sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy sand. In a few areas, carbonates are above a depth of 40 inches.

Permeability of the Orpha soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Terro soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage on the Terro soil is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of the Terro soil for rangeland seeding is fair. The main limitations are the hazards of wind and water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The Terro soil is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The potential plant community on the Tullock and Orpha soils is mainly prairie sandreed, sand bluestem, needleandthread, and Indian ricegrass. As the range condition deteriorates, sageworts increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 2,000 pounds of air-dry vegetation in normal years. Production varies from 2,500 pounds in favorable years to 1,400 pounds in unfavorable years.

The production of forage on the Tullock and Orpha soils is limited by droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is poor. The main limitations are the hazard of wind erosion and droughtiness. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

These soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are depth to soft bedrock and the hazard of excavations caving in. Areas of the Terro and Tullock soils are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. The Terro soil is in the Sandy, 10- to 14-inch ppt., Northern Plains range site. The Tullock and Orpha soils are in the Sands, 10- to 14-inch ppt., Northern Plains range site.

140—Theedle-Kishona association, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on alluvial flats, foot slopes, and toe slopes adjacent to rolling uplands. Slopes are medium to long in length and are slightly convex. The native vegetation is mainly grasses.

This unit is 45 percent Theedle loam and 35 percent Kishona loam. The Theedle soil is in the more convex areas, and the Kishona soil is in the more nearly plane areas.

Included in this unit are small areas of Cambria fine sandy loam, Bahl clay, and Cushman loam. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Theedle soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 5 inches thick. The underlying material to a depth of 28 inches is light gray loam and light brownish gray clay loam. Soft shale is at a depth of 28 inches.

Permeability of the Theedle soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

The Kishona soil is deep and well drained. It formed in loamy local residuum derived dominantly from calcareous shale. Typically, the surface layer is brown loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and light gray clay loam.

Permeability of the Kishona soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are depth of the Theedle soil to soft bedrock and moderate shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Areas of the Kishona soil are most suitable for use as septic tank absorption fields.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

141—Theedle-Kishona association, 6 to 15 percent slopes. This map unit is on pediment slopes in areas of rolling uplands and on alluvial fans adjacent to upland escarpments. Slopes are short and convex. The native vegetation is mainly grasses.

This unit is 55 percent Theedle loam and 25 percent Kishona loam. The Theedle soil is in the more convex areas, and the Kishona soil is in the more nearly level areas.

Included in this unit are small areas of Cambria sandy loam, Savageton clay loam, and Shingle clay loam. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Theedle soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 5 inches thick. The underlying material to a depth of 28 inches is light gray loam and light brownish gray clay loam. Soft shale is at a depth of 28 inches.

Permeability of the Theedle soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Kishona soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is brown loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and light gray clay loam.

Permeability of the Kishona soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are slope, depth of the Theedle soil to soft bedrock, and moderate shrink-swell potential. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Areas of the Kishona soil are more suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

142—Ulm-Bidman complex, 0 to 6 percent slopes. This map unit is on alluvial flats and in level to undulating areas on foot slopes and toe slopes. Slopes are long and are plane to concave. The native vegetation is mainly grasses and shrubs.

This unit is 45 percent Ulm clay loam and 40 percent Bidman sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Forkwood fine sandy loam, Bahl clay, and Absted fine sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Ulm soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown clay loam about 4 inches thick. The upper 13 inches of the subsoil is pale brown clay and pale brown clay loam, and the lower part to a depth of 60 inches or more is light yellowish brown clay loam.

Permeability of the Ulm soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Bidman soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray sandy loam about 3 inches thick. The subsurface layer is pale brown sandy loam about 4 inches thick. The upper 13 inches of the subsoil is light brownish gray clay, and the lower 28 inches is light brownish gray clay loam. The substratum to a depth of 60 inches or more is light brownish gray clay loam.

Permeability of the Bidman soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Ulm soil is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The potential plant community on the Bidman soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are high shrink-swell potential and slow permeability. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Constructing a larger absorption field helps to compensate for the slow permeability.

This map unit is in capability subclass IVe. The Ulm soil is in the Clayey, 10- to 14-inch ppt., Northern Plains range site. The Bidman soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

143—Ulm-Renohill complex, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on foot slopes and toe slopes. Slopes are medium to long in length and are plane to concave. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Ulm loam and 40 percent Renohill fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Forkwood fine sandy loam, Zigweid clay loam, and Cambria fine sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Ulm soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is brown loam about 5 inches thick. The upper 16 inches of the subsoil is brown clay loam and clay, and the lower part to a depth of 60 inches or more is pale brown clay loam and light yellowish brown sandy clay loam. In some areas the surface layer is sandy loam.

Permeability of the Ulm soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Renohill soil is moderately deep and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown fine sandy loam about 5 inches thick. The upper 15 inches of the subsoil is brown clay, and the lower 16 inches is pale brown clay loam. Calcareous shale is at a depth of 36 inches. In some areas the surface layer is thinner than is typical and has an abrupt boundary with the subsoil.

Permeability of the Renohill soil is slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Ulm soil is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The potential plant community on the Renohill soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that

the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are high shrink-swell potential, slow permeability, and the depth of the Renohill soil to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Constructing a larger septic tank absorption field helps to compensate for the slow permeability. Areas of the Renohill soil are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass IVe. The Ulm soil is in the Clayey, 10- to 14-inch ppt., Northern Plains range site. The Renohill soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

144—Ulm-Renohill clay loams, 6 to 15 percent slopes. This map unit is on ridges and hill slopes in areas of rolling uplands and on adjacent foot slopes. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 45 percent Ulm clay loam and 45 percent Renohill clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shingle clay loam and Worfka fine sandy loam. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Ulm soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The upper 12 inches of the subsoil is brown clay loam, and the lower part to a depth of 60 inches or more is light gray clay loam. In some areas the surface layer is sandy loam, and in some areas the subsoil is sandy clay.

Permeability of the Ulm soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Renohill soil is moderately deep and well drained. It formed in clayey residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 5 inches thick. The subsoil is light brownish gray clay loam about 20 inches thick. Calcareous, gritty shale is at a depth of 25 inches. In some areas the surface layer is sandy loam.

Permeability of the Renohill soil is moderately slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, green needlegrass, and thickspike wheatgrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are high shrink-swell potential, slow permeability, slope, and the depth of the Renohill soil to soft bedrock. Backfilling excavations with coarser textured material reduces the limitation of shrink-swell potential. Constructing a larger absorption field helps to compensate for the slow permeability. Areas of the Renohill soil are not suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. It is in the Clayey, 10- to 14-inch ppt., Northern Plains range site.

145—Ustic Torriorthents, reclaimed, 3 to 30 percent slopes. These deep, well drained soils consist of reclaimed areas around coal and uranium strip mines and porcellanite borrow areas. They formed in an overburden derived from mining operations.

Typically, the profile to a depth of 60 inches or more is strong brown to light gray loamy sand to clay loam. In some areas layers of rearranged coal and shale are at a depth of less than 60 inches.

Permeability of these soils is slow to moderately rapid. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. Runoff is medium to

rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight to severe.

This unit is used for livestock grazing and wildlife habitat.

A common plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, big sagebrush, and fourwing saltbush. As the range condition deteriorates, Russian-thistle, cheatgrass, buffalobur, kochia, and Japanese brome increase.

This unit responds well to fertilizer, range seeding, and proper grazing use. The main limitation for seeding is the reaction of the soil, which ranges from 3.8 to 8.4 in various layers. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment. Management practices suitable for use on this unit include proper range use, deferred grazing, mowing, rotation grazing, and aerial spraying for brush management. Livestock grazing should be managed to protect the soil from excessive erosion.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This map unit is in capability subclass VIe. It is not placed in a range site.

146—Vonalee-Terro complex, 0 to 6 percent slopes. This map unit is in nearly level to gently sloping areas on pediment slopes adjacent to rolling uplands and on stream terraces. Slopes are medium to long in length and are plane to slightly convex. The native vegetation is mainly grasses and shrubs.

This unit is 50 percent Vonalee loamy sand and 35 percent Terro sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Hiland sandy loam, Turnback sandy loam, and Keeline sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Vonalee soil is deep and somewhat excessively drained. It formed in loamy, wind-worked residuum and local alluvium derived from mixed sources. Typically, the surface layer is yellowish brown loamy sand about 4 inches thick. The upper 20 inches of the subsoil is yellowish brown and grayish brown sandy loam. The subsoil to a depth of 60 inches or more is brown loamy sand and light brownish gray sandy clay loam. In some areas soft sandstone is at a depth of 40 to 60 inches.

Permeability of the Vonalee soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is severe.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 6 inches of the subsoil is brown sandy loam, and the lower 24 inches is pale brown and light gray sandy loam. Soft, calcareous sandstone is at a depth of 34 inches.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of wind erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are the depth of the Terro soil to soft bedrock and the hazard of excavations caving in. Areas of the Vonalee soil are more suitable for use as septic tank absorption fields.

This map unit is in capability subclass IVe. It is in the Sandy, 10- to 14-inch ppt., Northern Plains range site.

147—Vonalee-Terro complex, 6 to 15 percent slopes. This map unit is on ridges and back slopes of rolling uplands. Slopes are short and convex. The native vegetation is mainly grasses and shrubs.

This unit is 45 percent Vonalee loamy sand and 40 percent Terro sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bowbac sandy loam, Turnback sandy loam, and Keeline sandy loam. Included areas make up about 15 percent of the total

acreage. The percentage varies from one area to another.

The Vonalee soil is deep and somewhat excessively drained. It formed in loamy wind-worked residuum derived dominantly from calcareous sandstone. Typically, the surface layer is dark grayish brown loamy sand about 3 inches thick. The upper 16 inches of the subsoil is light yellowish brown sandy loam, and the lower 5 inches is pale brown sandy loam. The substratum to a depth of 60 inches or more is pale brown sandy loam.

Permeability of the Vonalee soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Terro soil is moderately deep and somewhat excessively drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 6 inches of the subsoil is brown sandy loam, and the lower 24 inches is pale brown and light gray sandy loam and loamy sand. Soft, calcareous sandstone is at a depth of 34 inches.

Permeability of the Terro soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, sageworts and needleleaf sedge increase. As the range condition further deteriorates, annuals and broom snakeweed invade. The potential plant community produces about 1,600 pounds of air-dry vegetation in normal years. Production varies from 2,100 pounds in favorable years to 1,000 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitations are the hazards of wind and water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the mai limitations are slope, depth of the Terro soil to soft bedrock, and the hazard of excavations caving in. Areas of the Vonalee soil are more suitable for use as septic tank absorption fields.

This map unit is in capability subclass VIe. It is in the Sandy, 10- to 14-inch ppt., Northern Plains range site.

148—Wibaux-Rock outcrop-Shingle complex, 6 to 45 percent slopes. This map unit is on steep porcellanite-capped buttes and rolling shale uplands. Slopes are short to medium in length and are plane to convex. The native vegetation is mainly grasses and forbs.

This unit is 35 percent Wibaux channery loam, 30 percent Rock outcrop, and 20 percent Shingle clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Renohill clay loam and Sear loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Wibaux soil is shallow and somewhat excessively drained. It formed in channery residuum derived dominantly from fragmented porcellanite. Typically, the surface layer is pinkish gray channery loam about 4 inches thick. The underlying material to a depth of 11 inches is light brown very channery loam. Fragmented porcellanite in which soil partially fills voids is at a dept of 11 to 60 inches or more.

Permeability of the Wibaux soil is moderate to a depth of 11 inches and very rapid below this depth. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

Rock outcrop is exposures of shale and siltstone on scarp slopes.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from shale. Typically, the surface layer is pale brown clay loam about 4 inches thick. The underlying material to a depth of 13 inches is light brownish gray clay loam. Soft, interbedded shale and sandstone are at a depth of 13 inches.

Permeability of the Shingle soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Wibaux and Shingle soils is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further

deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The production of forage is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of these soils for rangeland seeding is poor. The main limitations are restricted rooting depth and the hazard of water erosion. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

These soils are limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitation is the depth to soft bedrock or fragmented porcellanite. Septic tank absorption fields should be constructed using selected material.

This map unit is in capability subclass VIIe. The Wibaux soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site. Rock outcrop is not assigned a range site. The Shingle soil is in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site.

149—Worf-Shingle-Tassel complex, 3 to 30 percent slopes. This map unit is on ridgetops and shoulder slopes of undulating to steep uplands and on partially stabilized escarpments. Slopes are medium in length and are convex. The native vegetation is mainly grasses and shrubs.

This unit is 35 percent Worf loamy sand, 30 percent Shingle clay loam, and 20 percent Tassel fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Theedle loam, Cushman loam, Samday clay loam, and Worfka fine sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Worf soil is shallow and well drained. It formed in loamy residuum derived dominantly from interbedded shale and sandstone. Typically, the surface layer is light brownish gray loamy sand about 5 inches thick. The subsoil is brown and yellowish brown clay loam about 10 inches thick. Calcareous shale and sandstone are at a depth of 15 inches.

Permeability of the Worf soil is moderate. Available water capacity is very low. Effective rooting depth is 8 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is severe.

The Shingle soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is light brownish gray clay loam about 4 inches thick. The underlying material to a depth of 18 inches is light brownish gray clay loam. Soft shale is at a depth of 18 inches.

Permeability of the Shingle soil is moderate. Available water capacity is low. Effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Tassel soil is shallow and well drained. It formed in loamy residuum derived dominantly from calcareous sandstone. Typically, the surface layer is pale brown fine sandy loam about 3 inches thick. The underlying material to a depth of 14 inches is pale brown and light yellowish brown fine sandy loam. Soft sandstone is at a depth of 14 inches.

Permeability of the Tassel soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Worf and Shingle soils is mainly western wheatgrass, bluebunch wheatgrass, needleandthread, and little bluestem. As the range condition deteriorates, blue grama and threadleaf sedge increase. As the range condition further deteriorates, broom snakeweed and cacti invade. The potential plant community produces about 900 pounds of air-dry vegetation in normal years. Production varies from 1,200 pounds in favorable years to 450 pounds in unfavorable years.

The potential plant community on the Tassel soil is mainly needleandthread, prairie sandreed, Indian ricegrass, and little bluestem. As the range condition deteriorates, threadleaf sedge and fringed sagewort increase. As the range condition further deteriorates, broom snakeweed and annuals invade. The potential plant community produces about 1,000 pounds of air-dry vegetation in normal years. Production varies from 1,400 pounds in favorable years to 600 pounds in unfavorable years.

The production of forage on this unit is limited by restricted rooting depth and droughtiness. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is poor. The main limitations are restricted rooting depth and the hazards of erosion by wind and water. Areas

that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

This unit is poorly suited to homesite development. The main limitations are slope and depth to soft bedrock. Septic tank absorption fields should be installed in the less sloping areas, and selected material should be used.

This map unit is in capability subclass VIIe. The Worf and Shingle soils are in the Shallow Loamy, 10- to 14-inch ppt., Northern Plains range site. The Tassel soil is in the Shallow Sandy, 10- to 14-inch ppt., Northern Plains range site.

150—Zigweid-Bahl association, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on alluvial flats and toe slopes adjacent to rolling uplands. Slopes are long and plane. The native vegetation is mainly grasses and shrubs.

This unit is 55 percent Zigweid loam and 30 percent Bahl clay. The Zigweid soil is on toe slopes, and the Bahl soil is on alluvial flats.

Included in this unit are small areas of Cambria fine sandy loam, Ulm clay loam, Theedle loam, and Haverdad fine sandy loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Zigweid soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is grayish brown loam about 2 inches thick. The subsoil is grayish brown and light brownish gray clay loam about 33 inches thick. The substratum to a depth of 60 inches or more is light brownish gray clay loam. In a few areas soft shale is at a depth of 40 to 60 inches.

Permeability of the Zigweid soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Bahl soil is deep and well drained. It formed in clayey local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale olive clay about 4 inches thick. The underlying material to a depth of 60 inches or more is pale olive clay.

Permeability of the Bahl soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Zigweid soil is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and brc snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The potential plant community on the Bahl soil is mainly western wheatgrass, thickspike wheatgrass, and green needlegrass. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti and broom snakeweed invade. The potential plant community produces about 1,300 pounds of air-dry vegetation in normal years. Production varies from 1,800 pounds in favorable years to 750 pounds in unfavorable years.

The production of forage on this unit is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are the slow permeability of the Bahl soil and shrink-swell potential. Constructing a larger absorption field helps to compensate for the slow permeability. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential.

This map unit is in capability subclass IVe. The Zigweid soil is in the Loamy, 10- to 14-inch ppt., Northern Plains range site. The Bahl soil is in the Clayey, 10- to 14-inch ppt., Northern Plains range site.

151—Zigweid-Cambria association, 0 to 6 percent slopes. This map unit is in nearly level to undulating areas on foot slopes and toe slopes adjacent to rolling uplands. Slopes are medium to long in length and are plane to slightly convex. The native vegetation is mainly grasses and shrubs.

This unit is 55 percent Zigweid clay loam and 30 percent Cambria fine sandy loam. The Zigweid soil is in the plane areas, and the Cambria soil is in the convex areas.

Included in this unit are small areas of Theedle loam and Bahl clay. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Zigweid soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is brown clay loam about 3 inches thick. The subsoil is pale brown and light brownish gray clay loam to a depth of 60 inches or more. In a few areas, soft bedrock is at a depth of 40 to 60 inches.

Permeability of the Zigweid soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from shale and sandstone. Typically, the surface layer is grayish brown fine sandy loam about 2 inches thick. The upper 8 inches of the subsoil is brown sandy clay loam, and the lower 19 inches is pale brown sandy clay loam and loam. The substratum to a depth of 60 inches or more is pale brown sandy clay loam.

Permeability of the Cambria soil capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is good. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improved by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitation is moderate shrink-swell potential. Backfilling excavations with coarser textured material helps to overcome this limitation. Septic tank absorption fields operative more effectively if they are placed deep in the subsoil.

This map unit is in capability subclass IVe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

152—Zigweid-Cambria-Theedle association, 6 to 15 percent slopes. This map unit is on pediment slopes of rolling uplands and on adjacent foot slopes. Slopes are short and are mostly convex. The native vegetation is mostly grasses and shrubs.

This unit is 35 percent Zigweid loam, 25 percent Cambria sandy loam, and 25 percent Theedle loam. The Zigweid soil is on the longer, more nearly plane slopes, the Cambria soil is on the intermediate slopes, and the Theedle soil is on the shorter, more convex slopes.

Included in this unit are small areas of Shingle clay loam, Bahl clay, and Renohill clay loam. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Zigweid soil is deep and well drained. It formed in loamy local alluvium derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 4 inches thick. The subsoil to a depth of 60 inches or more is pale brown and very pale brown clay loam. In a few areas, soft bedrock is at a depth of 40 to 60 inches.

Permeability of the Zigweid soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is slight.

The Cambria soil is deep and well drained. It formed in loamy local alluvium and residuum derived dominantly from shale and sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 4 inches of the subsoil is yellowish brown loam, and the lower 22 inches is pale brown loam. The substratum to a depth of 60 inches or more is brown loam.

Permeability of the Cambria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

The Theedle soil is moderately deep and well drained. It formed in loamy residuum derived dominantly from calcareous shale. Typically, the surface layer is pale brown loam about 5 inches thick. The underlying material to a depth of 28 inches is light gray loam and light brownish gray clay loam. Soft shale is at a depth of 28 inches.

Permeability of the Theedle soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly western wheatgrass, thickspike wheatgrass, and

needleandthread. As the range condition deteriorates, big sagebrush and blue grama increase. As the range condition further deteriorates, cacti, annuals, and broom snakeweed invade. The potential plant community produces about 1,500 pounds of air-dry vegetation in normal years. Production varies from 2,000 pounds in favorable years to 850 pounds in unfavorable years.

The production of forage is limited by low annual precipitation. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community.

The suitability of this unit for rangeland seeding is fair. The main limitation is the hazard of water erosion. Chiseling or other such practices can be used to improve areas of deteriorated rangeland. Such practices increase water infiltration, reduce plant competition, and allow the desirable native plants to increase. Areas that are heavily infested with undesirable plants can be improv by chemical or mechanical treatment.

The vegetation on this unit provides some food for antelope, deer, small mammals, and birds.

If this unit is used for homesite development, the main limitations are shrink-swell potential, slope, and the depth of the Theedle soil to soft bedrock. Backfilling excavations with coarser textured material helps to overcome the limitation of shrink-swell potential. Septic tank absorption fields in the Zigweid and Cambria soils operate most effectively if placed deep in the subsoil; areas of the Theedle soil are not suitable for this use.

This map unit is in capability subclass VIe. It is in the Loamy, 10- to 14-inch ppt., Northern Plains range site.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 14 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Aridisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the order. The last syllable in the name of a suborder indicates the order. An example is Argid (*Arg*, meaning clay-rich horizon, plus *id*, from Aridisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplargids (*Hapl*, meaning minimal horizonation, plus *argid*, the suborder of the Aridisols that have a layer of clay accumulation).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Ustollic* identifies the subgroup that has more organic matter and receives more precipitation than the one that typifies the great group. An example is Ustollic Haplargids.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Ustollic Haplargids.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Taxonomic Units and Their Morphology

In this section, each taxonomic unit recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each taxonomic unit. A pedon, a small three-dimensional area of soil, that is typical or representative of the taxonomic unit in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*5*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*7*). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the taxonomic unit.

The map units of each taxonomic unit are described in the section "Detailed Soil Map Units."

Absted Series

The Absted series consists of deep, well drained, slowly permeable soils on alluvial flats, toe slopes, and dissected terraces adjacent to major and minor drainageways. These soils formed in alluvial sediment derived from sedimentary rock. Slope is 0 to 6 percent.

Typical pedon of Absted fine sandy loam in an area of Absted-Arvada-Bone complex, 0 to 6 percent slopes, 1,250 feet east and 950 feet north of the southwest corner of sec. 30, T. 40 N., R. 68 W.

E—0 to 3 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak medium and coarse granular structure; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

Bt—3 to 14 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; strong medium and fine subangular blocky structure; continuous thick clay films on faces of peds; very hard, very firm, sticky and plastic; moderately alkaline; gradual smooth boundary.

Btnk—14 to 26 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; strong medium and fine subangular blocky structure; continuous thick clay films on faces of peds; very hard, very firm, sticky and plastic; violently effervescent; many medium soft masses of calcium carbonate; strongly alkaline; gradual wavy boundary.

Bnk—26 to 36 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; very hard, very firm, sticky and plastic; violently effervescent; many medium soft masses of calcium carbonate; strongly alkaline; gradual wavy boundary.

Bck—36 to 60 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; very hard, very firm, sticky and plastic; slightly effervescent; few fine soft masses of calcium carbonate; moderately alkaline.

The depth to calcium carbonate ranges from 12 to 28 inches.

The E horizon and the A horizon, where present, have hue of 2.5Y or 10YR, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 or 3. Reaction is neutral or mildly alkaline.

The Btnk horizon has hue of 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3. It is clay or clay loam that is 15 to 40 percent sand. The Btnk and Bnk horizons are moderately alkaline or strongly alkaline.

Aeric Haplaquepts

Aeric Haplaquepts are deep, poorly drained, very slowly permeable soils on playa lakebeds in areas characterized by centripetal drainage. These soils formed in clayey local alluvium derived from calcareous sedimentary rock. Slope is 0 to 3 percent.

Reference pedon of Aeric Haplaquepts clay loam in an area of Aeric Haplaquepts, 0 to 3 percent slopes, 800 feet south and 450 feet east of the northwest corner of sec. 15, T. 34 N., R. 71 W.

A—0 to 3 inches; light gray (10YR 6/1) clay loam, grayish brown (10YR 5/2) moist; weak fine granular structure; very hard, firm, sticky and plastic; common fine mottles; mildly alkaline; abrupt smooth boundary.

AC—3 to 8 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; very hard, firm, sticky and plastic; few fine mottles; neutral; clear wavy boundary.

C1—8 to 20 inches; light gray (10YR 6/1) clay, grayish brown (10YR 5/2) moist; massive; very hard, firm, sticky and plastic; few fine mottles; mildly alkaline; gradual irregular boundary.

C2—20 to 30 inches; light gray (10YR 7/2) clay, pale brown (10YR 6/3) moist; massive; very hard, firm, very sticky and very plastic; few fine mottles and few medium iron and manganese concretions; strongly effervescent; few fine calcium carbonate concretions; mildly alkaline; gradual irregular boundary.

C3—30 to 48 inches; very pale brown (10YR 7/3) clay, grayish brown (10YR 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine mottles and few fine iron and manganese concretions; mildly alkaline.

Depth to bedrock typically is more than 60 inches, but it is as little as 20 inches in the smaller playas. Accumulation of carbonates and depth to them vary with the parent material. The control section is fine or fine-loamy.

The A horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 1 or 2. Texture is clay loam or clay. Reaction is neutral or mildly alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 to 6 when moist, and chroma of 1 to 3. Reaction is mildly alkaline to strongly alkaline.

Arvada Series

The Arvada series consists of deep, well drained, slowly permeable soils on alluvial flats, toe slopes, and dissected terraces adjacent to major and minor drainageways. These soils formed in alluvial sediment derived from sedimentary rock. Slope is 0 to 6 percent.

Typical pedon of an Arvada loam in an area of Absted-Arvada-Bone complex, 0 to 6 percent slopes, 1,100 feet south and 1,000 feet east of the northwest corner of sec. 35, T. 41 N., R. 70 W.

A—0 to 3 inches; light brownish gray (10YR 6/2) loam, brown (10YR 5/3) moist; moderate fine platy structure parting to moderate very fine granular; soft, friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Btn1—3 to 7 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; weak medium and coarse prismatic structure parting to strong fine angular blocky; continuous thick clay films on faces of peds;

hard, friable, sticky and plastic; strongly alkaline; slightly effervescent; clear smooth boundary.

Btn2—7 to 15 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; strong fine angular blocky structure; continuous thick clay films on faces of peds; hard, friable, sticky and plastic; very strongly alkaline; slightly effervescent; clear wavy boundary.

Bk—15 to 22 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; hard, friable, sticky and plastic; slightly effervescent; moderately alkaline; clear wavy boundary.

C—22 to 48 inches; pale brown (10YR 6/3) clay, grayish brown (10YR 5/2) moist; massive; hard, friable, sticky and plastic; slightly effervescent; strongly alkaline.

The depth to calcium carbonate ranges from 0 to 12 inches.

The A horizon has hue of 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3. Reaction is mildly alkaline to strongly alkaline.

The Btn horizons have hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. They are typically clay or clay loam and are 10 to 40 percent sand. They are strongly alkaline or very strongly alkaline.

The C horizon is strongly alkaline or very strongly alkaline.

Bahl Series

The Bahl series consists of deep, well drained, slowly permeable soils on alluvial flats and toe slopes. These soils formed in local alluvium derived from calcareous shale. Slopes range from 0 to 6 percent.

Typical pedon of a Bahl clay in an area of Zigweid-Bahl association, 0 to 6 percent slopes, in the NE1/4NE1/4 of sec. 24, T. 40 N., R. 72 W.

A—0 to 4 inches; pale olive (5Y 6/3) clay, olive (5Y 5/3) moist; weak thick platy structure parting to weak medium and fine subangular blocky; hard, friable, sticky and plastic; strongly effervescent; moderately alkaline; gradual wavy boundary.

AC—4 to 9 inches; pale olive (5Y 6/3) clay, olive (5Y 5/3) moist; massive; hard, firm, sticky and plastic; strongly effervescent; strongly alkaline; gradual wavy boundary.

CK—9 to 40 inches; pale olive (5Y 6/3) clay, olive (5YR 5/3) moist; massive; hard, firm, sticky and plastic; strongly effervescent; few fine soft masses and filaments of calcium carbonate; strongly alkaline.

These soils typically are leached in the upper few inches, but in some areas they are calcareous throughout.

The A horizon has chroma of 2 or 3. Reaction is neutral to moderately alkaline.

The C horizon is mildly alkaline to strongly alkaline The control section typically is about 45 percent clay a. 15 to 25 percent sand.

Bidman Series

The Bidman series consists of deep, well drained, slowly permeable soils on alluvial flats, toe slopes, and foot slopes of upland hills. These soils formed in local alluvium derived from soft calcareous shale. Slope is 0 to 6 percent.

Typical pedon of a Bidman sandy loam in an area of Ulm-Bidman complex, 0 to 6 percent slopes, 2,500 feet east and 300 feet north of the southwest corner of sec. 1, T. 37 N., R. 68 W.

A—0 to 3 inches; light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; neutral; abrupt smooth boundary.

E—3 to 7 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bt—7 to 20 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist and crushed; weak medium prismatic structure parting to strong medi' and coarse angular blocky; very hard, firm, sticky and plastic; continuous thick clay films on faces o, peds; neutral; clear wavy boundary.

Bk1—20 to 35 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate medium and coarse angular blocky structure; very hard, firm, sticky and plastic; few medium hard iron concretions; strongly effervescent; common medium and fine filaments and seams of calcium carbonate; moderately alkaline; gradual wavy boundary.

Bk2—35 to 52 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and slightly plastic; few medium iron concretions; strongly effervescent; moderately alkaline; diffuse wavy boundary.

C—52 to 67 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable; slightly effervescent; moderately alkaline.

The depth to calcium carbonate ranges from 12 to 24 inches.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 2 or 3. It is sandy loam or loam.

The Bt horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. It is

dominantly clay, but the range includes clay loam and sandy clay. It averages 37 to 47 percent clay. Reaction is neutral to moderately alkaline.

The Bk horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. Texture is clay loam, sandy clay loam, or clay. Reaction is mildly alkaline to strongly alkaline.

Bigwinder Series

The Bigwinder series consists of deep, poorly drained, moderately permeable soils on flood plains and low stream terraces. These soils formed in recent stratified alluvium derived dominantly from sedimentary rock. Slope is 0 to 3 percent.

Typical pedon of a Bigwinder fine sandy loam in an area of Clarkelen-Haverdad-Bigwinder complex, 0 to 3 percent slopes; 1,250 feet north and 1,400 feet west of the southeast corner of sec. 24, T. 39 N., R. 75 W.

A—0 to 3 inches; light brownish gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; common fine strong brown (7.5YR 5/8) mottles along root channels; moderate thick platy structure; slightly hard, very friable, nonsticky and nonplastic; strongly effervescent; mildly alkaline; clear smooth boundary.

AC—3 to 8 inches; light gray (10YR 7/2), stratified sandy loam and loam, grayish brown (10YR 5/2) moist; common fine strong brown (7.5YR 5/8) mottles along root channels; weak thick platy structure; hard, friable, slightly sticky and plastic; strongly effervescent; moderately alkaline; clear smooth boundary.

C1—8 to 17 inches; light gray (10YR 7/2), stratified loamy sand, loam, and sandy loam, pale brown (10YR 6/3) moist; common medium strong brown (7.5YR 5/8) mottles and faint organic stains on faces of fragments; massive; slightly hard, very friable, nonsticky and nonplastic; violently effervescent; moderately alkaline; clear wavy boundary.

C2—17 to 24 inches; light gray (10YR 7/2), stratified sandy loam and loamy sand, light brownish gray (10YR 6/2) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; slightly effervescent; mildly alkaline; gradual smooth boundary.

C3—24 to 60 inches; mottled, light gray (10YR 7/2) and reddish yellow (7.5YR 6/8), stratified loamy sand, sandy loam, and sand, light brownish gray (10YR 6/2) and reddish yellow (5YR 6/8) moist; single grain; loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline.

Depth to sand strata ranges from 30 to 40 inches.

The A horizon is fine sandy loam or sandy clay loam. Reaction is neutral to moderately alkaline. It has weak or moderate grades of platy structure.

The C horizon has value of 5 or 6 when moist. Matrix chroma is 2 or 3. Reaction is on mildly alkaline or moderately alkaline. Texture of the strata ranges from loam to sand.

Bone Series

The Bone series consists of deep, well drained, very slowly permeable soils on alluvial flats and toe slopes of dissected terraces adjacent to major and minor drainageways. These soils formed in alluvial sediment derived from sedimentary rock. Slope is 0 to 6 percent.

Typical pedon of a Bone clay loam in an area of Absted-Arvada-Bone complex, 0 to 6 percent slopes, 1,100 feet south and 500 feet west of the northeast corner of sec. 8, T. 36 N., R. 68 W.

E—0 to 2 inches; pale brown (10YR 6/3) light clay loam, brown (10YR 5/3) moist; weak thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

Bt—2 to 5 inches; light brownish gray (10YR 6/2) clay loam, brown (10YR 5/3) moist; moderate fine subangular blocky structure; few thin clay films on faces of peds; hard, friable, slightly sticky and slightly plastic; moderately alkaline; clear smooth boundary.

Bk—5 to 10 inches; light gray (10YR 7/2) clay loam, pale brown (10YR 6/3) moist; moderate fine subangular blocky structure; very hard, friable, sticky and plastic; strongly effervescent; calcium carbonate segregated in common fine soft masses; moderately alkaline; gradual smooth boundary.

C1—10 to 20 inches; very pale brown (10YR 7/3) heavy clay loam, pale brown (10YR 6/3) moist; massive; very hard, firm, sticky and plastic; strongly effervescent; calcium carbonate disseminated throughout matrix; very strongly alkaline; gradual smooth boundary.

C2—20 to 60 inches; very pale brown (10YR 7/3) clay, pale brown (10YR 6/3) moist; massive; very hard, friable, sticky and plastic; strongly effervescent; calcium carbonate disseminated throughout matrix; moderately alkaline.

The profile commonly is leached to a depth of 2 to 5 inches, or to the base of the Bt horizon, but many pedons are calcareous throughout. The solum has hue of 2.5Y or 10YR.

The E horizon has value of 6 or 7 when dry and 4 to 6 when moist. The Bt horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. The Bk and C horizons are heavy clay loam or clay.

Bowbac Series

The Bowbac series consists of moderately deep, well drained, moderately permeable soils on shoulder slopes, back slopes, and pediment slopes of rolling uplands. These soils formed in residuum derived from soft sandstone. Slope is 0 to 15 percent.

Typical pedon of a Bowbac sandy loam (fig. 3) in an area of Hiland-Bowbac complex, 6 to 15 percent slopes, 2,450 feet north and 500 feet east of the southwest corner of sec. 27, T. 36 N., R. 70 W.

A—0 to 3 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure parting to single grain; soft, loose, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

Bt1—3 to 6 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; strong coarse subangular blocky structure parting to strong fine angular blocky; slightly hard, friable, sticky and plastic; few thin clay bridges between mineral grains; neutral; clear smooth boundary.

Bt2—6 to 18 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; strong coarse prismatic structure parting to strong fine subangular blocky; hard, friable, sticky and plastic; common moderately thick clay bridges between mineral grains; neutral; clear smooth boundary.

Btk—18 to 26 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; thin clay bridges between mineral grains; slightly effervescent; disseminated calcium carbonate; mildly alkaline; gradual wavy boundary.

Bk—26 to 36 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure parting to weak very fine granular; soft, loose, slightly sticky and slightly plastic; strongly effervescent; disseminated calcium carbonate; moderately alkaline; gradual wavy boundary.

Cr—36 inches; soft calcareous sandstone.

The depth to calcium carbonate ranges from 14 to 26 inches. The depth to bedrock ranges from 24 to 37 inches.

The Bt horizon has chroma of 3 or 4. Texture is dominantly sandy clay loam that is 20 to 35 percent clay and more than 35 percent sand that is fine or coarser. The Bk horizon has hue of 2.5Y to 10YR, value of 6 or 7 when dry, and chroma of 2 to 4.

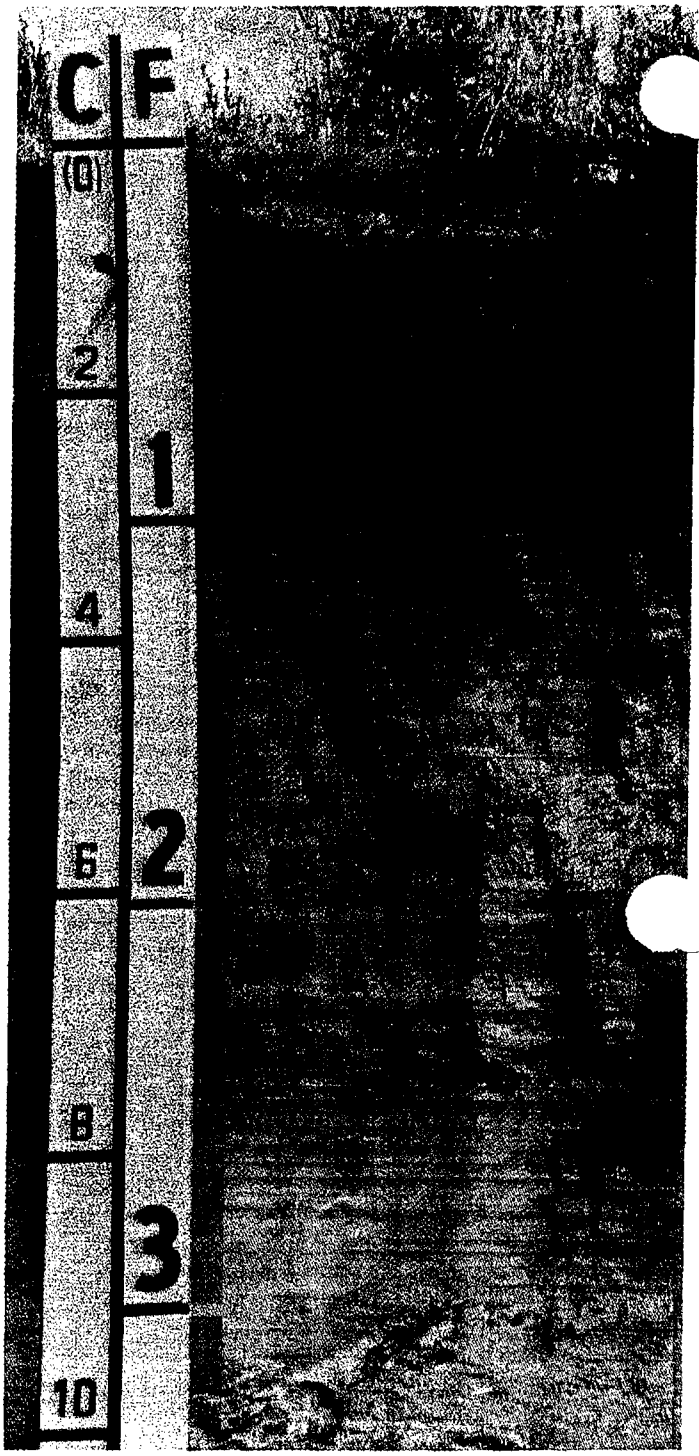

Figure 3.—Profile of Bowbac sandy loam. Soft sandstone is at depth of about 2.5 feet.

Cambria Series

The Cambria series consists of deep, well drained, moderately permeable soils on ridge crests, back slopes, foot slopes, and toe slopes of nearly level to rolling uplands. These soils formed in mixed residuum and local alluvium derived from shale and sandstone. Slope is 0 to 15 percent.

Typical pedon of a Cambria fine sandy loam in an area of Forkwood-Cambria fine sandy loams, 0 to 6 percent slopes, 2,000 feet south and 500 feet east of the northwest corner of sec. 10, T. 36 N., R. 70 W.

A—0 to 2 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/3) moist; weak moderate subangular blocky structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bt1—2 to 4 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate coarse subangular structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; few thin clay films on faces of peds; neutral; clear wavy boundary.

Bt2—4 to 10 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; many moderately thick clay films on faces of peds; mildly alkaline; clear wavy boundary.

Bk—10 to 14 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; few thin clay films on faces of peds; strongly effervescent; common fine irregularly shaped calcium carbonate masses in the form of filaments and threads; moderately alkaline; gradual wavy boundary.

Bk1—14 to 29 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; violently effervescent; few fine soft masses of calcium carbonate; moderately alkaline; gradual wavy boundary.

Bk2—29 to 60 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist. It is fine sandy loam, sandy loam, loam, or clay loam.

The Bt horizon has hue of 2.5Y to 10YR, value of 5 or 6 when dry, and and chroma of 3 or 4. Texture is loam or clay loam. The Bt horizon is 24 to 34 percent clay.

The Bk horizon has hue of 2.5Y to 10YR, value of 5 to 7 when dry and 4 or 5 when moist, and chroma of 2 or 3.

Cambria Variant

The Cambria Variant consists of deep, well drained, moderately permeable soils in nearly level to undulating areas on toe slopes and alluvial flats. These soils formed in alluvium derived from interbedded shale and sandstone. Slope is 0 to 6 percent.

Typical pedon of a Cambria Variant fine sandy loam in an area of Cambria Variant-Forkwood Variant complex, 0 to 6 percent slopes; 1,150 feet west and 400 feet south of the northeast corner of sec. 27, T. 39 N., R. 71 W.

A—0 to 2 inches; light gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky and granular structure; soft, very friable, nonsticky and nonplastic; neutral; abrupt smooth boundary.

Bw—2 to 5 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bt—5 to 9 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; common moderately thick clay films on faces of peds; neutral; clear smooth boundary.

Bt—9 to 16 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; fine medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; slightly effervescent; few fine soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

2Bk1—16 to 30 inches; light brownish gray (2.5Y 6/2), stratified clay loam, loam, and fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; few fine soft masses of calcium carbonate; moderately alkaline; gradual smooth boundary.

2Bk2—30 to 60 inches; light brownish gray (2.5Y 6/2), stratified loam, sandy clay loam, and sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; few fine soft masses of calcium carbonate; moderately alkaline.

Depth to carbonates ranges from 8 to 12 inches. Depth to stratified textures ranges from 12 to 24 inches. The profile is 0 to 5 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 2 or

3. Texture is fine sandy loam or sandy loam. Reaction is neutral or mildly alkaline.

The Bt horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 2 or 3. Texture is fine sandy loam or sandy loam. Reaction is neutral or mildly alkaline.

The 2Bk horizon and the C horizon, where present, have hue of 10YR or 2.5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 or 3. Texture varies, but centers on loam or clay loam with thin coarser textured strata. Reaction is mildly alkaline or moderately alkaline.

Clarkelen Series

The Clarkelen series consists of deep, somewhat excessively drained, moderately rapidly permeable soils on flood plains and low stream terraces. These soils formed in stratified Recent alluvium derived from sedimentary rock. Slope is 0 to 3 percent.

Typical pedon of a Clarkelen sandy loam in an area of Clarkelen-Draknab complex, 0 to 3 percent slopes, 2,130 feet north and 285 feet east of the southwest corner of sec. 31., T. 41 N., R. 69 W.

A—0 to 1 inch; pale brown (10YR 6/3) sandy loam, grayish brown (10YR 5/2) moist; weak thin platy structure parting to moderate very fine granular; soft, very friable; slightly effervescent; mildly alkaline; clear smooth boundary.

AC—1 to 3 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; soft, very friable; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—3 to 37 inches; light brownish gray (10YR 6/2) and pale brown (10YR 6/3), stratified sandy loam, loamy sand, sandy clay loam, and silt loam, grayish brown (10YR 5/2) and brown (10YR 5/3) moist; massive; soft, very friable; slightly effervescent; mildly alkaline; clear smooth boundary.

C2—37 to 60 inches; light brownish gray (10YR 6/2) sand, grayish brown (10YR 5/2) moist; single grain; loose; slightly effervescent; mildly alkaline.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist. It is sandy loam, loamy sand, or loam.

Cushman Series

The Cushman series consists of moderately deep, well drained, moderately permeable soils on upland ridges, back slopes, and pediment slopes. These soils formed in residuum derived dominantly from calcareous shale and sandstone. Slope is 0 to 15 percent.

Typical pedon of a Cushman loam in an area of Cambria-Cushman complex, 6 to 15 percent slopes, in the SW1/4 of sec. 15, T. 38 N., R. 72 W.

A—0 to 3 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bt—3 to 9 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to coarse angular blocky; hard, firm, slightly sticky and slightly plastic; common moderately thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Btk—9 to 17 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate coarse angular blocky structure parting to moderate medium angular blocky; hard, firm, slightly sticky and slightly plastic; common thin clay films on faces of peds; effervescent; mildly alkaline; gradual wavy boundary.

Bk—17 to 25 inches; pale yellow (2.5Y 7/4) loam, light yellowish brown (2.5Y 6/4) moist; hard, friable, sticky and slightly plastic; strongly effervescent; moderately alkaline, clear smooth boundary.

Crk—25 to 35 inches; calcareous shale; common fine soft masses of calcium carbonate, abrupt smooth boundary.

2Cr—35 inches; calcareous sandstone.

The depth to bedrock ranges from 24 to 35 inches. The depth to calcium carbonate ranges from 9 to 18 inches.

The A horizon has chroma of 2 or 3.

The Bt and Btk horizons have value of 5 or 6 when and 4 or 5 when moist. Reaction is neutral to modera. alkaline. The Bk horizon has value of 5 to 7 when dry and 4 to 6 when moist.

Draknab Series

The Draknab series consists of deep, excessively drained, rapidly permeable soils on flood plains. These formed in Recent alluvium derived dominantly from calcareous sedimentary rock. Slope is 0 to 3 percent.

Typical pedon of a Draknab loamy sand in an area of Clarkelen-Draknab complex, 0 to 3 percent slopes, 1,900 feet north and 400 feet east of the southwest corner of sec. 5, T. 40 N., R. 74 W.

A1—0 to 2 inches; yellowish brown (10YR 5/4) loamy sand, brown (10YR 4/3) moist; weak medium and fine granular structure; soft, very friable, nonsticky and nonplastic; strongly effervescent; moderately alkaline; abrupt smooth boundary.

AC—2 to 8 inches; yellowish brown (10YR 5/4) sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—8 to 18 inches; very pale brown (10YR 7/3) sand, yellowish brown (10YR 5/4) moist; single grain; loose; strongly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.
C2—18 to 26 inches; pale brown (10YR 6/3) loamy coarse sand, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable; strongly effervescent; moderately alkaline; gradual smooth boundary.
C3—26 to 60 inches; very pale brown (10YR 7/3), stratified coarse sand and loamy sand, pale brown (10YR 6/3) moist; single grain; loose; strongly effervescent; moderately alkaline.

The profile typically is calcareous throughout, but depth to calcium carbonate is as much as 10 inches. Coarse fragment content ranges from 0 to 15 percent.

The A horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 4. Texture is loam, sandy loam, or loamy sand. Reaction is mildly alkaline or moderately alkaline.

The C horizon has hue of 2.5Y to 7.5YR. Most pedons are highly stratified. Texture is loamy sand, loamy coarse sand, or sand. Thickness and texture of the strata are highly variable. Reaction is mildly alkaline to strongly alkaline.

Dwyer Series

The Dwyer series consists of deep, excessively drained, rapidly permeable soils on dunes. These soils formed in eolian sand. Slope is 0 to 15 percent.

Typical pedon of a Dwyer loamy sand in an area of Dwyer-Orpha loamy sands, 3 to 15 percent slopes, 50 feet west and 1,050 feet north of the southeast corner of sec. 29, T. 35 N., R. 73 W.

A—0 to 5 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; weak coarse granular structure parting to single grain; soft, loose; strongly effervescent; moderately alkaline; gradual wavy boundary.
AC—5 to 21 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; single grain; soft, loose; strongly effervescent; moderately alkaline; gradual wavy boundary.
C—21 to 60 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; single grain; soft, loose; strongly effervescent; moderately alkaline.

Carbonates commonly are throughout the profile, but in some pedons the carbonates are leached from the A and AC horizons.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 3 or 4. It is loamy sand to fine sand. The C horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. It is mildly alkaline or moderately alkaline. In some pedons a layer of sandy clay loam, clay loam, loam, or clay is below a depth of 40 inches.

Forkwood Series

The Forkwood series consists of deep, well drained, moderately permeable soils on foot slopes and toe slopes of rolling uplands. These soils formed in local alluvium that is derived from calcareous shale and in some places has a thin mantle of eolian deposits. Slope is 0 to 15 percent.

Typical pedon of a Forkwood fine sandy loam in an area of Forkwood-Cambria fine sandy loams, 0 to 6 percent slopes, 1,050 feet west and 1,600 feet north of the southeast corner of sec. 35, T. 36 N., R. 68 W.

A—0 to 4 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.
BA—4 to 7 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.
Bt—7 to 14 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; strong medium and coarse subangular blocky structure; thin continuous clay films on faces of peds; very hard, firm, sticky and plastic; neutral; clear smooth boundary.
Bk1—14 to 20 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; strongly effervescent; few fine calcium carbonate concretions; mildly alkaline; gradual wavy boundary.
Bk2—20 to 27 inches; light gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; weak coarse subangular blocky structure; very hard, friable, sticky and plastic; strongly effervescent; common fine soft masses and filaments of calcium carbonate; mildly alkaline; diffuse wavy boundary.
Bk3—27 to 60 inches; light gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; massive; very hard, friable, sticky and plastic; strongly effervescent; many medium soft masses of calcium carbonate; mildly alkaline.

The depth to calcium carbonate typically is 12 to 20 inches, but it is as much as 30 inches in some pedons.

The A horizon has hue of 10YR or less; it typically is 2.5Y. It has value of 3 to 5 when moist. Reaction is neutral or mildly alkaline.

The Bt horizon has hue of 10YR or 2.5Y, and it has value of 5 or 6 when dry.

The Bk horizon has hue of 10YR or 2.5Y. It is not present in some pedons that are deeply leached.

Forkwood Variant

The Forkwood Variant consists of deep, well drained, moderately slowly permeable soils in nearly level to undulating areas on toe slopes and alluvial flats. These soils formed in alluvium derived from shale with some interbedded sandstone. Slope is 0 to 6 percent.

Typical pedon of a Forkwood Variant clay loam in an area of Cambria Variant-Forkwood Variant complex, 0 to 6 percent slopes, 1,400 feet north and 1,100 feet west of the southeast corner of sec. 21, T. 39 N., R. 71 W.

A—0 to 3 inches; light gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; neutral; abrupt smooth boundary.

Bt1—3 to 9 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common thin clay films on faces of peds; neutral; clear smooth boundary.

Bt2—9 to 16 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; common thin clay films on faces of peds; neutral; clear smooth boundary.

2Bk1—16 to 30 inches; light gray (2.5Y 7/2), stratified loam, clay loam, and fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and plastic; few fine soft masses of calcium carbonate and concretions of calcium carbonate in a noncalcareous matrix; mildly alkaline; gradual smooth boundary.

2Bk2—30 to 60 inches; light gray (10YR 7/2), stratified clay loam and loam, grayish brown (10YR 5/2) moist; massive; hard, firm, sticky and plastic; slightly effervescent; few fine soft masses of calcium carbonate and concretions of calcium carbonate; moderately alkaline.

Depth to carbonates and stratified material ranges from 12 to 24 inches. Coarse fragments typically are absent, but where present they make up as much as 5 percent of the profile.

The A horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 to 6 when moist, and chroma of 2 or 3. Texture is loam or clay loam. Reaction is neutral or mildly alkaline.

The Bt horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3. Texture is clay loam or heavy loam. Reaction is neutral or mildly alkaline.

The 2Bk horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 or 3. Texture is stratified clay loam to fine sandy loam. Reaction is mildly alkaline or moderately alkaline.

Gateson Variant

The Gateson Variant consists of shallow, well drained, moderately permeable soils on upland shoulder slopes and back slopes. These soils formed in residuum derived dominantly from noncalcareous sandstone. Slope is 10 to 45 percent.

Typical pedon of a Gateson Variant loamy sand in an area of Gateson Variant-Tassel Variant association, 10 to 45 percent slopes, in the NE1/4NE1/4SW1/4 of sec. 12, T. 40 N., R. 77 W.

Oi—1 inch to 0; forest litter consisting largely of undecomposed pine needles.

E—0 to 4 inches; pinkish gray (7.5YR 7/2) loamy sand, pinkish gray (7.5YR 6/2) moist; weak medium platy structure; soft, very friable, nonsticky and nonplastic; neutral; clear smooth boundary.

Bt—4 to 11 inches; reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and plastic; common thin yellowish red (5YR 5/6) clay films on faces of peds; mildly alkaline; clear smooth boundary.

2C—11 to 16 inches; pinkish gray (5YR 7/2) clay, reddish brown (5YR 5/3) moist; massive; hard, f sticky and plastic; about 15 percent shale chips a sandstone channery fragments; mildly alkaline; gradual smooth boundary.

3Cr—16 inches; soft interbedded noncalcareous fractured sandstone and shale flagstones.

Depth to rock and thickness of the solum range from 15 to 24 inches. Coarse fragment content typically is less than 15 percent.

The Bt horizon typically is 18 to 35 percent clay, but in a few pedons it is as little as 15 percent clay. In some pedons there is a BK or CK horizon.

Haverdad Series

The Haverdad series consists of deep, well drained, moderately permeable soils on flood plains and low terraces. These soils formed in stratified Recent alluvium derived from sedimentary rock. Slope is 0 to 6 percent.

Typical pedon of a Haverdad fine sandy loam in an area of Haverdad-Lohmiller complex, 0 to 6 percent slopes, 1,300 feet east and 130 feet south of the northwest corner of sec. 31., T. 40 N., R. 68 W.

A—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist;

moderate medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

C1—6 to 10 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C2—10 to 60 inches; light brownish gray (10YR 6/2) loam stratified with sandy loam, clay loam, and loamy sand, grayish brown (10YR 5/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline.

The profile typically is leached in the A horizon, but some pedons are calcareous throughout.

The A horizon has chroma of 2 or 3. It is fine sandy loam, loam, silt loam, or sandy loam. Reaction is mildly alkaline or moderately alkaline.

The control section is clay loam, loam, or very fine sandy loam.

Heldt Series

The Heldt series consists of deep, well drained, slowly permeable soils on toe slopes and alluvial flats. These soils formed in local alluvium derived dominantly from calcareous shale. Slope is 0 to 6 percent.

Typical pedon of a Heldt clay loam in an area of Silhouette-Heldt association, 0 to 6 percent slopes; 1,200 feet east and 75 feet south of the northwest corner of sec. 15, T. 38 N., R. 71 W.

E—0 to 1 inch; light gray (10YR 7/2) clay loam, brown (10YR 5/3) moist; vesicular crust; massive; slightly hard, friable, sticky and plastic; slightly effervescent; neutral; abrupt smooth boundary.

AB—1 to 8 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak fine subangular blocky and granular structure; hard, firm, sticky and plastic; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw1—8 to 15 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak medium and fine subangular blocky structure; very hard, very firm, sticky and plastic; slightly effervescent; mildly alkaline; gradual smooth boundary.

Bw2—15 to 26 inches; light gray (10YR 7/2) clay, pale brown (10YR 6/3) moist; weak medium angular blocky structure; very hard, very firm, sticky and plastic; slightly effervescent; mildly alkaline; gradual smooth boundary.

C—26 to 35 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; massive; very hard, very firm, sticky and plastic; common distinct pressure faces at an angle of about 20 degrees from vertical; slightly effervescent; mildly alkaline; gradual smooth boundary.

Ck—35 to 60 inches; very pale brown (10YR 7/3) clay, yellowish brown (10YR 5/4) moist; massive; very hard, very firm, sticky and plastic; slightly effervescent; common medium seams and filaments of calcium carbonate; mildly alkaline.

Electrical conductivity typically is less than 4 millimhos per centimeter, and cation exchange capacity per 100 grams of clay ranges from 90 to 100.

The E horizon has hue of 10YR or 2.5Y and chroma of 2 or 3.

The Bw horizon has hue of 10YR or 2.5Y and chroma of 2 or 3.

The Ck horizon has hue of 10YR or 2.5Y. It is mildly alkaline or moderately alkaline.

Hiland Series

The Hiland series consists of deep, well drained, moderately permeable soils on back slopes of rolling uplands and adjacent foot slopes. These soils formed in residuum and local alluvium derived from soft calcareous sandstone and in eolian material. Slope is 0 to 15 percent.

Typical pedon of a Hiland sandy clay loam in an area of Hiland-Bowbac complex, 6 to 15 percent slopes, 3,000 feet west and 600 feet south of the northeast corner of sec. 26, T. 35 N., R. 75 W.

A—0 to 3 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; weak medium granular structure; soft, very friable, nonsticky and nonplastic; neutral; clear wavy boundary.

BA—3 to 10 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bt—10 to 19 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong very coarse prismatic structure parting to moderate coarse subangular blocky; hard, friable, sticky and plastic; many moderately thick clay bridges between sand grains; mildly alkaline; clear smooth boundary.

Btk—19 to 24 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; many moderately thick clay bridges between sand grains; strongly effervescent; common fine irregularly shaped calcium carbonate filaments and threads; moderately alkaline; gradual wavy boundary.

Bk1—24 to 36 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; moderate coarse subangular blocky structure; hard,

friable, sticky and plastic; strongly effervescent; common fine calcium carbonate filaments; moderately alkaline; gradual wavy boundary.
Bk2—36 to 60 inches; light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, sticky and plastic; strongly effervescent; common fine irregularly shaped calcium carbonate filaments and threads; moderately alkaline.

The depth to calcium carbonate ranges from 15 to 30 inches.

The A horizon is sandy loam or sandy clay loam.

The Bt horizon has hue of 2.5Y to 10YR, and it has value of 5 or 6 when dry and 4 or 5 when moist. Clay content averages 24 to 34 percent. Reaction is neutral to moderately alkaline. The Bk horizon has hue of 2.5Y to 10YR, and it has value of 4 or 5 when moist. Reaction is mildly alkaline or moderately alkaline.

Keeline Series

The Keeline series consists of deep, somewhat excessively drained, moderately rapidly permeable soils on ridges and sides slopes of rolling uplands. These soils formed in wind-worked residuum derived dominantly from calcareous sandstone. Slope is 6 to 15 percent.

Typical pedon of a Keeline sandy loam in an area of Keeline-Tassel-Turnback complex, 6 to 15 percent slopes; 2,100 feet north and 400 feet west of the southeast corner of sec. 29, T. 40 N., R. 75 W.

A—0 to 3 inches; yellowish brown (10YR 5/4) sandy loam, brown (10YR 4/3) moist; weak fine subangular blocky and granular structure; soft, very friable, nonsticky and nonplastic; slightly effervescent; mildly alkaline; abrupt smooth boundary.
Bw—3 to 8 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; calcium carbonate disseminated throughout matrix; mildly alkaline; clear smooth boundary.
C1—8 to 17 inches; very pale brown (10YR 7/3) sandy loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; strongly effervescent; calcium carbonate disseminated throughout matrix; moderately alkaline; gradual smooth boundary.
C2—17 to 30 inches; very pale brown (10YR 7/3) sandy loam, pale brown (10YR 6/3) moist; massive; soft, very friable, nonsticky and nonplastic; strongly effervescent; calcium carbonate disseminated throughout matrix; moderately alkaline; gradual smooth boundary.
C3—30 to 60 inches; very pale brown (10YR 7/3) sandy loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; strongly effervescent; calcium carbonate disseminated throughout matrix; moderately alkaline

The profile is calcareous throughout in most pedons but in some pedons the upper few inches is leached.

The A horizon has hue of 7.5YR or 10YR and chroma of 3 or 4. Reaction is mildly alkaline or neutral.

The C horizon has hue of 7.5YR to 2.5Y. Reaction is moderately alkaline or strongly alkaline.

Kishona Series

Kishona series consists of deep, well drained, moderately permeable soils on upland hill slopes and on adjacent toe slopes, foot slopes, and alluvial flats and fans. These soils formed in calcareous local alluvium derived dominantly from sedimentary rock. Slope is 0 to 15 percent.

Typical pedon of a Kishona loam in an area of Theedle-Kishona association, 6 to 15 percent slopes; 2,600 feet east and 50 feet north of the southwest corner of sec. 35, T. 38 N., R. 75 W.

A—0 to 3 inches; brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak fine and medium granular structure; soft, friable, slightly sticky and slightly plastic; violently effervescent; moderately alkaline; abrupt smooth boundary.
AC—3 to 12 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; violently effervescent; moderately alkaline clear smooth boundary.
C1—12 to 36 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; violently effervescent; few fine soft masses of calcium carbonate; moderately alkaline; gradual smooth boundary.
C2—36 to 60 inches; light gray (2.5Y 7/2) clay loam, light yellowish brown (2.5Y 6/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; violently effervescent; few fine soft masses of calcium carbonate; moderately alkaline.

The A horizon is loam or light clay loam.

The C horizon has hue of 10YR or 2.5Y. Reaction is moderately alkaline or strongly alkaline.

Lohmiller Series

The Lohmiller series consists of deep, well drained, moderately slowly permeable soils on narrow flood plains. These soils formed in stratified Recent alluvium derived from sedimentary rock. Slope is 0 to 6 percent.

Typical pedon of a Lohmiller clay loam in an area of Haverdad-Lohmiller complex, 0 to 6 percent slopes,

1,980 feet south and 1,580 feet west of the northeast corner of sec. 35, T. 37 N., R. 73 W.

A—0 to 3 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; slightly effervescent; mildly alkaline; clear smooth boundary.

AC—3 to 16 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; moderate medium and fine subangular blocky structure; hard, very firm, sticky and plastic; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—16 to 19 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, slightly sticky and nonplastic; slightly effervescent; moderately alkaline; clear wavy boundary.

C2—19 to 60 inches; light yellowish brown (2.5Y 6/4) and brown (10YR 5/3), stratified sandy clay loam, sandy loam, and sandy clay, light olive brown (2.5Y 5/4) and brown (10YR 4/3) moist; massive; hard, friable, slightly sticky and plastic; slightly effervescent; moderately alkaline.

The profile commonly is calcareous throughout, but in some pedons the upper few inches is leached.

The A horizon has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3. Reaction is mildly alkaline to strongly alkaline.

The C horizon has hue of 2.5Y or 10YR. Reaction is moderately alkaline or strongly alkaline. The control section is heavy clay loam or silty clay.

Orella Series

The Orella series consists of shallow, well drained, slowly permeable soils on back slopes and ridgetops of uplands. These soils formed in residuum derived from sodic shale. Slope is 3 to 25 percent.

Typical pedon of an Orella clay loam in an area of Orella-Rock outcrop-Samday complex, 3 to 30 percent slopes, 1,800 feet north and 1,200 feet west of the southeast corner of sec. 2, T. 40 N., R. 71 W.

A—0 to 4 inches; light gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few medium and fine roots; slightly effervescent; moderately alkaline; clear smooth boundary.

ACk—4 to 13 inches; light gray (2.5Y 7/2) light clay, light brownish gray (2.5Y 6/2) moist; moderate fine angular blocky structure; hard, firm, sticky and plastic; few fine roots; content of shale fragments increases with increasing depth; strongly effervescent; common medium seams of calcium carbonate; moderately alkaline; gradual smooth boundary.

Ck—13 to 20 inches; light brownish gray (2.5Y 6/2) clay between weathered shale fragments, grayish brown (2.5Y 5.2) moist; common medium yellowish red (5YR 5/6) oxide stains on shale fragments; massive; hard, firm, very sticky and very plastic; few fine and very fine roots; noneffervescent; few medium and fine calcium carbonate concretions; moderately alkaline; gradual smooth boundary.

Cr—20 to 60 inches; light gray (2.5Y 7/2) shale, grayish brown (2.5Y 5.2) moist; common medium and fine olive yellow (2.5Y 6/8) and brownish yellow (10YR 6/8) oxides and oxide stains; noneffervescent.

The depth to shale ranges from 10 to 20 inches. The profile commonly is calcareous throughout, but in some pedons it is leached to a depth of as much as 10 inches.

The A horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 or 3. It is typically clay loam or clay.

The Ck horizon has hue of 2.5Y or 10YR, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 or 3. It is clay or heavy clay loam.

Orpha Series

The Orpha series consists of deep, excessively drained, very rapidly permeable soils on dunes. These soils formed in eolian sand. Slope is 0 to 15 percent.

Typical pedon of an Orpha loamy sand in an area of Dwyer-Orpha loamy sands, 3 to 15 percent slopes, 200 feet west and 1,250 feet south of the northeast corner of sec. 31, T. 41 N., R. 67 W.

A—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; weak moderate and coarse granular structure parting to single grain; loose; mildly alkaline; gradual wavy boundary.

C—6 to 60 inches; light brownish gray (10YR 6/2) sand, grayish brown (10YR 5/2) moist; single grain; loose; mildly alkaline.

Depth to calcium carbonate ranges from 40 to 60 inches or more.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 or 3. It is loamy sand or sand.

The C horizon has value of 6 or 7 when dry and 5 or 6 when moist, and it has chroma of 2 to 4. Clay content ranges from 3 to 10 percent. Reaction is neutral or mildly alkaline.

Renohill Series

The Renohill series consists of moderately deep, well drained, slowly permeable soils on upland ridgetops,

back slopes, and foot slopes. These soils formed in residuum derived from soft shale. Slope is 0 to 15 percent.

Typical pedon of a Renohill fine sandy loam in an area of Ulm-Renohill complex, 0 to 6 percent slopes, 2,640 feet south of the northeast corner of sec. 31, T. 38 N., R. 68 W.

A—0 to 5 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak fine and medium granular structure; soft, very friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bt—5 to 20 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; strong coarse prismatic structure parting to coarse subangular blocky; very hard, very firm, sticky and plastic; common moderately thick clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bk—20 to 36 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; slightly effervescent; few fine soft white filaments and threads of carbonates; moderately alkaline.

Cr—36 inches; calcareous shale.

The depth to bedrock ranges from 20 to 40 inches. The depth to calcium carbonate ranges from 10 to 20 inches.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 or 3. It is fine sandy loam or clay loam.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 7 when dry and 4 or 5 when moist, and chroma of 2 to 4. It is clay or clay loam and averages 37 to 46 percent clay. Reaction is neutral to moderately alkaline.

The Bk horizon has value of 6 or 7 when dry and chroma of 2 to 4. It is moderately alkaline or strongly alkaline.

The Cr horizon is calcareous shale or sandstone.

Samday Series

The Samday series consists of shallow, well drained, very slowly permeable soils on summits, shoulder slopes, and ridges of upland hills and on scarps where the shale beds have been exposed by geologic erosion. These soils formed in residuum derived from soft calcareous shale. Slope is 3 to 30 percent.

Typical pedon of a Samday clay loam in an area of Samday-Shingle-Worf complex, 3 to 15 percent slopes, 2,500 feet north and 1,600 feet west of the southeast corner of sec. 36, T. 37 N., R. 69 W.

A—0 to 2 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate coarse platy structure parting to weak fine granular; slightly hard, friable, sticky and plastic; effervescent; disseminated carbonates; moderately alkaline; gradual wavy boundary.

C—2 to 10 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; strong coarse subangular blocky structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; strongly effervescent; disseminated carbonates; moderately alkaline; gradual wavy boundary.

Cky—10 to 18 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; hard, firm, sticky and plastic; strongly effervescent; gypsum crystals and many fine soft filaments and threads of carbonates and gypsum crystals; about 20 percent soft weathered shale chips; moderately alkaline, clear wavy boundary.

Cr—18 inches; calcareous shale and sandstone.

The A horizon has value of 6 or 7 when dry and 5 or 6 when moist. It is clay loam or clay.

The AC horizon has value of 6 or 7 when dry and 5 or 6 when moist, and it has chroma of 2 or 3. Reaction is moderately alkaline or strongly alkaline.

The Cky horizon has value of 5 or 6 when moist. Reaction is neutral to moderately alkaline.

The Cr horizon is calcareous shale or sandstone.

Savageton Series

The Savageton series consists of moderately deep, well drained, slowly permeable soils on toe slopes an alluvial flats. These soils formed in residuum or local alluvium derived from calcareous shale. Slope is 0 to 6 percent.

Typical pedon of a Savageton clay loam in an area of Bahl-Savageton complex, 0 to 6 percent slopes, 400 feet north and 750 feet west of the southeast corner of sec. 31, T. 37 N., R. 68 W.

A—0 to 2 inches; gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist; moderate medium platy structure and moderate medium granular; slightly hard, friable, sticky and plastic, mildly alkaline; clear wavy boundary.

Bw—2 to 22 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; moderate coarse prismatic structure that parts to moderate medium subangular blocky; hard, firm, sticky and plastic; slightly effervescent; moderately alkaline; abrupt wavy boundary.

Bk1—22 to 28 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; moderate coarse subangular blocky structure parting to fine subangular blocky; hard, firm, sticky and plastic; many moderately thick clay films on faces of peds; strongly effervescent; common fine irregularly

shaped filaments or threads of calcium carbonate; moderately alkaline; clear smooth boundary.
Bk2—28 to 32 inches; grayish brown (10YR 5/2) clay, dark brown (10YR 4/2) moist; massive; hard, firm, sticky and plastic; strongly effervescent; common fine irregularly shaped filaments or threads of calcium carbonate; moderately alkaline; abrupt wavy boundary.
Cr—32 inches; calcareous platy shale.

The depth to calcium carbonate ranges from 10 to 22 inches. Depth to bedrock ranges from 32 to 39 inches.

The A horizon has value of 4 to 6 when dry and chroma of 1 or 2.

The Bw horizon has value of 5 or 6 when dry. It averages 35 to 40 percent clay.

Sear Series

The Sear series consists of very shallow, well drained, moderately permeable soils on hill slopes and on the summit of buttes. These soils formed in residuum derived from porcellanite. Slope is 0 to 15 percent.

Typical pedon of a Sear loam in an area of Sear-Wibaux complex, 0 to 15 percent slopes, 1,825 feet north and 1,650 feet west of the southeast corner of sec. 2, T. 40 N., R. 71 W.

A—0 to 2 inches; pinkish gray (7.5YR 6/2) loam, brown (7.5YR 4/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots and few medium roots; about 15 percent reddish yellow (5YR 6/8) and red (2.5YR 6/8) porcellanite fragments 0.25 to 1.0 inch in diameter; neutral; clear smooth boundary.
Bt—2 to 9 inches; brown (7.5YR 5/4) channery loam, dark brown (7.5YR 4/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and slightly plastic; few thin clay films on faces of peds; common fine and very fine roots; about 30 percent red (2.5YR 6/8) and brown (7.5YR 5/4) porcellanite fragments 0.25 inch to 2.0 inches in diameter; neutral; clear irregular boundary.
Bk1—9 to 35 inches; red (2.5YR 6/8) and reddish yellow (5YR 6/8) porcellanite fragments 0.5 inch to 4.0 inches in diameter; light brown (7.5YR 6/4) loam fills voids in upper part of horizon and decreases to a trace in lower part; calcium carbonate coating on undersides of larger fragments; diffuse wavy boundary.
Bk2—35 to 60 inches; red (2.5YR 5/6 and 5/8) porcellanite fragments 1 inch to 4 inches in diameter; traces of red (2.5YR 5/6) sandy loam in vertical and horizontal fractures in upper part.

Depth to calcium carbonate ranges mainly from 5 to 10 inches, but it is as much as 20 inches in some pedons. Fragmented porcellanite makes up 90 percent or more of all horizons below a depth of 10 inches.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3. Reaction is neutral or mildly alkaline.

The Bt horizon has hue of 5YR to 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. It is clay loam or loam and is 10 to 35 percent porcellanite fragments. Reaction is neutral to moderately alkaline.

The Bk horizon has traces of soil material between porcellanite fragments.

Shingle Series

The Shingle series consists of shallow, well drained, moderately permeable soils on ridgetops, shoulder slopes, and back slopes of uplands and on scarps in areas where the shale beds have been exposed by geologic erosion. These soils formed in residuum derived from soft calcareous shale. Slope is 3 to 45 percent.

Typical pedon of a Shingle clay loam in an area of Worf-Shingle-Tassel complex, 3 to 30 percent slopes, 1,320 feet west and 550 feet north of the southeast corner of sec. 30, T. 40 N., R. 68 W.

A—0 to 4 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate very thin and thin platy structure parting to moderate very fine and fine granular; slightly hard, friable, slightly sticky and slightly plastic; slightly effervescent; disseminated carbonates; moderately alkaline; clear wavy boundary.
C—4 to 18 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky and plastic; strongly effervescent; disseminated carbonates; about 15 percent shale fragments; strongly alkaline, clear wavy boundary.
Cr—18 inches; calcareous shale.

The A horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 or 5 when moist, and chroma of 2 to 4. It is clay loam, very fine sandy loam, loam, or sandy clay loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 4. It is mildly alkaline to strongly alkaline.

Silhouette Series

The Silhouette series consists of deep, well drained, slowly permeable soils on foot slopes and alluvial flats. These soils formed in local alluvium derived dominantly from calcareous shale. Slope is 0 to 6 percent.

Typical pedon of a Silhouette clay loam in an area of Silhouette-Heldt association, 0 to 6 percent slopes, 150

feet west and 600 feet south of the northeast corner of sec. 20, T. 39 N., R. 71 W.

A—0 to 2 inches; light brownish gray (10YR 6/2) clay loam, brown (10YR 5/3) moist; weak medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly effervescent; mildly alkaline; abrupt smooth boundary.

BA—2 to 6 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; slightly effervescent; moderately alkaline; clear smooth boundary.

Bw1—6 to 14 inches; pale brown (10YR 6/3) clay, grayish brown (10YR 5/2) moist; weak fine prismatic structure; hard, friable, sticky and plastic; slightly effervescent; moderately alkaline; clear smooth boundary.

Bw2—14 to 22 inches; pale brown (10YR 6/3) clay, grayish brown (10YR 5/2) moist; weak fine angular blocky structure; very hard, firm, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; gradual smooth boundary.

Bk1—22 to 34 inches; very pale brown (10YR 7/3) clay, light brownish gray (10YR 6/2) moist; massive; very hard, firm, slightly sticky and slightly plastic; slightly effervescent; common medium seams and filaments of calcium carbonate; moderately alkaline; gradual smooth boundary.

Bk2—34 to 60 inches; light gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) moist; massive; very hard, very firm, slightly sticky and slightly plastic; slightly effervescent; few medium soft calcium carbonate masses and iron concretions; mildly alkaline.

Electrical conductivity typically is less than 4 millimhos per centimeter, and cation exchange capacity per 100 grams of clay ranges from 80 to 90.

Tassel Series

The Tassel series consists of shallow, well drained, moderately rapidly permeable soils on shoulder slopes and ridgetops of uplands. These soils formed in residuum derived from soft calcareous sandstone. Slope is 3 to 30 percent.

Typical pedon of a Tassel loamy fine sand in an area of Tassel-Tullock-Vonalee association, 6 to 30 percent slopes, 1,950 feet east and 375 feet south of the northwest corner of sec. 8, T. 40 N., R. 68 W.

A—0 to 2 inches; light brownish gray (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak medium and coarse granular structure; soft, very friable, nonsticky and nonplastic; slightly effervescent; disseminated carbonates; mildly alkaline; gradual wavy boundary.

AC—2 to 5 inches; light brownish gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; we medium and coarse granular structure; soft, very friable, nonsticky and nonplastic; slightly effervescent; disseminated carbonates; mildly alkaline; gradual wavy boundary.

C—5 to 16 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak very fine and fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine pores; slightly effervescent; disseminated carbonates; mildly alkaline, clear wavy boundary.

Cr—16 inches; soft, calcareous, light gray (5Y 7/1) sandstone.

The profile is neutral to moderately alkaline. It commonly has calcium carbonate throughout, but in a few areas it is noncalcareous.

The A horizon is loamy fine sand, loamy sand, sandy loam, or fine sandy loam.

The C horizon has chroma of 3 or 4. The control section is fine sandy loam or sandy loam.

Tassel Variant

The Tassel Variant consists of very shallow, well drained, moderately rapidly permeable soils on ridges of rolling and hilly uplands. These soils formed in residuum derived from calcareous sandstone interbedded with shale. Slope is 10 to 30 percent.

Typical pedon of a Tassel Variant very fine sandy l in an area of Gateson Variant-Tassel Variant association, 10 to 45 percent slopes, in the S1/4 of sec. 11, T. 40 N., R. 77 W.

A—0 to 4 inches; light yellowish brown (10YR 6/4) very fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; strongly effervescent; mildly alkaline; clear smooth boundary.

Ck—4 to 9 inches; gray (5YR 5/1) loam, dark gray (5YR 4/1) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; few fine soft masses and filaments of calcium carbonate; moderately alkaline; gradual wavy boundary.

Cr—9 inches; interbedded sedimentary rock, dominantly shale.

Depth to soft sedimentary rock ranges from 5 to 10 inches. Content of coarse fragments does not normally exceed 5 percent, but in some areas as much as 10 percent of the surface is covered with ironstone flagstones.

The A horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 2 to 4. Texture is fine sandy loam or very fine sandy loam. Reaction is neutral or mildly alkaline.

The Ck horizon has hue of 5YR to 10YR, value of 5 or when dry and 4 or 5 when moist, and chroma of 1 to 3. Texture is loam or sandy loam. Reaction is mildly alkaline or moderately alkaline.

Terro Series

The Terro series consists of moderately deep, somewhat excessively drained, moderately rapidly permeable soils on ridges, hill slopes, and pediment slopes of uplands. These soils formed in residuum derived from soft calcareous sandstone. Slope is 0 to 30 percent.

Typical pedon of a Terro sandy loam (fig. 4) in an area of Vonalee-Terro complex, 0 to 15 percent slopes, 1,000 feet west and 1,250 feet south of the northeast corner of sec. 17, T. 31 N., R. 74 W.

A—0 to 4 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak medium and fine granular structure; loose, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bt1—4 to 10 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic, clear smooth boundary.

Bt2—10 to 23 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common thin clay bridges between sand grains; mildly alkaline; clear smooth boundary.

Bk—23 to 34 inches; light gray (10YR 7/2) sandy loam, light brownish gray (10YR 6/2) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; violently effervescent; many fine irregularly shaped soft masses of calcium carbonate; moderately alkaline; clear irregular boundary.

Cr—34 inches; white (10YR 8/2) calcareous coarse-grained soft sandstone.

The depth to continuous carbonates ranges from 15 to 30 inches. Depth to bedrock ranges from 26 to 39 inches.

The A horizon has value of 5 or 6 when dry and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The Bt horizon has value of 5 or 6 when dry and chroma of 3 or 4. Reaction is neutral to moderately alkaline.

The Bk horizon has value of 6 or 7 when dry and 5 or 6 when moist, and it has chroma of 2 to 4. It is neutral to moderately alkaline.

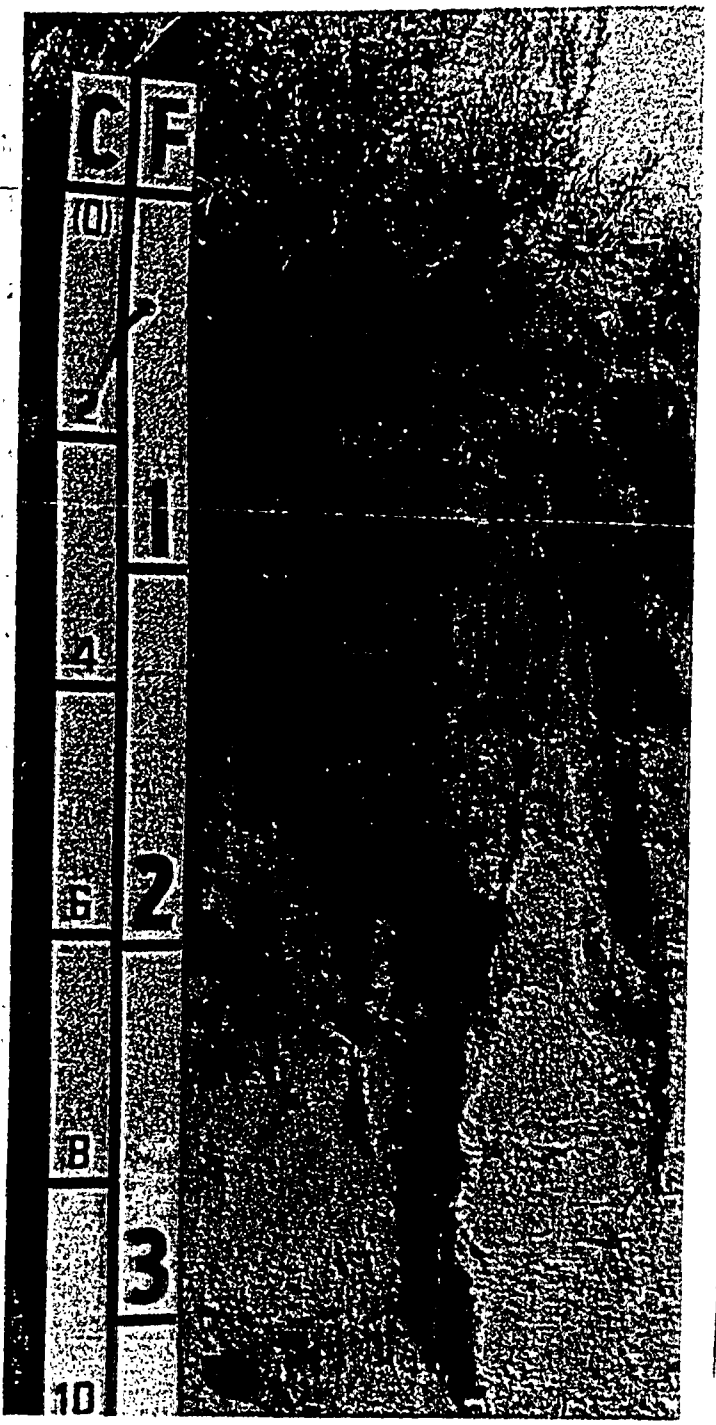

Figure 4.—Profile of Terro sandy loam. Soft sandstone is at depth of 2 feet; some roots have penetrated to depths of 3 feet in softer soils.

Theedle Series

The Theedle series consists of moderately deep, well drained, moderately permeable soils on ridges, hill slopes, and pediment slopes of uplands and on alluvial fans and foot slopes adjacent to major and minor drainageways. These soils formed in residuum derived from calcareous shale. Slope is 0 to 30 percent.

Typical pedon of a Theedle loam in an area of Zigweid-Cambria-Theedle association, 6 to 15 percent slopes, 1,580 feet south and 10 feet west of the northeast corner of sec. 19, T. 35 N., R. 67 W.

A—0 to 2 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; strongly effervescent; calcium carbonate disseminated throughout matrix; mildly alkaline; clear wavy boundary.

AC—2 to 5 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; strongly effervescent; calcium carbonate disseminated throughout matrix; mildly alkaline; gradual wavy boundary.

Ck—5 to 20 inches; light gray (10YR 7/2) loam, very pale brown (10YR 7/4) moist; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; common fine masses and seams of calcium carbonate; moderately alkaline; gradual wavy boundary.

Ck2—20 to 28 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; massive; very hard, friable, sticky and plastic; strongly effervescent; few fine soft masses and seams of calcium carbonate; strongly alkaline; clear wavy boundary.

Crk—28 to 48 inches; gray (10YR 5/1) clay shale changing with depth to light gray (10YR 6/1) noncalcareous; common medium seams and filaments of calcium carbonate that decrease in number and size as depth increases.

The C horizon has hue of 10YR to 5Y and value of 5 or 6 when moist. Reaction is moderately alkaline or strongly alkaline. Texture is loam or light clay loam.

Tullock Series

The Tullock series consists of moderately deep, excessively drained, rapidly permeable soils on shoulder slopes, back slopes, and ridges of upland hills. These soils formed in residuum derived from calcareous sandstone. Slope is 0 to 30 percent.

Typical pedon of a Tullock loamy sand in an area of Tassel-Tullock-Vonalee association, 6 to 30 percent slopes, 1,200 feet west and 1,000 feet north of the southeast corner of sec. 29, T. 35 N., R. 73 W.

A—0 to 5 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; weak medium and fine crumb structure; soft, loose; slightly effervescent disseminated calcium carbonate; mildly alkaline; clear wavy boundary.

AC—5 to 20 inches; brown (10YR 5/3) sand, dark brown (10YR 4/3) moist; massive; soft, loose; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear wavy boundary.

C—20 to 31 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; massive; soft, loose; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear wavy boundary.

Cr—31 inches; soft calcareous sandstone.

The depth to bedrock ranges from 24 to 36 inches.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. Reaction is mildly alkaline or moderately alkaline.

The AC horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. It is loamy sand, fine sand, loamy fine sand, or fine sandy loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 to 4. Reaction is mildly alkaline or moderately alkaline.

The Cr horizon is dominantly soft calcareous sandstone, but in some pedons it is interbedded with seams of calcareous shale.

Turnback Series

The Turnback series consists of moderately deep, well drained, moderately rapidly permeable soils on upland ridgetops and shoulders. These soils formed in wind-worked residuum derived from calcareous sandstone. Slope is 6 to 15 percent.

Typical pedon of a Turnback loamy fine sand in an area of Keeline-Tassel-Turnback complex, 6 to 15 percent slopes, 2,500 feet east and 1,900 feet north of the southwest corner of sec. 19, T. 39 N., R. 74 W.

A—0 to 4 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; weak fine granular structure; loose, nonsticky and nonplastic; few fine calcium carbonate seams; moderately alkaline; clear smooth boundary.

Bw1—4 to 8 inches; pale brown (10YR 6/3) sandy loam, yellowish brown (10YR 5/4) moist; weak medium and fine subangular blocky structure; loose, nonsticky and nonplastic; violently effervescent; few fine calcium carbonate seams; moderately alkaline; clear smooth boundary.

Bw2—8 to 20 inches; light yellowish brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) moist; weak medium subangular blocky structure; soft, very

friable, slightly sticky and slightly plastic; strongly effervescent; common medium and fine calcium carbonate seams; moderately alkaline; clear wavy boundary.

Bk1—20 to 30 inches; pale yellow (2.5Y 7/4) sandy loam, light olive brown (2.5Y 5/4) moist; massive with some inherited rock structural planes; soft, very friable, slightly sticky and slightly plastic; strongly effervescent; few medium and coarse soft masses of calcium carbonate and few fine calcium carbonate seams; moderately alkaline; gradual wavy boundary.

Cr—30 inches; yellow (10YR 7/8) soft calcareous sandstone; moderately alkaline; very slightly effervescent.

The profile commonly is leached in the upper few inches, but in some pedons it is calcareous throughout. Coarse fragment content is typically less than 5 percent.

Ulm Series

The Ulm series consists of deep, well drained, moderately permeable to slowly permeable soils on alluvial flats and toe slopes and on foot slopes of rolling uplands. These soils formed in local alluvium derived from soft calcareous shale. Slope is 0 to 15 percent.

Typical pedon of an Ulm loam in an area of Ulm-Bidman complex, 0 to 6 percent slopes, 751 feet west and 203 feet north of the southeast corner of sec. 32, T. 35 N., R. 70 W.

—0 to 5 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine and medium subangular blocky structure parting to moderate medium granular; slightly hard, very friable, slightly sticky and slightly plastic; neutral; gradual wavy boundary.

Bt1—5 to 9 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; hard, friable, sticky and plastic; few thin clay bridges between mineral grains; neutral; clear wavy boundary.

Bt2—9 to 21 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; strong fine and medium prismatic structure parting to strong fine and medium subangular blocky; very hard, very firm, very sticky and very plastic; many moderately thick clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bk1—21 to 36 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, very firm, sticky and plastic; strongly effervescent; common medium masses of carbonates; moderately alkaline; clear wavy boundary.

Bk2—36 to 60 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky and plastic; violently effervescent; common fine masses of carbonates; moderately alkaline.

The depth to calcium carbonate ranges from 15 to 28 inches.

The A horizon has value of 4 to 7 when dry and 4 or 5 when moist, and it has chroma of 2 or 3. It is loam or clay loam.

The Bt horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. Texture is clay, clay loam, or sandy clay that averages 37 to 45 percent clay. Reaction is neutral or mildly alkaline.

The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 1 to 4. Texture is clay loam, fine sandy loam, sandy loam, loam, or sandy clay loam. Reaction is moderately alkaline or strongly alkaline.

Ustic Torriorthents

Ustic Torriorthents are mainly deep, well drained soils of variable permeability around coal and uranium strip mines and porcellanite borrow areas. These soils formed in recently reclaimed overburden from mining operations. Slope is 3 to 30 percent.

Reference pedon of Ustic Torriorthents, reclaimed, 3 to 30 percent slopes, 800 feet south and 250 feet west of the northeast corner of sec. 10, T. 35 N., R. 75 W.

A—0 to 5 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; moderately acid; clear wavy boundary.

C1—5 to 9 inches; light gray (10YR 7/2) loamy sand, light brownish gray (10YR 6/2) moist; massive; loose, very friable, nonsticky and nonplastic; extremely acid; gradual broken boundary.

C2—9 to 15 inches; reddish yellow (7.5YR 6/8) loamy sand, strong brown (7.5YR 6.8) moist; massive; loose, very friable, nonsticky and nonplastic; extremely acid; gradual broken boundary.

C3—15 to 20 inches; light brownish gray (10YR 6/2) loamy sand, grayish brown (10YR 5/2) moist; massive; loose, very friable, nonsticky and nonplastic; about 10 percent fine coal fragments; extremely acid; gradual broken boundary.

C4—20 to 60 inches; light gray (10YR 7/2) loamy sand, light brownish gray (10YR 6/2) moist; massive; loose, very friable, nonsticky and nonplastic; very strongly acid.

Reaction ranges from extremely acid to moderately alkaline. The control section is loamy sand to clay loam.

Thin seams of mostly shale or coal fragments are present in some pedons.

Vonalee Series

The Vonalee series consists of deep, somewhat excessively drained, rapidly permeable soils in undulating to rolling areas on uplands and high terraces. These soils formed in eolian sand and wind-reworked sandstone residuum. Slope is 0 to 15 percent.

Typical pedon of a Vonalee loamy sand in an area of Vonalee-Terro complex, 6 to 15 percent slopes, 100 feet west and 1,600 feet north of southeast corner of sec. 29, T. 35 N., R. 73 W.

A—0 to 4 inches; yellowish brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) moist; moderate thin platy structure parting to weak fine granular; soft, loose, nonsticky and nonplastic; neutral; gradual wavy boundary.

BA—4 to 10 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; moderate coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; neutral; gradual wavy boundary.

Bt1—10 to 17 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few thin clay bridges between sand grains; mildly alkaline; gradual wavy boundary.

Bt2—17 to 24 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; moderate coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few thin clay bridges between sand grains; moderately alkaline; clear wavy boundary.

Bk1—24 to 44 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; moderate coarse prismatic structure; soft, loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline; clear wavy boundary.

Bk2—44 to 60 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, sticky and plastic; violently effervescent; many fine and medium irregularly shaped threads and filaments of calcium carbonate; moderately alkaline.

Wibaux Series

The Wibaux series consists of shallow, somewhat excessively drained, moderately permeable soils on hill slopes, buttes, and ridge crests of uplands. These soils formed in residuum derived from porcellanite. Slope is 0 to 45 percent.

Typical pedon of a Wibaux channery loam in an area of Sear-Wibaux complex, 0 to 15 percent slopes, 1,450 feet west and 1,300 feet south of the northeast corner of sec. 2, T. 40 N., R. 71 W.

A—0 to 4 inches; pinkish gray (7.5YR 6/2) channery loam, brown (7.5YR 5/4) moist; weak fine granular structure; soft, friable; about 35 percent red (2.5YR 4/8) porcellanite fragments 0.5 inch to 1.5 inches in diameter; mildly alkaline; clear smooth boundary.

AC—4 to 11 inches; light brown (7.5YR 6/4) very channery loam, brown (7.5YR 4/4) moist; very weak fine granular structure; soft, very friable; about 75 percent brown (7.5YR 4/4) porcellanite fragments 0.5 inch to 2.0 inches in diameter; neutral; clear smooth boundary.

C—11 to 28 inches; dark yellowish brown (10YR 4/6) fragmented porcellanite grading to strong brown (7.5YR 5/6) in the lower part; single grain; yellowish brown (10YR 5/6) sandy loam occupies narrow voids between 1- to 3-inch fragments; neutral; gradual wavy boundary.

Ck—28 to 60 inches; red (2.5YR 5/6) porcellanite flagstones underlain by red (2.5YR 5/6) fractured porcellanite; traces of light reddish brown (2.5YR 6/3) sandy loam, mostly along vertical fractures, extend to a depth of about 45 inches; calcium carbonate coatings on underside of larger flagstones.

Depth to calcium carbonate and porcellanite ranges from 10 to 20 inches.

The A horizon has hue of 2.5YR to 7.5YR, value or 6 when dry and 4 or 5 when moist, and chroma o to 4. Reaction is neutral or mildly alkaline. Texture is commonly loam that has 20 to 60 percent porcellanite fragments.

The C horizon has hue of 10R to 5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 6. Reaction is neutral to moderately alkaline. The horizon commonly is fractured porcellanite with loam or sandy loam in the voids in the upper part grading to largely in place fractured porcellanite with traces of soil in voids in the lower part.

Worf Series

The Worf series consists of shallow, well drained, moderately permeable soils on shoulder slopes, back slopes, and ridges and other summits of rolling uplands. These soils formed in residuum derived from interbedded shale and sandstone. Slope is 3 to 30 percent.

Typical pedon of a Worf fine sandy loam in an area of Worf-Shingle-Tassel complex, 3 to 30 percent slopes, in the NW1/4NW1/4NW1/4 of sec. 29, T. 35 N., R. 73 W.

A—0 to 2 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak thin platy structure parting to weak fine granular;

soft, loose, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bt1—2 to 8 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few thin clay films on ped faces; mildly alkaline; clear wavy boundary.

Bt2—8 to 14 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, sticky and plastic; common moderately thick clay films on ped faces; mildly alkaline; clear wavy boundary.

Bk—14 to 18 inches; light yellowish brown (2.5Y 5/3) sandy clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm, sticky and plastic; strongly effervescent; disseminated calcium carbonates and few fine calcium carbonate filaments; moderately alkaline; abrupt wavy boundary.

Cr—18 inches; soft calcareous shale.

Depth to calcium carbonate ranges from 7 to 18 inches, and depth to bedrock ranges from 14 to 19 inches. Rock fragment content is 0 to 18 percent but typically is less than 3 percent. In some areas gravel covers 15 percent of surface.

The A horizon has value 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 2 or 3. It is fine sandy loam, sandy loam, or loam.

The Bt horizon has hue of 2.5Y to 7.5YR, value of 5 to 7 when dry and 4 or 5 when moist, and chroma of 2 to . It is sandy clay loam, clay loam, or loam and is 22 to 34 percent clay. Reaction is neutral to moderately alkaline.

The Bk horizon has hue of 2.5Y or 10YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 4.

The Cr horizon is soft, interbedded shale and sandstone.

Worfka Series

The Worfka series consists of shallow, well drained, slowly permeable soils on summits and back slopes of undulating to rolling uplands. These soils formed in residuum derived from interbedded shale and sandstone. Slope is 0 to 15 percent.

Typical pedon of a Worfka fine sandy loam in an area of Renohill-Worfka-Shingle complex, 6 to 15 percent slopes, 2,640 feet south and 300 feet east of the northwest corner of sec. 21., T. 36 N., R. 70 W.

A—0 to 3 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure parting to moderate very fine granular; soft, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

Bt—3 to 8 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; strong coarse subangular blocky structure parting to moderately fine subangular blocky; slightly hard, friable, sticky and plastic; many moderately thick clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Btk—8 to 14 inches; light yellowish brown (10YR 6/4) clay loam, pale brown (10YR 6/3) moist; strong coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; many moderately thick clay films on faces of peds; strongly effervescent; common fine irregularly shaped calcium carbonate in seams; moderately alkaline; gradual wavy boundary.

Cr—14 inches; soft calcareous shale.

Depth to bedrock ranges from 10 to 20 inches.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. Texture is fine sandy loam, sandy loam, loam, or clay loam.

The Bt horizon has value 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 to 4. It is clay or clay loam. Reaction is neutral to moderately alkaline.

The Btk horizon has hue of 2.5Y to 10YR, value of 5 to 7 when dry and 5 or 6 when moist, and chroma of 2 to 4. It is mildly alkaline to strongly alkaline.

The Cr horizon is soft interbedded shale and sandstone.

Zigweid Series

The Zigweid series consists of deep, well drained, moderately permeable soils on foot slopes, toe slopes, and alluvial flats. These soils formed in local alluvium derived dominantly from calcareous shale. Slope is 0 to 15 percent.

Typical pedon of a Zigweid clay loam in an area of Zigweid-Cambria-Theedle association, 6 to 15 percent slopes, 300 feet east and 1,800 feet north of the southwest corner of sec. 4, T. 38 N., R. 74 W.

A—0 to 3 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; weak medium platy structure parting to weak fine subangular blocky; hard, friable, sticky and plastic; neutral; abrupt smooth boundary.

Bw—3 to 9 inches; pale brown (10YR 6/3) clay loam, grayish brown (10YR 5/2) moist; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; strongly effervescent; neutral; clear smooth boundary.

Bk1—9 to 28 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak fine subangular blocky structure; hard, friable, sticky and plastic; violently effervescent; common fine soft masses and filaments of calcium carbonate; moderately alkaline; gradual smooth boundary.

Bk2—28 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, sticky and plastic; violently effervescent; few fine soft masses and filaments of calcium carbonate; moderately alkaline.

The A horizon has hue of 10YR or 2.5YR. Some pedons have weak platy structure in the surface layer. Texture is loam or clay loam. Reaction is neutral to moderately alkaline.

The Bw horizon has hue of 10YR or 2.5Y and chr of 2 to 4. Reaction is neutral to moderately alkaline.

The Bk horizon has hue of 2.5YR or 10YR. Reaction centers on moderately alkaline. A Ck horizon is present in some pedons.

TABLE 11.--ENGINEERING INDEX PROPERTIES

[Symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
101*:											
Absted	0-3	Fine sandy loam	SM	A-4	0-5	85-100	85-100	65-80	35-50	15-20	NP-5
	30-60	Clay, clay loam	CH, CL	A-7	0	85-100	85-100	80-100	70-95	40-60	20-30
Arvada	0-3	Loam	CL-ML	A-4	0	90-100	95-100	85-95	70-80	15-25	5-10
	3-22	Clay	CL, CH	A-7	0	80-100	75-100	70-100	65-95	40-65	20-35
	22-60	Clay	CL	A-7	0	80-100	75-100	70-100	55-90	40-45	20-25
Bone	0-2	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-15
	2-5	Clay loam	CL, CH	A-7	0	90-100	90-100	80-90	70-80	40-55	20-35
	5-60	Clay loam, clay	CL, CH	A-7	0	90-100	90-100	80-90	70-80	40-55	20-35
102	0-8	Clay loam	CL	A-6, A-7	0	100	90-100	85-95	75-90	35-50	15-25
Aeric Haplaquepts	8-60	Clay	CL, CH	A-7	0	100	100	90-100	80-95	45-65	25-40
103*:											
Bahl	0-4	Clay	CL	A-6, A-7	0	100	95-100	85-100	60-80	35-45	15-25
	4-60	Clay	CL, CH	A-7	0	100	100	90-100	85-95	40-60	20-35
Savageton	0-2	Clay loam	CL, CH	A-7	0	100	100	90-100	85-95	40-55	20-35
	2-32	Clay	CL, CH	A-7	0	100	100	90-100	85-95	40-55	20-35
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
104:											
Cambria	0-2	Fine sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	2-10	Sandy clay loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	75-85	55-75	25-40	5-15
	10-60	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-95	70-80	25-40	5-15
Cushman	0-4	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	4-15	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	15-33	Sandy clay loam, clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	33	Weathered bedrock	---	---	---	---	---	---	---	---	---
105*:											
Cambria	0-4	Sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	4-8	Loam	CL-ML, ML	A-4	0	95-100	95-100	75-85	60-70	20-30	NP-10
	8-60	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	75-85	55-75	25-40	5-15
Cushman	0-3	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	3-17	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	17-25	Loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	25	Weathered bedrock	---	---	---	---	---	---	---	---	---
106*:											
Cambria Variant	0-2	Fine sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	---	NP
	2-16	Clay loam, loam	CL	A-6	0	95-100	95-100	75-85	60-70	30-40	10-15
	16-60	Stratified clay loam to sandy loam.	CL	A-6	0	95-100	95-100	75-85	55-65	25-35	10-15

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
106*:											
Forkwood Variant	0-3	Clay loam	CL	A-6	0	95-100	95-100	75-90	55-70	25-40	10-15
	3-16	Clay loam	CL	A-6	0	95-100	95-100	80-95	65-80	30-40	10-15
	16-60	Stratified fine sandy loam to clay loam.	CL-ML, CL	A-4, A-6	0	95-100	95-100	60-80	50-65	20-35	5-15
107*:											
Clarkelen	0-3	Sandy loam	SM	A-2, A-4	0	100	95-100	55-75	25-40	20-25	NP-5
	3-60	Stratified sand to silt loam	SM	A-2	0-5	95-100	90-100	55-70	25-35	---	NP
Draknab	0-2	Loamy sand	SM	A-2	0	100	95-100	50-70	20-35	---	NP
	2-60	Stratified sandy loam to sand.	SM, SP-SM	A-1, A-2, A-3	0-5	95-100	85-100	45-60	5-25	---	NP
108*:											
Clarkelen	0-3	Sandy loam	SM	A-2, A-4	0	100	95-100	55-75	25-40	20-25	NP-5
	3-60	Stratified sand to silt loam.	SM	A-2	0-5	95-100	90-100	55-70	25-35	---	NP
Dwyer	0-5	Loamy sand	SM	A-2	0	100	100	65-80	20-35	---	NP
	5-60	Loamy sand	SP-SM, SM	A-3, A-2	0	85-100	75-100	50-80	5-35	---	NP
Orpha	0-5	Loamy sand	SM	A-2	0	100	95-100	50-60	20-30	---	NP
	5-60	Sand	SM	A-2	0	100	95-100	60-80	15-35	---	NP
109*:											
Clarkelen	0-3	Sandy loam	SM	A-2, A-4	0	100	95-100	55-75	25-40	20-25	NP-5
	3-60	Stratified sand to silt loam.	SM	A-2	0-5	95-100	90-100	55-70	25-35	---	NP
Laverdad	0-6	Fine sandy loam	SM, ML	A-4	0	75-100	75-100	60-90	35-65	15-20	NP-5
	6-60	Stratified fine sandy loam to clay loam.	CL-ML, CL	A-4, A-6	0	75-100	75-100	70-90	50-60	25-35	5-15
Bigwinder	0-3	Fine sandy loam	SM	A-2	0	100	95-100	65-80	25-35	---	NP
	3-24	Stratified sand to loam.	SM, SM-SC	A-4	0	100	95-100	50-70	35-45	15-30	NP-10
110*:											
Cushman	0-4	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	4-15	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	15-33	Loam, clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	33	Weathered bedrock	---	---	---	---	---	---	---	---	---
Terro	0-4	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-23	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	23-34	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-40	20-25	NP-5
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
111*:											
Cushman	0-3	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	3-17	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	17-25	Loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	25	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Pl tic... index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
111*:											
Terro	0-4	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-23	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	23-34	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-40	20-25	NP-5
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
112*:											
Cushman	0-3	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	3-17	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	17-25	Loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	25	Weathered bedrock	---	---	---	---	---	---	---	---	---
Worf	0-2	Fine sandy loam	SM	A-4	0	100	95-100	70-95	35-45	---	NP
	2-18	Sandy clay loam	CL	A-6	0	100	95-100	65-85	60-75	25-40	10-20
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
113*:											
Dwyer	0-5	Loamy sand	SM	A-2	0	100	100	65-80	20-35	---	NP
	5-60	Loamy sand	SP-SM, SM	A-3, A-2	0	85-100	75-100	50-80	5-35	---	NP
Orpha	0-6	Loamy sand	SM	A-2	0	100	95-100	50-60	20-30	---	NP
	6-60	Sand	SM	A-2	0	100	95-100	60-80	15-35	---	NP
114*:											
Forkwood	0-7	Fine sandy loam	SM	A-2	0	75-100	75-100	50-85	20-35	20-25	NP-5
	7-60	Clay loam	CL	A-6	0	75-100	75-100	70-90	55-75	25-35	10-20
Cambria	0-2	Fine sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	2-10	Sandy clay loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	75-85	55-75	25-40	5-
	10-60	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-95	70-80	25-40	5-
115*:											
Forkwood	0-5	Fine sandy loam	SM	A-2	0	75-100	75-100	50-85	20-35	20-25	NP-5
	5-18	Clay loam	CL	A-6	0	75-100	75-100	70-90	55-75	25-35	10-20
	18-60	Loam	CL	A-6	0	75-100	75-100	70-90	55-75	25-40	10-25
Cambria	0-4	Sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	4-8	Loam	CL-ML, ML	A-4	0	95-100	95-100	75-85	60-70	20-30	NP-10
	8-60	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-95	70-80	25-40	5-15
Cushman	0-3	Loam	CL-ML, ML	A-4	0	90-100	90-100	70-85	60-70	20-30	NP-10
	3-17	Clay loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	17-25	Loam	CL	A-6	0	90-100	90-100	80-90	70-80	30-40	10-20
	25	Weathered bedrock	---	---	---	---	---	---	---	---	---
116*:											
Forkwood	0-7	Fine sandy loam	SM	A-2	0	75-100	75-100	50-85	20-35	20-25	NP-5
	7-60	Clay loam	CL	A-6	0	75-100	75-100	70-90	55-75	25-35	10-20
Ulm	0-5	Loam	CL-ML	A-4	0-5	95-100	95-100	80-100	70-80	20-30	5-10
	5-21	Clay loam, clay	CL	A-6, A-7	0-5	75-100	75-100	75-100	60-80	35-45	20-30
	21-36	Clay loam	CL	A-6	0-5	75-100	75-100	75-100	60-80	30-40	15-20
	36-60	Sandy clay loam	CL, SC	A-6	0-5	75-100	75-100	70-90	40-55	30-40	10-20
117*:											
Forkwood	0-7	Fine sandy loam	SM	A-2	0	75-100	75-100	50-85	20-35	20-25	NP-5
	7-60	Clay loam	CL	A-6	0	75-100	75-100	70-90	55-75	25-35	10-20
Ulm	0-4	Clay loam	CL	A-6	0-5	95-100	95-100	80-100	70-80	30-40	10-20
	4-16	Clay loam	CL	A-6, A-7	0-5	75-100	75-100	75-100	60-80	35-45	20-30
	16-60	Clay loam	CL	A-6	0-5	75-100	75-100	75-100	60-80	30-40	15-20

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
7*:											
Benohill	0-5	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-90	30-40	10-20
	5-25	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-80	30-40	15-25
	25	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
8*:											
Bateridge	0-4	Loamy sand	SM	A-2	0	100	85-100	75-90	15-30	---	NP
	4-11	Sandy clay loam	SC, CL	A-6	0	100	85-100	80-100	35-55	25-35	10-20
	11-16	Clay	CL, CH	A-7, A-6	0	100	80-100	80-100	60-90	30-60	15-35
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Bassel Variant	0-4	Very fine sandy loam.	SM	A-4	0-5	100	95-100	80-95	35-45	15-25	NP-5
	4-9	Loam	CL-ML, SM-SC	A-4	0	100	95-100	70-85	45-55	20-30	5-10
	9	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
9*. Bullied land											
10*:											
Laverdad	0-6	Fine sandy loam	SM, ML	A-4	0	75-100	75-100	60-90	35-65	15-20	NP-5
	6-60	Stratified fine sandy loam to clay loam.	CL-ML, CL	A-4, A-6	0	75-100	75-100	70-90	50-60	25-35	5-15
[illegible]	0-3	Clay loam	CL	A-6, A-7	0	100	95-100	90-100	70-85	35-50	12-25
	3-60	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	65-95	35-60	12-30
11*:											
Miland	0-5	Sandy loam	SM	A-2, A-4	0	95-100	90-100	65-75	30-40	20-25	NP-5
	5-30	Sandy clay loam	SC,CL	A-6	0	95-100	90-100	60-80	40-60	30-40	10-20
	30-60	Sandy Loam	SM	A-2	0	85-100	75-100	45-75	15-30	20-25	NP-5
Nowbac	0-3	Sandy loam	SM	A-2	0	90-100	90-100	65-80	35-50	15-25	NP-5
	3-18	Sandy clay loam	CL	A-6	0	90-100	90-100	70-85	50-60	25-40	10-20
	18-36	Sandy loam	SM-ML, SM-SC, CL-ML	A-4, A-6	0	90-100	90-100	60-80	45-55	25-35	5-15
	36	Weathered bedrock	---	---	---	---	---	---	---	---	---
12*:											
Miland	0-3	Sandy clay loam	SC	A-2, A-6	0	95-100	90-100	65-85	30-45	30-35	10-15
	3-60	Sandy clay loam	SC, CL	A-6	0	95-100	90-100	60-80	40-60	30-40	10-20
Nowbac	0-3	Sandy loam	SM	A-2	0	90-100	90-100	65-80	35-50	15-25	NP-5
	3-18	Sandy clay loam	CL	A-6	0	90-100	90-100	70-85	50-60	25-40	10-20
	18-36	Sandy loam	SM, ML, SM-SC, CL-ML	A-4, A-6	0	90-100	90-100	60-80	45-55	25-35	5-15
	36	Weathered bedrock	---	---	---	---	---	---	---	---	---
13*:											
Keeline	0-8	Sandy loam	SM	A-2, A-4	0	100	95-100	55-75	25-40	20-25	NP-5
	8-60	Sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	60-85	25-50	20-30	NP-10

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
123*:											
Tassel	0-2	Loamy fine sand	SM	A-2	0	95-100	90-100	65-95	15-30	---	NP
	2-16	Fine sandy loam,	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Turnback	0-4	Loamy fine sand	SM	A-2	0	100	95-100	75-90	20-35	---	NP
	4-30	Sandy loam	SM	A-2, A-4	0	100	95-100	60-80	30-40	15-25	NP-5
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
124*:											
Kishona	0-3	Loam	ML	A-4	0	85-100	75-100	65-85	55-75	25-30	NP-5
	3-60	Clay loam	CL-ML, CL	A-4, A-6	0	85-100	75-100	70-90	65-85	20-30	5-15
Dwyer	0-5	Loamy sand	SM	A-2	0	100	100	65-80	20-35	---	NP
	5-60	Loamy sand	SP-SM, SM	A-3, A-2	0	85-100	75-100	50-80	5-35	---	NP
Orpha	0-5	Loamy sand	SM	A-2	0	100	95-100	50-60	20-30	---	NP
	5-60	Loamy sand	SM	A-2	0	100	95-100	60-80	15-35	---	NP
125*:											
Orella	0-4	Clay loam	CH, CL	A-6, A-7	0	100	100	95-100	70-95	38-65	20-40
	4-20	Clay	CH	A-7	0	100	100	90-100	75-95	50-70	30-50
	20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Samday	0-2	Clay loam	CL	A-6, A-7	0	100	90-100	85-95	75-90	35-50	15-[illegible]
	2-18	Clay	CL, CH	A-6	0	100	95-100	85-100	75-95	40-55	20-[illegible]
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
126*. Pits											
127*:											
Renohill	0-5	Fine sandy loam	SM, ML	A-4	0	85-100	80-100	70-80	35-55	20-25	NP-5
	5-20	Clay	CL, CH	A-7, A-6	0	95-100	90-100	90-100	75-95	35-65	20-35
	20-36	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-80	30-40	15-25
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Worfka	0-6	Fine sandy loam	SM, ML	A-4	0	85-100	80-100	70-80	35-55	20-25	NP-5
	6-18	Clay loam, clay	CL	A-6, A-7	0	95-100	90-100	85-95	75-90	35-45	NP
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-18	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
128*:											
Renohill	0-5	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-90	30-40	10-20
	5-25	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-80	30-40	15-25
	25	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Worfka	0-3	Fine sandy loam	SM, ML	A-4	0	85-100	80-100	70-80	35-55	20-25	NP-5
	3-14	Clay loam, clay	CL	A-6, A-7	0	95-100	90-100	85-95	75-90	35-45	NP
	14	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

ame and ymbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
128*:											
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-18	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
129*:											
Samday	0-2	Clay loam	CL	A-6, A-7	0	100	90-100	85-95	75-90	35-50	15-30
	2-18	Clay	CL, CH	A-6	0	100	95-100	85-100	75-95	40-55	20-30
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-18	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Worf	0-2	Fine sandy loam	SM	A-4	0	100	95-100	70-95	35-45	---	NP
	2-18	Sandy clay loam	CL	A-6	0	100	95-100	65-85	60-75	25-40	10-20
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
130*:											
Sear	0-2	Loam	CL, CL-ML	A-6, A-4	0	75-100	75-100	65-80	60-70	25-40	5-15
	2-9	Channery loam	CL, CL-ML, GC, GM-GC	A-6, A-4	0	55-75	55-75	50-65	40-55	25-40	5-15
	9-60	Fragmental material.	GP	A-1	10-25	0-10	0-10	0-5	0-5	---	NP
F'	0-4	Channery loam	GM-GC, SM-SC	A-4	0-5	55-75	50-70	40-60	35-45	25-35	5-10
	4-11	Extremely channery loam.	GM-GC	A-2	0-25	30-55	25-50	20-35	20-30	25-35	5-10
	11-60	Fragmental material.	GP	A-1	0-25	0-10	0-5	0-5	0-5	---	NP
131*:											
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-13	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Samday	0-2	Clay loam	CL	A-6, A-7	0	100	90-100	85-95	75-90	35-50	15-30
	2-18	Clay	CL, CH	A-6	0	100	95-100	85-100	75-95	40-55	20-30
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
132*:											
Shingle	0-2	Loam	ML	A-4	0-5	75-100	75-100	70-95	55-75	25-35	NP-10
	2-9	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	9	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Tassel	0-2	Loamy fine sand	SM	A-2	0	95-100	90-100	65-95	15-30	---	NP
	2-8	Sandy loam	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	8	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

' footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Pl. tici.. index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
133*:											
Shingle----------	0-4	Clay loam---------	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-18	Clay loam---------	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Theedle----------	0-5	Loam--------------	CL-ML	A-4	0	95-100	95-100	70-85	60-70	20-30	5-10
	5-28	Loam, clay loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	70-85	60-70	25-40	5-20
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Cambria----------	0-4	Sandy loam--------	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	4-8	Loam--------------	CL-ML, ML	A-4	0	95-100	95-100	75-85	60-70	20-30	NP-10
	8-60	Loam--------------	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-95	70-80	25-40	5-15
134*:											
Silhouette------	0-2	Clay loam---------	CL	A-6, A-7	0	90-100	90-100	85-95	75-90	35-50	15-30
	2-22	Clay--------------	CL, CH	A-7	0	100	95-100	85-100	85-95	40-55	20-35
	22-60	Clay loam, clay	CL	A-6, A-7	0	100	95-100	85-100	75-95	35-50	15-30
Heldt------------	0-1	Clay loam---------	CL	A-7, A-6	0	95-100	95-100	95-100	75-95	35-45	20-30
	1-60	Clay--------------	CH, CL	A-7	0	95-100	95-100	95-100	75-95	45-55	25-35
135*:											
Tassel-----------	0-3	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	75-100	40-65	<35	NP-7
	3-14	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Shingle----------	0-4	Clay loam---------	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-
	4-18	Clay loam---------	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-2.
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
136*:											
Tassel-----------	0-2	Loamy fine sand	SM	A-2	0	95-100	90-100	65-95	15-30	---	NP
	2-16	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Terro------------	0-4	Sandy loam--------	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-34	Sandy loam--------	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
137*:											
Tassel-----------	0-2	Loamy fine sand	SM	A-2	0	95-100	90-100	65-95	15-30	---	NP
	2-16	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Tullock----------	0-5	Loamy sand--------	SM	A-2	0	100	100	75-90	25-35	---	NP
	5-31	Loamy sand, sand loamy sand, sand.	SM	A-2	0	100	100	70-90	10-35	---	NP
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
137*:											
Vonalee	0-3	Loamy sand	SM	A-2	0	100	95-100	70-90	20-30	---	NP
	3-24	Sandy loam	SM-SC, SM	A-2, A-4	0	100	90-100	55-75	30-40	20-30	NP-10
	24-60	Loamy sand	SM	A-2	0	100	90-100	70-90	20-30	---	NP
138*, 139*:											
Terro	0-4	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-34	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	
Tullock	0-5	Loamy sand	SM	A-2	0	100	100	75-90	25-35	---	NP
	5-31	Loamy sand, sand	SM	A-2	0	100	100	70-90	10-35	---	NP
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Orpha	0-5	Loamy sand	SM	A-2	0	100	95-100	50-60	20-30	---	NP
	5-60	Sand	SM	A-2	0	100	95-100	60-80	15-35	---	NP
140*, 141*:											
Theedle	0-5	Loam	CL-ML	A-4	0	95-100	95-100	70-85	60-70	20-30	5-10
	5-28	Loam, clay loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	70-85	60-70	25-40	5-20
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Kishona	0-3	Loam	ML	A-4	0	85-100	75-100	65-85	55-75	25-30	NP-5
	3-60	Clay loam	CL-ML, CL	A-4, A-6	0	85-100	75-100	70-90	65-85	20-30	5-15
[illegible]	0-4	Clay loam	CL	A-6	0-5	95-100	95-100	80-100	70-80	30-40	10-20
	4-17	Clay loam, clay	CL	A-6, A-7	0-5	75-100	75-100	75-100	60-80	35-45	20-30
	17-60	Clay loam	CL	A-6	0-5	75-100	75-100	75-100	60-80	30-40	15-20
Bidman	0-7	Sandy loam	SM	A-2, A-4	0	80-100	80-100	50-75	30-40	---	NP
	7-20	Clay	CH	A-7	0	80-100	80-100	80-100	70-90	50-60	30-40
	20-60	Clay loam	CL	A-6, A-7	0	80-100	80-100	75-100	65-80	35-45	20-30
143*:											
Ulm	0-5	Loam	CL-ML	A-4	0-5	95-100	95-100	80-100	70-80	20-30	5-10
	5-21	Clay loam, clay	CL	A-6, A-7	0-5	75-100	75-100	75-100	60-80	35-45	20-30
	21-36	Clay loam	CL	A-6	0-5	75-100	75-100	75-100	60-80	30-40	15-20
	36-60	Sandy clay loam	CL, SC	A-6	0-5	75-100	75-100	70-90	40-55	30-40	10-20
Renohill	0-5	Fine sandy loam	SM, ML	A-4	0	85-100	80-100	70-80	35-55	20-25	NP-5
	5-20	Clay	CL, CH	A-7, A-6	0	95-100	90-100	90-100	75-95	35-65	20-35
	20-36	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-80	30-40	15-25
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
144*:											
Ulm	0-4	Clay loam	CL	A-6	0-5	95-100	95-100	80-100	70-80	30-40	10-20
	4-16	Clay loam	CL	A-6, A-7	0-5	75-100	75-100	75-100	60-80	35-45	20-30
	16-60	Clay loam	CL	A-6	0-5	75-100	75-100	75-100	60-80	30-40	15-20
Renohill	0-5	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-90	30-40	10-20
	5-25	Clay loam	CL	A-6	0	85-100	80-100	80-95	70-80	30-40	15-25
	25	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
145. Ustic [illegible]riorthents	0-60	Variable	---	---	---	---	---	---	---	---	---

[illegible]ee footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
146*:											
Vonalee	0-4	Loamy sand	SM	A-2	0	100	95-100	70-90	20-30	---	NP
	4-24	Sandy loam	SM-SC, SM	A-2, A-4	0	100	90-100	55-75	30-40	20-30	NP-10
	24-44	Loamy sand	SM	A-2	0	100	90-100	70-90	20-30	---	NP
	44-60	Sandy loam	SM	A-2, A-4	0	100	95-100	60-90	30-45	---	NP
Terro	0-4	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-34	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	34	Unweathered bedrock	---	---	---	---	---	---	---	---	---
147*:											
Vonalee	0-4	Loamy sand	SM	A-2	0	100	95-100	70-90	20-30	---	NP
	4-24	Sandy loam	SM-SC, SM	A-2, A-4	0	100	90-100	55-75	30-40	20-30	NP-10
	24-60	Loamy sand, loam	SM	A-2	0	100	90-100	70-90	20-30	---	NP
Terro	0-4	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	---	NP
	4-34	Sandy loam	SM	A-2, A-4	0-15	100	100	60-90	30-45	20-25	NP-5
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
148*:											
Wibaux	0-4	Channery loam	GM-GC, SM-SC	A-4	0-5	55-75	50-70	40-60	35-45	25-35	5-10
	4-11	Extremely channery loam.	GM-GC	A-2	0-25	30-55	25-50	20-35	20-30	25-35	5-10
	11-60	Fragmental material.	GP	A-1	0-25	0-10	0-5	0-5	0-5	---	NP
Rock outcrop.											
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-13	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
149*:											
Worf	0-5	Loamy sand	SM	A-2	0	100	95-100	70-90	20-30	---	NP
	5-15	Clay loam	CL	A-6	0	100	95-100	65-85	60-75	25-40	10-20
	15	Weathered bedrock	---	---	---	---	---	---	---	---	---
Shingle	0-4	Clay loam	CL	A-6	0-5	75-100	70-100	65-100	50-80	35-40	15-20
	4-18	Clay loam	CL	A-6	0	75-100	75-100	65-100	50-80	30-40	10-20
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Tassel	0-3	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	75-100	40-65	<35	NP-7
	3-14	Fine sandy loam	ML, SM	A-4	0	95-100	90-100	65-95	40-65	<35	NP-7
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
150*:											
Zigweid	0-2	Loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
	2-60	Clay loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
Bahl	0-4	Clay	CL	A-6, A-7	0	100	95-100	85-100	60-80	35-45	15-25
	4-60	Clay	CL, CH	A-7	0	100	100	90-100	85-95	40-60	20-35

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

name and symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
151*:											
Zigweid	0-3	Clay loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
	3-60	Clay loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
Cambria	0-2	Fine sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	2-60	Clay loam, sandy clay loam, loam.	CL-ML, CL	A-4, A-6	0	95-100	95-100	75-85	55-75	25-40	5-15
152*:											
Zigweid	0-4	Loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
	4-60	Clay loam	CL	A-6	0	75-100	75-100	70-85	60-70	25-40	10-20
Cambria	0-4	Sandy loam	SM	A-4	0	95-100	95-100	60-80	35-45	20-25	NP-5
	4-8	Loam	CL-ML, ML	A-4	0	95-100	95-100	75-85	60-70	20-30	NP-10
	8-60	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-95	70-80	25-40	5-15
Theedle	0-5	Loam	CL-ML	A-4	0	95-100	95-100	70-85	60-70	20-30	5-10
	5-28	Loam, clay loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	70-85	60-70	25-40	5-20
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
101*:											
Absted----------	0-3	8-18	2.0-6.0	0.11-0.13	6.6-7.8	<2	Low-------	0.32	5	3	1-2
	3-60	35-50	0.06-0.2	0.11-0.13	>7.8	>16	High------	0.55			
Arvada----------	0-3	15-27	0.6-2.0	0.16-0.18	6.6-9.0	<4	Low-------	0.32	5	5	.5-1
	3-22	40-60	<0.06	0.07-0.09	>7.8	2-8	High------	0.32			
	22-60	40-45	0.06-0.2	0.09-0.11	>7.8	<4	High------	0.32			
Bone------------	0-2	27-35	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32	5	5	<.5
	2-5	35-40	<0.06	0.12-0.15	>7.8	2-8	High------	0.37			
	5-60	35-50	<0.06	0.08-0.10	>7.8	4-16	High------	0.43			
102--------------	0-8	30-40	<0.06	0.15-0.20	6.6-9.0	<2	High------	0.32	5	6	2-4
Aeric Haplaquepts	8-60	40-60	<0.06	0.14-0.17	6.6-9.0	<2	High------	0.32			
103*:											
Bahl------------	0-4	40-45	0.06-0.2	0.17-0.20	6.6-8.4	<2	Moderate	0.32	5	6	1-2
	4-60	40-55	0.06-0.2	0.15-0.20	7.4-9.0	2-4	High------	0.37			
Savageton-------	0-2	35-40	<0.06	0.15-0.20	6.6-8.4	<2	High------	0.32	2	6	1-2
	2-32	40-50	<0.06	0.15-0.20	7.9-9.0	<2	High------	0.37			
	32	---	---	---	---	---	----------	----			
104*:											
Cambria---------	0-2	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low-------	0.32	5	3	1-2
	2-10	20-35	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate	0.37			
	10-60	18-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
Cushman---------	0-4	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low-------	0.32	2	5	1-2
	4-15	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	15-33	20-35	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	33	---	---	---	---	---	----------	----			
105*:											
Cambria---------	0-4	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low-------	0.32	5	3	1-2
	4-8	10-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.37			
	8-60	18-27	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate	0.37			
Cushman---------	0-3	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low-------	0.32	2	5	1-2
	3-17	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	17-25	20-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	25	---	---	---	---	---	----------	----			
106*:											
Cambria Variant-	0-2	5-15	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low-------	0.32	5	3	1-2
	2-16	20-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	16-60	15-30	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate	0.37			
Forkwood Variant	0-3	27-35	0.6-2.0	0.17-0.20	6.6-7.8	<2	Moderate	0.32	5	6	1-2
	3-16	27-35	0.6-2.0	0.17-0.20	6.6-7.8	<2	Moderate	0.37			
	16-60	10-27	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.37			
107*:											
Clarkelen-------	0-3	5-15	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low-------	0.24	5	3	1-2
	3-60	5-18	2.0-6.0	0.12-0.15	7.4-9.0	<4	Low-------	0.28			
Draknab---------	0-2	0-10	6.0-20	0.07-0.09	7.4-8.4	2-4	Low-------	0.20	5	2	.5-1
	2-60	0-10	6.0-20	0.06-0.09	7.4-9.0	2-4	Low-------	0.15			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
108*:											
Clarkelen	0-3	5-15	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low	0.24	5	3	1-2
	3-60	5-18	2.0-6.0	0.12-0.15	7.4-9.0	<4	Low	0.28			
Dwyer	0-5	3-8	6.0-20	0.08-0.11	6.1-9.0	<2	Low	0.32	5	2	1-3
	5-60	1-8	6.0-20	0.04-0.11	7.9-9.0	<2	Low	0.32			
Orpha	0-5	5-10	>20	0.06-0.07	6.6-7.8	<2	Low	0.17	5	2	1-2
	5-60	3-8	>20	0.06-0.07	6.6-7.8	<2	Low	0.28			
109*:											
Clarkelen	0-3	5-15	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low	0.24	5	3	1-2
	3-60	5-18	2.0-6.0	0.12-0.15	7.4-9.0	<4	Low	0.28			
Haverdad	0-6	5-20	0.6-2.0	0.13-0.15	7.4-9.0	<8	Low	0.28	5	3	1-2
	6-60	20-35	0.6-2.0	0.16-0.18	7.9-9.0	<8	Low	0.37			
Bigwinder	0-3	5-15	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low	0.28	5	3	2-4
	3-60	5-20	0.6-6.0	0.12-0.16	7.4-8.4	<2	Low	0.32			
110*:											
Cushman	0-4	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low	0.32	2	5	1-2
	4-15	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	15-33	20-35	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	33	---	---	---	---	---	---	---			
Terro	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low	0.28	2	3	1-2
	4-23	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low	0.28			
	23-34	10-18	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low	0.32			
	34	---	---	---	---	---	---	---			
111*:											
Cushman	0-3	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low	0.32	2	5	1-2
	3-17	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	17-25	20-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	25	---	---	---	---	---	---	---			
Terro	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low	0.28	2	3	1-2
	4-23	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low	0.28			
	23-34	10-18	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low	0.32			
	34	---	---	---	---	---	---	---			
112*:											
Cushman	0-3	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low	0.32	2	5	1-2
	3-17	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	17-25	20-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	25	---	---	---	---	---	---	---			
Worf	0-2	10-15	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low	0.28	2	3	1-3
	2-18	20-35	0.6-2.0	0.19-0.21	6.6-8.4	<2	Moderate	0.37			
	18	---	---	---	---	---	---	---			
113*:											
Dwyer	0-5	3-8	6.0-20	0.08-0.11	6.1-9.0	<2	Low	0.32	5	2	1-3
	5-60	1-8	6.0-20	0.04-0.11	7.9-9.0	<2	Low	0.32			
Orpha	0-6	5-10	>20	0.06-0.07	6.6-7.8	<2	Low	0.17	5	2	1-2
	6-60	3-8	>20	0.06-0.07	6.6-7.8	<2	Low	0.28			
114*:											
Forkwood	0-7	10-20	2.0-6.0	0.13-0.15	6.6-8.4	2-4	Low	0.24	5	3	1-2
	7-60	27-30	0.6-2.0	0.19-0.21	6.6-8.4	2-4	Moderate	0.32			
ria	0-2	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low	0.32	5	3	1-2
	2-10	20-35	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate	0.37			
	10-60	18-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
115*:											
Forkwood--------	0-5	10-20	2.0-6.0	0.13-0.15	6.6-8.4	2-4	Low--------	0.24	5	3	1-2
	5-18	27-35	0.6-2.0	0.19-0.21	6.6-8.4	2-4	Moderate	0.32			
	25-60	20-27	0.6-2.0	0.16-0.18	7.9-9.0	2-4	Low--------	0.28			
Cambria---------	0-4	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low--------	0.32	5	3	1-2
	4-8	10-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low--------	0.37			
	8-60	18-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
Cushman---------	0-3	10-20	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low--------	0.32	2	5	1-2
	3-17	27-35	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.37			
	17-25	20-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
	25	---	---	---	---	---	----------	----			
116*:											
Forkwood--------	0-7	10-20	2.0-6.0	0.13-0.15	6.6-8.4	2-4	Low--------	0.24	5	3	1-2
	7-60	27-30	0.6-2.0	0.19-0.21	6.6-8.4	2-4	Moderate	0.32			
Ulm---------	0-5	20-25	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low--------	0.32	5	6	1-3
	5-21	35-50	0.06-2.0	0.19-0.21	6.6-8.4	<2	High-------	0.37			
	21-36	30-40	0.6-2.0	0.19-0.21	7.9-9.0	<2	Moderate	0.37			
	36-60	25-35	0.6-2.0	0.12-0.15	7.9-9.0	<2	Moderate	0.37			
117*:											
Forkwood--------	0-7	10-20	2.0-6.0	0.13-0.15	6.6-8.4	2-4	Low--------	0.24	5	3	1-2
	7-60	27-30	0.6-2.0	0.19-0.21	6.6-8.4	2-4	Moderate	0.32			
Ulm---------	0-4	28-35	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32	5	6	1-3
	4-16	35-40	0.06-2.0	0.19-0.21	6.6-8.4	<2	High-------	0.37			
	16-60	30-40	0.6-2.0	0.19-0.21	7.9-9.0	<2	Moderate	0.37			
Renohill--------	0-5	27-35	0.2-0.6	0.17-0.21	6.6-7.8	<2	Moderate	0.37	3	6	1-3
	5-25	30-40	0.2-0.6	0.19-0.21	7.9-9.0	<4	Moderate	0.37			
	25	---	---	---	---	---	----------	----			
118*:											
Gateridge-------	0-4	5-10	6.0-20	0.11-0.13	6.6-7.8	<2	Low--------	0.10	1	2	1-2
	4-11	20-35	0.6-2.0	0.13-0.15	6.6-7.8	<2	Moderate	0.24			
	11-16	40-50	0.06-0.2	0.19-0.21	6.6-7.8	<2	High-------	0.37			
	16	---	---	---	---	---	----------	----			
Tassel Variant--	0-4	5-15	2.0-6.0	0.13-0.17	6.6-7.8	<2	Low--------	0.32	1	3	1-2
	4-9	5-20	0.6-2.0	0.11-0.18	7.4-8.4	<2	Low--------	0.37			
	9	---	---	---	---	---	----------	----			
119*. Gullied land											
120*:											
Haverdad--------	0-6	5-20	0.6-2.0	0.13-0.15	7.4-9.0	<8	Low--------	0.28	5	3	1-2
	6-60	20-35	0.6-2.0	0.16-0.18	7.9-9.0	<8	Low--------	0.37			
Lohmiller-------	0-3	30-40	0.06-0.6	0.14-0.17	6.6-8.4	<4	Moderate	0.32	5	4L	1-3
	3-60	35-50	0.06-0.6	0.14-0.16	7.4-8.4	<8	High-------	0.32			
121*:											
Hiland----------	0-5	8-18	6.0-20	0.07-0.12	6.6-8.4	<2	Low--------	0.20	5	3	1-2
	5-30	15-25	0.6-2.0	0.12-0.15	7.9-9.0	<4	Low--------	0.28			
	30-60	8-16	2.0-6.0	0.07-0.14	7.9-9.0	<4	Low--------	0.20			
Bowbac----------	0-3	5-15	0.6-2.0	0.12-0.14	6.6-8.4	---	Low--------	0.32	2	3	1-2
	3-18	20-35	0.6-2.0	0.14-0.16	7.4-8.4	<2	Moderate	0.37			
	18-36	15-20	0.6-2.0	0.12-0.17	7.9-9.0	<2	Low--------	0.37			
	36	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

l name and ap symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
122*:											
Hiland----------	0-3	20-25	2.0-6.0	0.13-0.15	6.6-8.4	<2	Moderate	0.24	5	5	1-2
	3-60	20-35	0.6-2.0	0.14-0.16	6.6-8.4	<2	Moderate	0.28			
Bowbac----------	0-3	5-15	0.6-2.0	0.12-0.14	6.6-8.4	---	Low-------	0.32	2	3	1-2
	3-18	20-35	0.6-2.0	0.14-0.16	7.4-8.4	<2	Moderate	0.37			
	18-36	15-20	0.6-2.0	0.12-0.17	7.9-9.0	<2	Low-------	0.37			
	36	---	---	---	---	---	----------	----			
123*:											
Keeline----------	0-8	5-15	2.0-6.0	0.12-0.14	6.6-8.4	<4	Low-------	0.24	5	3	1-2
	8-60	5-18	2.0-6.0	0.09-0.14	7.9-9.0	<4	Low-------	0.28			
Tassel----------	0-2	2-8	6.0-20	0.10-0.12	7.4-8.4	<2	Low-------	0.17	2	2	.5-1
	2-16	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24			
	16	---	---	---	---	---	----------	----			
Turnback--------	0-4	0-5	2.0-20	0.08-0.10	7.4-8.4	<2	Low-------	0.32	2	2	1-2
	4-30	5-15	2.0-6.0	0.12-0.14	7.4-8.4	<2	Low-------	0.37			
	30	---	---	---	---	---	----------	----			
124*:											
Kishona----------	0-3	10-27	0.6-2.0	0.16-0.18	7.4-8.4	<4	Low-------	0.28	5	4L	.5-1
	3-60	27-35	0.6-2.0	0.10-0.17	7.9-9.0	2-8	Moderate	0.32			
Dwyer----------	0-5	3-8	6.0-20	0.08-0.11	6.1-9.0	<2	Low-------	0.32	5	2	1-3
	5-60	1-8	6.0-20	0.04-0.11	7.9-9.0	<2	Low-------	0.32			
a----------	0-5	5-10	>20	0.06-0.07	6.6-7.8	<2	Low-------	0.17	5	2	1-2
	5-60	3-8	>20	0.06-0.07	6.6-7.8	<2	Low-------	0.28			
125*:											
Orella----------	0-4	27-40	0.2-0.6	0.12-0.14	7.4-8.4	<4	High------	0.32	2	4L	.5-1
	4-20	40-65	<0.06	0.09-0.11	7.4-9.0	4-16	High------	0.32			
	20	---	---	---	---	---	----------	----			
Rock outcrop.											
Samday----------	0-2	30-40	0.2-0.6	0.15-0.20	6.6-8.4	<2	High------	0.37	1	6	1-2
	2-18	40-50	0.06-0.2	0.14-0.18	7.4-9.0	<4	High------	0.32			
	18	---	---	---	---	---	----------	----			
126*. Pits											
127*:											
Renohill--------	0-5	8-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low-------	0.28	3	3	1-2
	5-20	40-50	0.06-0.2	0.14-0.16	6.6-8.4	<2	High------	0.32			
	20-36	30-40	0.2-0.6	0.19-0.21	7.9-9.0	<4	Moderate	0.37			
	36	---	---	---	---	---	----------	----			
Worfka----------	0-6	8-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low-------	0.28	2	3	1-2
	6-18	35-45	0.06-0.2	0.19-0.21	7.4-9.0	<2	Moderate	0.37			
	18	---	---	---	---	---	----------	----			
Shingle----------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	----------	----			
128*:											
Renohill--------	0-5	27-35	0.2-0.6	0.17-0.21	6.6-7.8	<2	Moderate	0.37	3	6	1-3
	5-25	30-40	0.2-0.6	0.19-0.21	7.9-9.0	<4	Moderate	0.37			
	25	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
128*:											
Worfka----------	0-3	8-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low-------	0.28	2	3	1-2
	3-14	35-45	0.06-0.2	0.19-0.21	7.4-9.0	<2	Moderate	0.37			
	14	---	---	---	---	---	----------	----			
Shingle---------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	----------	----			
129*:											
Samday----------	0-2	30-45	0.2-0.6	0.15-0.20	6.6-8.4	<2	High------	0.37	1	6	1-2
	2-18	40-50	0.06-0.2	0.14-0.18	7.4-9.0	<4	High------	0.32			
	18	---	---	---	---	---	----------	----			
Shingle---------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	----------	----			
Worf----------	0-2	10-15	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low-------	0.28	2	3	1-3
	2-18	20-35	0.6-2.0	0.19-0.21	6.6-8.4	<2	Moderate	0.37			
	18	---	---	---	---	---	----------	----			
130*:											
Sear----------	0-2	15-35	0.6-2.0	0.13-0.20	6.6-7.8	<2	Low-------	0.32	1	7	1-2
	2-9	18-27	0.6-2.0	0.10-0.13	6.6-8.4	<2	Low-------	0.15			
	9-60	0-2	>20	0.	7.4-8.4	<2	Low-------	0.00			
Wibaux----------	0-4	15-25	0.6-2.0	0.09-0.11	6.6-7.8	<2	Low-------	0.15	1	8	1-3
	4-11	15-25	0.6-2.0	0.04-0.06	6.6-7.8	<2	Low-------	0.15			
	11-60	0	>20	---	---	<2	----------	0.00			
131*:											
Shingle----------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-13	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	13	---	---	---	---	---	----------	----			
Rock outcrop.											
Samday----------	0-2	30-40	0.2-0.6	0.15-0.20	6.6-8.4	<2	High------	0.37	1	6	1-2
	2-18	40-50	0.06-0.2	0.14-0.18	7.4-9.0	<4	High------	0.32			
	18	---	---	---	---	---	----------	----			
132*:											
Shingle----------	0-2	18-27	0.6-2.0	0.16-0.18	7.4-9.0	<2	Low-------	0.32	2	5	1-3
	2-9	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	9	---	---	---	---	---	----------	----			
Rock outcrop----	0-60	---	---	---	---	<2	----------	----	---	---	---
Tassel----------	0-2	2-8	6.0-20	0.10-0.12	7.4-8.4	<2	Low-------	0.17	2	2	.5-1
	2-8	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24			
	8	---	---	---	---	---	----------	----			
133*:											
Shingle----------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	----------	----			
Theedle----------	0-5	10-20	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low-------	0.32	2	5	1-2
	5-28	18-35	0.6-2.0	0.17-0.20	7.4-8.4	<8	Moderate	0.37			
	28	---	---	---	---	---	----------	----			
Cambria----------	0-4	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low-------	0.32	5	3	1-2
	4-8	10-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.37			
	8-60	18-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
134*:											
Silhouette	0-2	30-45	0.2-0.6	0.15-0.20	7.4-8.4	<2	High	0.32	5	6	1-2
	2-22	40-50	0.06-0.2	0.14-0.18	7.4-9.0	<4	High	0.37			
	22-60	30-45	0.2-0.6	0.15-0.20	7.4-8.4	<2	High	0.37			
Heldt	0-1	30-40	0.06-0.6	0.12-0.17	7.9-9.0	<8	High	0.28	5	4	.5-2
	1-60	40-50	0.06-0.6	0.12-0.17	7.9-9.0	<8	High	0.28			
135*:											
Tassel	0-3	5-12	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low	0.24	2	3	.5-1
	3-14	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low	0.24			
	14	---	---	---	---	---	---	---			
Shingle	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	---	---			
136*:											
Tassel	0-2	2-8	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17	2	2	.5-1
	2-16	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low	0.24			
	16	---	---	---	---	---	---	---			
Terro	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low	0.28	2	3	1-2
	4-34	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low	0.28			
	34	---	---	---	---	---	---	---			
Rock outcrop.											
137*											
	0-2	2-8	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17	2	2	.5-1
	2-16	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low	0.24			
	16	---	---	---	---	---	---	---			
Tullock	0-5	5-10	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17	3	2	1-2
	5-31	0-10	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17			
	31	---	---	---	---	---	---	---			
Vonalee	0-3	0-10	6.0-20	0.07-0.09	6.6-7.8	<2	Low	0.24	5	2	1-2
	3-24	5-15	2.0-6.0	0.12-0.14	6.6-8.4	<2	Low	0.32			
	24-60	0-10	6.0-20	0.07-0.09	7.4-9.0	<2	Low	0.24			
138*, 139*:											
Terro	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low	0.28	2	3	1-2
	4-34	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low	0.28			
	34	---	---	---	---	---	---	---			
Tullock	0-5	5-10	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17	3	2	1-2
	5-31	0-10	6.0-20	0.10-0.12	7.4-8.4	<2	Low	0.17			
	31	---	---	---	---	---	---	---			
Orpha	0-5	5-10	>20	0.06-0.07	6.6-7.8	<2	Low	0.17	5	2	1-2
	5-60	3-8	>20	0.06-0.07	6.6-7.8	<2	Low	0.28			
140*, 141*:											
Theedle	0-5	10-20	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low	0.32	2	5	1-2
	5-28	18-35	0.6-2.0	0.17-0.20	7.4-8.4	<8	Moderate	0.37			
	28	---	---	---	---	---	---	---			
Kishona	0-3	10-27	0.6-2.0	0.16-0.18	7.4-8.4	<4	Low	0.28	5	4L	.5-1
	3-60	27-35	0.6-2.0	0.10-0.17	7.9-9.0	2-8	Moderate	0.32			
142*:											
	0-4	28-35	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32	5	6	1-3
	4-17	35-50	0.06-2.0	0.19-0.21	6.6-8.4	<2	High	0.37			
	17-60	30-40	0.6-2.0	0.19-0.21	7.9-9.0	<2	Moderate	0.37			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
142*:											
Bidman----------	0-7	5-15	0.6-2.0	0.16-0.18	6.1-7.3	<2	Low--------	0.28	5	3	1-2
	7-20	40-50	0.06-0.2	0.14-0.16	6.6-7.8	<2	High-------	0.32			
	20-60	27-35	0.2-0.6	0.19-0.21	7.9-9.0	<2	High-------	0.43			
143*:											
Ulm---------------	0-5	20-25	0.6-2.0	0.16-0.18	6.6-7.8	<2	Low--------	0.32	5	6	1-3
	5-21	35-50	0.06-2.0	0.19-0.21	6.6-8.4	<2	High-------	0.37			
	21-36	30-40	0.6-2.0	0.19-0.21	7.9-9.0	<2	Moderate	0.37			
	36-60	25-35	0.6-2.0	0.12-0.15	7.9-9.0	<2	Moderate	0.37			
Renohill---------	0-5	8-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.28	3	3	1-2
	5-20	40-50	0.06-0.2	0.14-0.16	6.6-8.4	<2	High-------	0.32			
	20-36	30-40	0.2-0.6	0.19-0.21	7.9-9.0	<4	Moderate	0.37			
	36	---	---	---	---	---	----------	----			
144*:											
Ulm---------------	0-4	28-35	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32	5	6	1-3
	4-16	40-50	0.06-2.0	0.19-0.21	6.6-8.4	<2	High-------	0.37			
	16-60	30-40	0.6-2.0	0.19-0.21	7.9-9.0	<2	Moderate	0.37			
Renohill---------	0-5	27-35	0.2-0.6	0.17-0.21	6.6-7.8	<2	Moderate	0.37	3	6	1-3
	5-25	30-40	0.2-0.6	0.19-0.21	7.9-9.0	<4	Moderate	0.37			
	25	---	---	---	---	---	----------	----			
145---------------	0-60	---	---	---	---	---	----------	----	---	---	---
Ustic Torriorthents											
146*:											
Vonalee-----------	0-4	0-10	6.0-20	0.07-0.09	6.6-7.8	<2	Low--------	0.24	5	2	1-2
	4-24	5-15	2.0-6.0	0.12-0.14	6.6-8.4	<2	Low--------	0.32			
	24-44	0-10	6.0-20	0.07-0.09	7.4-9.0	<2	Low--------	0.24			
	44-60	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low--------	0.28			
Terro-------------	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low--------	0.28	2	3	1-2
	4-34	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low--------	0.28			
	34	---	---	---	---	---	----------	----			
147*:											
Vonalee-----------	0-3	0-10	6.0-20	0.07-0.09	6.6-7.8	<2	Low--------	0.24	5	2	1-2
	3-24	5-15	2.0-6.0	0.12-0.14	6.6-8.4	<2	Low--------	0.32			
	24-60	0-10	0.6-6.0	0.09-0.14	7.4-9.0	<2	Low--------	0.24			
Terro-------------	0-4	8-12	2.0-6.0	0.09-0.14	6.6-7.8	<2	Low--------	0.28	2	3	1-2
	4-34	10-18	2.0-6.0	0.12-0.14	6.6-7.8	<2	Low--------	0.28			
	34	---	---	---	---	---	----------	----			
148*:											
Wibaux------------	0-4	15-25	0.6-2.0	0.09-0.11	6.6-7.8	<2	Low--------	0.15	1	8	1-3
	4-11	15-25	0.6-2.0	0.04-0.06	6.6-7.8	<2	Low--------	0.15			
	11-60	0	>20	---	---	<2	----------	0.00			
Rock outcrop.											
Shingle-----------	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-13	27-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	13	---	---	---	---	---	----------	----			
149*:											
Worf--------------	0-5	0-10	6.0-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.24	1	2	1-2
	5-15	27-35	0.6-2.0	0.19-0.21	6.6-8.4	<2	Moderate	0.37			
	15	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 12.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	In/hr	In/in	pH	mmhos/cm					Pct
149*:											
Shingle	0-4	27-35	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	6	1-3
	4-18	17-35	0.6-2.0	0.16-0.21	7.4-9.0	<2	Moderate	0.49			
	18	---	---	---	---	---	---	---			
Tassel	0-3	5-12	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low	0.24	2	3	.5-1
	3-14	5-12	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low	0.24			
	14	---	---	---	---	---	---	---			
150*:											
Zigweid	0-2	18-35	0.6-2.0	0.16-0.21	6.6-8.4	<2	Moderate	0.32	5	6	1-2
	2-60	27-35	0.6-2.0	0.16-0.21	7.9-9.0	<2	Moderate	0.43			
Bahl	0-4	40-45	0.06-0.2	0.17-0.20	6.6-8.4	<2	Moderate	0.32	5	6	1-2
	4-60	40-55	0.06-0.2	0.15-0.20	7.4-9.0	2-4	High	0.37			
151*:											
Zigweid	0-3	27-35	0.6-2.0	0.16-0.21	6.6-8.4	<2	Moderate	0.32	5	6	1-2
	3-60	27-35	0.6-2.0	0.16-0.21	7.9-9.0	<2	Moderate	0.43			
Cambria	0-2	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low	0.32	5	3	1-2
	2-60	18-35	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate	0.37			
152*:											
Zigweid	0-4	18-27	0.6-2.0	0.16-0.21	6.6-8.4	<2	Moderate	0.32	5	6	1-2
	4-60	27-35	0.6-2.0	0.16-0.21	7.9-9.0	<2	Moderate	0.43			
Cambria	0-4	5-15	0.6-2.0	0.12-0.14	6.6-8.4	<2	Low	0.32	5	3	1-2
	4-8	10-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low	0.37			
	8-60	18-27	0.6-2.0	0.17-0.20	7.9-9.0	<2	Moderate	0.37			
Theedle	0-5	10-20	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low	0.32	2	5	1-2
	5-28	18-35	0.6-2.0	0.17-0.20	7.4-8.4	<8	Moderate	0.37			
	28	---	---	---	---	---	---	---			

* See description of the map unit for composition and behavior characteristics of the map unit.

101	Absted-Arv[illegible]one complex, 0 to 6 percent slopes	Complex		57399	Not prime farmland	13016	479
102	Aeric Hapl[illegible], 0 to 3 percent slopes	Consociation		2868	Not prime farmland	13016	480
103	Bahl-Savag[illegible]complex, 0 to 6 percent slopes	Complex		1167	Not prime farmland	13016	351481
104	Cambria-Cushman complex, 0 to 6 percent slopes	Complex		7191	Not prime farmland	13016	351482
105	Cambria-Cushman complex, 6 to 15 percent slopes	Complex		8124	Not prime farmland	13016	351483
106	Cambria variant-Forkwood variant complex, 0 to 6 percent slopes	Complex		2543	Not prime farmland	13016	351484
107	Clarkelen-Draknab complex, 0 to 3 percent slopes	Complex		15692	Not prime farmland	13016	351485
108	Clarkelen-Dwyer-Orpha association, 0 to 10 percent slopes	Association		11390	Not prime farmland	13016	351486
109	Clarkelen-Haverdad-Bigwinder complex, 0 to 3 percent slopes	Complex		13794	Not prime farmland	13016	351487
110	Cushman-Terro complex, 0 to 6 percent slopes	Complex		663	Not prime farmland	13016	351488
111	Cushman-Terro complex, 6 to 15 percent slopes	Complex		1444	Not prime farmland	13016	351489
112	Cushman-Worf association, 6 to 15 percent slopes	Association		14050	Not prime farmland	13016	351490
113	Dwyer-Orpha loamy sands, 3 to 15 percent slopes	Complex		31539	Not prime farmland	13016	351491
114	Forkwood-Cambria fine sandy loams, 0 to 6 percent slopes	Complex		51477	Not prime farmland	13016	351492
115	Forkwood-Cambria-Cushman complex, 6 to 15 percent slopes	Complex		26989	Not prime farmland	13016	351493
116	Forkwood-Ulm complex, 0 to 6 percent slopes	Complex		30340	Not prime farmland	13016	351494
117	Forkwood-Ulm-Renohill complex, 6 to 15 percent slopes	Complex		8780	Not prime farmland	13016	351495
118	Gateridge-Blacksheep association, 10 to 45 percent slopes	Association		2751	Not prime farmland	13016	351496
119	Ustic Torriorthents, gullied	Consociation		28930	Not prime farmland	13016	351497
120	Haverdad-Lohmiller complex, 0 to 6 percent slopes	Complex		20662	Not prime farmland	13016	351498
121	Hiland-Bowbac sandy loams, 0 to 6 percent slopes	Complex		88990	Not prime farmland	13016	351499
122	Hiland-Bowbac complex, 6 to 15 percent slopes	Complex		184664	Not prime farmland	13016	351500
123	Keeline-Tassel-Turnback complex, 6 to 15 percent slopes	Complex		19672	Not prime farmland	13016	351501
124	Kishona-Dwyer-Orpha association, 0 to 10 percent slopes	Association		3238	Not prime farmland	13016	351502
125	Orella-Rock outcrop-Samday complex, 3 to 30 percent slopes	Complex		16853	Not prime farmland	13016	351503
126	Pits,mine	Consociation		93	Not prime farmland	13016	351504
127	Renohill-Worfka-Shingle complex, 0 to 6 percent slopes	Complex		3650	Not prime farmland	13016	351505
128	Renohill-Worfka-Shingle complex, 6 to 15 percent slopes	Complex		15686	Not prime farmland	13016	351506
129	Samday-Shingle-Worf complex, 3 to 15 percent slopes	Complex		70850	Not prime farmland	13016	351507
130	Sear-Wibaux complex, 0 to 15 percent slopes	Complex		2935	Not prime farmland	13016	351508
131	Shingle-Badland-Samday complex, 10 to 30 percent slopes	Complex		176746	Not prime farmland	13016	351509
132	Shingle, thin solum-Rock outcrop-Tassel,thin solum complex, cool, 6 to 45 percent slopes	Complex		5282	Not prime farmland	13016	351510
133	Shingle-Theedle-Cambria association, 6 to 30 percent slopes	Association		6636	Not prime farmland	13016	351511
134	Silhouette-Heldt association, 0 to 6 percent slopes	Association		9251	Not prime farmland	13016	351512
135	Tassel-Shingle complex, 2 to 30 percent slopes	Complex		33590	Not prime farmland	13016	351513
136	Tassel-Terro-Rock outcrop complex, 15 to 30 percent slopes	Complex		21942	Not prime farmland	13016	351514
137	Tassel-Tullock-Vonalee association, 6 to 30 percent slopes	Association		72041	Not prime farmland	13016	351515
138	Terro-Tullock-Orpha complex, 0 to 6 percent slopes	Complex		972	Not prime farmland	13016	351516
139	Terro-Tullock-Orpha complex, 6 to 15 percent slopes	Complex		8199	Not prime farmland	13016	351517
140	Theedle-Kishona loams, 0 to 6 percent slopes	Complex		4973	Not prime farmland	13016	351518
141	Theedle-Kishona loams, 6 to 15 percent slopes	Complex		16372	Not prime farmland	13016	351519
142	Ulm-Bidman complex, 0 to 6 percent slopes	Complex		25050	Not prime farmland	13016	351520
143	Ulm-Renohill complex, 0 to 6 percent slopes	Complex		57813	Not prime farmland	13016	351521
144	Ulm-Renohill clay loams, 6 to 15 percent slopes	Complex		28079	Not prime farmland	13016	351522
145	Ustic Torriorthents, reclaimed, 3 to 30 percent slopes	Consociation		3494	Not prime farmland	13016	351523
146	Vonalee-Terro complex, 0 to 6 percent slopes	Complex		4025	Not prime farmland	13016	351524
147	Vonalee-Terro complex, 6 to 15 percent slopes	Complex		9060	Not prime farmland	13016	351525
148	Wibaux-Rock outcrop-Shingle complex, 6 to 45 percent slopes	Complex		20474	Not prime farmland	13016	351526
149	Worf-Shingle-Tassel complex, 3 to 30 percent slopes	Complex		125455	Not prime farmland	13016	351527
150	Zigweid-Bahl association, 0 to 6 percent slopes	Association		6525	Not prime farmland	13016	351528

151	Zigweid-C[illegible]a association, 0 to 6 percent slopes	Association		12487	Not prime farmland	13016	[illegible]1529
152	Zigweid-C[illegible]·Theedle association, 6 to 15 percent slopes	Association		11753	Not prime farmland	13016	530
222	Denied acc[illegible]	Consociation		8174	Not prime farmland	13016	[illegible]1531
215	Water	Consociation		1734	Not prime farmland	13016	351532
200	Arvada, thick surface-Arvada-Slickspots complex, 0 to 6 percent slopes	Complex		113	Not prime farmland	13016	361268
201	Embry-Orpha complex, 3 to 15 percent slopes	Complex		242	Not prime farmland	13016	361270
203	Forkwood-Cushman loams, 6 to 15 percent slopes	Complex		306	Not prime farmland	13016	361272
207	Keeline-Tullock-Niobrara, dry, complex, 3 to 30 percent slopes	Complex		221	Not prime farmland	13016	361273
204	Forkwood-Ulm loams, 0 to 6 percent slopes	Complex		82	Not prime farmland	13016	361274
205	Hiland-Bowbac fine sandy loams, 6 to 15 percent slopes	Complex		1740	Not prime farmland	13016	361275
206	Hilight-Wags-Badland complex, 3 to 45 percent slopes	Complex		2704	Not prime farmland	13016	361279
208	Samday-Shingle-Badland complex, 10 to 45 percent slopes	Complex		324	Not prime farmland	13016	361280
209	Shingle-Taluce complex, 3 to 30 percent slopes	Complex		316	Not prime farmland	13016	361281
210	Theedle-Kishona-Shingle loams, 3 to 30 percent slopes	Complex		614	Not prime farmland	13016	361282
211	Ulm clay loam, 0 to 6 percent slopes	Consociation		995	Not prime farmland	13016	361283
212	Ustic Torriorthents, gullied	Consociation		552	Not prime farmland	13016	361284
213	Wibaux-Wibaux, thin solum complex, 6 to 40 percent slopes	Complex		92	Not prime farmland	13016	361285
214	Wibaux-Shingle-Badland complex, 6 to 60 percent slopes	Complex		723	Not prime farmland	13016	361286
216	Theedle-Kishona loams, 6 to 20 percent slopes	Complex		28	Not prime farmland	13016	361287
217	Renohill-Worfka clay loams, 3 to 15 percent slopes	Complex		42	Not prime farmland	13016	361288
218	Renohill-Shingle-Worf complex, 3 to 15 percent slopes	Association		9	Not prime farmland	13016	361289
219	Shingle-Worf loams, 3 to 30 percent slopes	Complex		80	Not prime farmland	13016	361290
221	Haverdad loam, 0 to 3 percent slopes	Consociation		32	Not prime farmland	13016	361295
202	Forkwood-Cambria loams, 0 to 6 percent slopes	Complex		489	Not prime farmland	13016	361296
223	Absted-Arvada complex, 0 to 3 percent slopes	Complex		934	Not prime farmland	13016	1427841
224	Clarkelen fine sandy loam, overflow, 0 to 3 percent slopes	Consociation		57	Not prime farmland	13016	1427842
225	Cushman-Forkwood loams, 0 to 6 percent slopes	Complex		142	Not prime farmland	13016	1427843
226	Endoaquolls-Torrifluvents complex, 0 to 3 percent slopes	Complex		4	Not prime farmland	13016	1427844
227	Forkwood-Cambria-Cushman loams, 6 to 15 percent slopes	Complex		365	Not prime farmland	13016	1427845
228	Haverdad loam, overflow, 0 to 4 percent slopes	Consociation		541	Not prime farmland	13016	1427846
229	Kishona-Cambria loams, 0 to 6 percent slopes	Complex		206	Not prime farmland	13016	1427847
230	Kishona-Cambria-Theedle loams, 6 to 15 percent slopes	Complex		158	Not prime farmland	13016	1427848
231	Taluce-Shingle complex, 3 to 20 percent slopes	Complex		593	Not prime farmland	13016	1427849
232	Taluce-Tullock-Rock outcrop complex, 3 to 45 percent slopes	Complex		151	Not prime farmland	13016	1427850
233	Taluce-Turnercrest-Keeline fine sandy loams, 3 to 20 percent slopes	Complex		221	Not prime farmland	13016	1427851
235	Ulm-Bidman loams, 0 to 6 percent slopes	Complex		393	Not prime farmland	13016	1427852
236	Hiland-Bowbac associaton, 6 to 15 percent slopes	Association		495	Not prime farmland	13016	1427893
237	Hiland-Bowbac sandy loams, thick surface, 0 to 6 percent slopes	Complex		1259	Not prime farmland	13016	1427894
238	Hiland-Bowbac complex, 0 to 10 percent slopes	Complex		5	Not prime farmland	13016	1427895
239	Bidman-Ulm association, undulating	Association		297	Not prime farmland	13016	1427896
240	Lohmiller-Haverdad complex, 1 to 4 percent slopes	Complex		101	Not prime farmland	13016	1427897
241	Absted-Bone complex, 0 to 6 percent slopes	Complex		27	Not prime farmland	13016	1427898
242	Dwyer fine sand, 3 to 15 percent slopes	Consociation		112	Not prime farmland	13016	1427899
243	Parmleed-Renohill complex, 0 to 6 percent slopes	Complex		235	Not prime farmland	13016	1427900
244	Samday-Shingle-Worf complex, northeast, 3 to 15 percent slopes	Complex		10	Not prime farmland	13016	1427901
245	Forkwood-Cambria-Cushman loams, 0 to 12 percent slopes	Complex		169	Not prime farmland	13016	1427902
246	Forkwood-Zigweid association, sloping	Association		118	Not prime farmland	13016	1427903
247	Cushman-Forkwood association, rolling	Association		757	Not prime farmland	13016	1427904
248	Theedle-Shingle-Kishona complex, 6 to 40 percent slopes, gullied	Complex		540	Not prime farmland	13016	1427905
249	Zigweid-Theedle loams, 3 to 15 percent slopes	Complex		29	Not prime farmland	13016	1427906

250	Arvada-Ab[illegible]Slickspots complex, 0 to 6 percent slopes	Complex		41	Not prime farmland	13016	[illegible]907
251	Hiland-Bo[illegible]ne sandy loams; 0 to 6 percent slopes	Complex		368	Not prime farmland	13016	908
252	Ulm-Reno[illegible].y loams, 0 to 6 percent slopes	Complex		450	Not prime farmland	13016	[illegible]7909
253	Orpha-Tullock loamy sands, 6 to 30 percent slopes	Complex		27	Not prime farmland	13016	1427910
254	Cushman-Worf loams, 3 to 15 percent slopes	Complex		180	Not prime farmland	13016	1427911
255	Savageton-Silhouette clay loams, 0 to 6 percent slopes	Complex		13	Not prime farmland	13016	1427912
256	Bidman-Ulm loams, 0 to 6 percent slopes	Complex		305	Not prime farmland	13016	1427913

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE

THAT CAN BE VIEWED AT THE RECORD TITLED:

"REYNOLDS RANCH
URANIUM PROJECT
SOILS MAP"
PLATE D7-1

WITHIN THIS PACKAGE.....

D-01

ADDENDUM D7-2

ORDER 1-2 BASELINE SOIL ASSESSMENT, 1997

BKS ENVIRONMENTAL ASSOCIATES, INC.

(Prepared for Rio Algom Mining Corporation)

Baseline Soil Assessment of the 1997 Reynold's Ranch Permit Extension Area

Prepared for:

RIO ALGOM MINING CORPORATION
P.O. Box 1390
Glenrock, WY 82637

Prepared by:

BKS ENVIRONMENTAL ASSOCIATES, INC.
P.O. Box 3467
Gillette, WY 82717-3467

July 1998

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1. INTRODUCTION

This report presents information on the soils occurring on the Reynold's Ranch permit extension area to the Smith Ranch Facility which is located approximately 40 miles northwest of Douglas, Wyoming. The area has been previously surveyed, on a large scale, by the U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) in 1982. The major objective of the 1997 assessment was to define the existing topsoil resource within the extension area and determine the extent, availability, and suitability of soils material for use in reclamation. The mapping and reporting for the 1997 extension area incorporated map unit information from previous site-specific soil surveys. 1997 soil sampling needs were determined from overall Smith Ranch permit sample numbers from 1979. However, this report has been compiled in order that the current extension area soil survey can be a stand-alone document.

2. METHODS

2.1. Review of Existing Literature

The soils in this portion of Converse County were studied and mapped to an Order 3 scale by the USDA, NRCS in 1982. The NRCS has recently centralized dissemination of nationwide soil series descriptions; county-wide information is available on the Internet through a site at Iowa State. Soil mapping of the original Smith Ranch Facility was conducted in 1979 by Woodward-Clyde Associates of Denver, Colorado.

2.2 1997 Project Participants

BKS Environmental Associates, Inc. performed the 1997 soil survey field work. All soil analysis was handled by Rio Algom Mining Corporation under separate contract with Energy Laboratories of Casper, Wyoming.

2.3. Soil Survey

Construction of the extension area soil map was accomplished according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (November, 1984) of the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD) was followed during all phases of the work.

A reconnaissance of the extension area was used to determine the validity of the previous NRCS soil survey and to familiarize the field personnel with the area. Soil profiles were examined on a widely scattered basis according to physiographic configuration. Information derived from these profiles was compared with previous mapping information to determine which soils were likely to occur on specific landscape positions. Previous mapping information for the extension area was available throughout the field survey.

Following the reconnaissance survey, an Order 1-2 soil survey was conducted. Actual soil boundaries were delineated in the field by exposing additional soil profiles to determine the nature

and extent of soil series present on the extension area. Soil map unit boundaries were delineated on a 1"=400' photographic base map. Refer to Table 1 for soil mapping unit designations and associated acreage. Table 2 describes the soil map units in terms of actual map designations and slope percentage.

2.4. Field Sampling

Per written communication with WDEQ-LQD personnel on October 15, 1997, all soils were sampled and described by exposing the solum with a shovel and then sampling below this point with a hand auger or by coring with a mechanical auger, i.e., truck-mounted Giddings. Refer to Addendum 1, Correspondence. The physical and, where possible, chemical nature of each horizon within the sampled profile was described and recorded in the field. The field location was plotted on the map. At least two quarts of sampled soil material were placed in clean, labeled, polyethylene plastic bags and kept cool and as dry as possible to limit chemical changes. Due to the timing of the sampling (i.e., fall 1997), ambient air temperatures were not considered excessive. Samples were kept out of direct sunlight and transported to the Gillette office of Energy for shipment to the Casper office for analysis. In general, samples were taken to Energy within two weeks of actual collection.

A total of 27 sites on the extension area was sampled in 1997 for analysis and corresponding soil profile descriptions written. These 27 locations supplemented previous permit sampling in 1979.

2.5. Laboratory Analysis

Upon receipt at the Casper office of Energy, topsoil samples were logged into the computer system. Samples were placed into lined aluminum pans to air dry. Coarse fragments were measured with a 10 mesh screen prior to grinding; the entire sample was then hand ground to pass 10 mesh. An approximate 20 ounce subsample was obtained through splitting with a series of riffle splitters and subsequently analyzed. A second subsample was maintained in storage at Energy. Approximately 20 percent of the samples are run for duplicate analysis.
Actual laboratory analysis follows the methodology outlined in WDEQ-LQD Guideline 1. Refer to the end of Addendum 2, Summary of Soil Analytical Results. In general, samples were analyzed within 30 days of receipt of the samples. All analytical data is also found in Addendum 2, Summary of Soil Analytical Results.

3. RESULTS AND DISCUSSION

3.1. Soil Survey - General

The soils occurring on the Reynold's Ranch extension area are typical of the semi-arid grasslands of the western United States. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly and is confined primarily to the surface horizon(s) resulting in light-coloration. Subsoil color is usually light brown.

The greatest proportion of the upland soils of the extension area are residual (i.e., developed in place) and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of the bedrock. Areas of sandy and medium-textured friable soils are underlain by sandstone and sandy shale. Typical toposequences under such conditions may be Taluce on the shallow end to Bowbac (moderately deep) to Hiland on the deep end. Heavy clay soils are underlain by clayey shale. A typical toposequence under such conditions may be Shingle on the shallow end to Cushman (moderately deep) to Forkwood on the deep end for medium textured soils. These soils vary widely in both depth and suitability of the material for topsoiling depending primarily on the parent material from which the soils have formed.

Major stream channels of the extension area are characterized by alluvial soils such as the Kishona (formerly Kim) series, Clarkelen series, and Draknab series. Smaller ephemeral channels in unstable landscapes are characterized by the moderately deep Theedle (formerly Thedalund) series or the deep Kishona series. These soils are developed from a variety of material washed from the uplands and redeposited along the stream courses. The soils formed in alluvium reflect the character of the weathered, transported material. These soils often have a generally dark friable surface that contains a larger amount of organic matter than upland soils.

3.2. Soil Mapping Unit Interpretation

The 1997 mapping did result in a number of new series, previously unmapped in the existing 1979 baseline, being described within the extension area. Previously derived mapping units within the

existing permit area and their existing series descriptions were utilized wherever possible. Refer to Addendums 3, 4, and 5.

Since the actual amount of affected land within the extension area was not known at the time of the survey, it was difficult to base soil sample location numbers on an actual percent of the combined total **affected** area between the proposed extension and the main permit areas. Instead, sample numbers were based on percent of total permit acreage. The maximum number of soil pedons according to WDEQ Guideline 1 were sampled, wherever possible.

3.3. Analytical Results

Lab analyses of the 1997 soil samples did include percent very fine sands. The very fine sand fraction was useful in the differentiation between series. Laboratory information was used in part with field observations of fine sands within individual peds as well as topographic position to determine series designation. None of the 1997 samples exceeded 50% very fine sand. Refer to Addendum 2, Summary of Soil Analytical Results for a complete collection of original laboratory data.

3.4. Evaluation of Soil Suitability as a Plant Growth Medium

Within the extension area, suitability of soil as a plant growth medium is generally limited by physical factors such as texture (sand or clay) or saturation percentage or chemical factors such as pH. In general, questionable chemical quality material is found within the high clay horizons

found at depth within deeper soils or sandy alluviated/residual material. No unsuitable material, according to WDEQ Guideline 1, was found. Marginal or unsuitable parameters are found in the following soil series and sample points:

Series	Sample Point #	Parameter
Aeric Haplaquept	23	saturation %/ texture (marginal)
Draknab sandy loam	51	saturation %/texture (marginal)
Ulm loam	57	texure (marginal)
Cambria loam	66	pH (marginal)

3.5. Topsoil Volume Calculations

Based on the extension area field work and subsequent chemical analysis, topsoil depths of previous permit sample locations were confirmed for the individual mapped soil series and revised, if necessary. Since the disturbed area was not known at the time of the survey, no volumes were determined. Every attempt was made to conform to previously determined stripping depths for a particular series; however, for purposes of the 1997 extension area, listed stripping depths may or may not match exactly to previously determined depths. Table 3 lists approximate stripping depths for each map unit.

3.6. Prime Farmland Assessment

No prime farmland determination was conducted since no cropland or hayland is located within the proposed extension area.

Table 1. Soil Series 1997 Sample Summary for the Reynolds Ranch Extension Area.

Map Unit/ Soil Series	Reynolds Ranch Existing Permit Acreage (%)	No. of Chemical Analysis Locations	Number of Samples/ Location	Total Number of Samples
Aeric Haplaquept	16.7 (<1)	1	4	4
Bowbac	3770.0 (28)	3	4+	13
Cambria	428.7 (3)	1	4	4
Cushman	2307.9 (17)	3	3+	11
Clarkelen	55.9 (<1)	1	5	5
Draknab	45.1 (<1)	1	6	6
Dwyer	17.9 (<1)	1	4	4
Exposed Sandstone	98.0 (1)	0	0	0
Forkwood	497.8 (4)	1	6	6
Haverdad	54.5 (<1)	1	4	4
Hiland	978.3 (7)	1	6	6
Kishona	13.1 (<1)	1	6	6
Renohill	269.2 (2)	1	4	4
Shingle	94.5 (1)	2	1+	3
Taluce	1984.5 (15)	2	1+	3
Terro	1032.0 (7)	2	3+	7
Theedle	25.7 (2)	1	3	3
Tullock	537.8 (4)	1	3	3
Ulm	9.7 (<1)	1	5	5
Vonalee	267.2 (2)	1	5	5
Worf	928.5 (7)	2	2+	5
TOTALS	13440 (100.00)	27		107

**NOTE: Disturbed acreage is not known at this time.

Table 2. Key to Soil Mapping Units within the Reynold's Ranch Permit Extension Area

Map Designation	Description (including slope percentages)
13A	Vonalee, 0-3%
13B	Vonalee, 3-6%
13AB	Vonalee, 0-6%
14A	Kishona, 0-3%
15A	Cambria, 0-3%
15B	Cambria, 3-6%
16A	Hiland, 0-3%
16AB	Hiland, 0-6%
17A	Terro, 0-3%
17B	Terro, 3-6%
17AB	Terro, 0-6%
17BC	Terro, 3-15%
18A	Dwyer, 0-3%
19A	Forkwood, 0-3%
20A	Ulm, 0-3%
21A	Cushman, 0-3%
21B	Cushman, 3-6%
21AB	Cushman, 0-6%
22A	Renohill, 0-3%
23A	Bowbac, 0-3%
23B	Bowbac, 3-6%
23AB	Bowbac, 0-6%
23C	Bowbac, 6-15%
25A	Tullock, 0-3%
25B	Tullock, 3-6%
25AB	Tullock, 0-6%
30A	Shingle, 0-3%
31A	Worf, 0-3%
31B	Worf, 3-6%
31BC	Worf, 6-15%
32A	Taluce (Tassel), 0-3%
32B	Taluce (Tassel, 3-6%
32AB	Taluce (Tassel), 0-6%
32C	Taluce (Tassel), 6-15%
32D	Taluce (Tassel), 15-30%
49A	Theedle, 0-3%
50	Exposed Sandstone (Rock Outcrop)
51A	Draknab, 0-3%
52A	Haverdad, 0-3%
53A	Clarkelen, 0-3%
56A	Aeric Haplaquept, 0-3%

Table 3. Approximate Soil Salvage Depths for the Reynold's Ranch Extension Area.

Map Symbol	Map Unit Description	Approximate Salvage Depth
13	Vonalee	48-60
14	Kishona	48
15	Cambria	48
16	Hiland	48-60
17	Terro	30
18	Dwyer	12-30
19	Forkwood	48-60
20	Ulm	48
21	Cushman	30
22	Renohill	24
23	Bowbac	30
25	Tullock	30
30	Shingle	12
31	Worf	12
32	Taluce	6-12
49	Theedle	30
50	Exposed Sandstone (Rock Outcrop)	0
51	Draknab	12
52	Haverdad	12-30
53	Clarkelen	12-30
56	Aeric Haplaquept	0

REFERENCES

Rio Algom Mining Corporation. 1979. Smith Ranch Facility Permit Application. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

U.S.D.A. Natural Resource Conservation Service. 1982. Soil Survey of Northern Converse County, Wyoming.

U.S.D.A. 1993. Soil Survey Manual. U.S. Dept. of Agric. Handbook 18, 437 pp. Government Printing Office.

U.S.D.A. 1975. Soil Taxonomy. U.S. Dept. of Agric. Handbook 436, 754 pp. Government Printing Office.

Wyoming Dept. of Environmental Quality, Land Quality Division. 1984. Guideline 1, Topsoil and Overburden.

ADDENDUM 1
CORRESPONDENCE

FILE COPY

BKS ENVIRONMENTAL ASSOCIATES, INC.

P.O. Box 3467
Gillette, WY 82717-3467
(307) 682-3810
Fax (307) 682-0125

P.O. Box 6021
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October 15, 1997

Mr. Matt Jankovsky
WDEQ-LQD
Herschler Building
122 West 25th
Cheyenne, WY 82001

Dear Matt:

Attached is the soil methodology including proposed sample numbers associated with the Reynold's Ranch baseline soil assessment for Rio Algom Mining Corporation. The field mapping phase of this assessment has been completed and the sampling phase should be completed this fall. I am assuming you will have Lowell Spackman review this methodology.

I would appreciate any "short turn-around" comments you may have since we are formulating fall 1997 sampling plans. Thank you for your input. If you have any questions, please feel free to contact me in Gillette at (307)682-3810.

Sincerely,

Brenda K. Schladweiler/PhD

Brenda K. Schladweiler
BKS ENVIRONMENTAL ASSOCIATES, INC.

cc. Pam French, Rio Algom Mining Corporation

1997 Soil Sampling Methodology
Rio Algom Mining Corporation's Reynold's Ranch Property
October 8, 1997

General

It is assumed the original baseline soils inventory for the Smith Ranch permit area, Permit No.304C was limited and conducted in the same timeframe as the baseline vegetation assessment, i.e., late 1970's and possibly 1990. As part of the limitations, it is assumed that the previous soil work is a general reproduction of previous Natural Resource Conservation Service (NRCS), formerly Soil Conservation Service (SCS), mapping and that little or no soil analytical data is available for the current Smith Ranch property. The Reynolds Ranch permit extension was proposed in 1996 and consists of approximately 13,440 acres that lie adjacent to the existing Smith Ranch permit area.

Review of Existing Literature

The northern portion of Converse County has been mapped by the NRCS. This material, as well as the existing soils section for the current permit area, if any, was reviewed prior to summer 1997 fieldwork.

Soil Survey

Field soil mapping will be accomplished according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (November, 1984) of the Wyoming Department of Environmental Quality, Land Quality Division will be used as a general guide during all phases of the study.

A reconnaissance of the Reynolds Ranch extension area was used to determine the validity of the previous NRCS soil survey and to familiarize the field personnel with the area. Soil profiles were examined on a widely scattered basis according to physiographic configuration. Information derived from these profiles was used to determine which soils were likely to occur on specific landscape positions.

Following the reconnaissance survey, a higher intensity Order 1-2 soil survey was conducted. Actual soil boundaries were delineated in the field by exposing additional soil profiles to determine the nature and extent of soil series present on the extension area. The soil boundaries were delineated on the 1"=400' scale topographic basemap. The acreages of individual map units were compiled in Table 1.

Soil Sampling, Description, and Analysis

Profile sampling and description for the original baseline survey was limited, based on requirements of non-coal facilities. It is assumed that little or no previous analytical data exists and that existing profile descriptions would be a general reproduction of existing NRCS information. Since the 1997 assessment is an Order 1-2 survey, sampling for analysis and profile descriptions has been included.

1997 Soil Sampling Methodology
Rio Algom Mining Corporation's Reynold's Ranch Property
October 8, 1997 (cont.)

The extent of proposed disturbed area within the Reynold's Ranch permit extension is not known at this time. Therefore the proposed sample numbers proposed in Table 1 are based on total permit acreages. Sampling requirements for those series found within the Reynolds Ranch extension area will generally follow the acreage recommendations in Guideline 1, page 5 (November 1984). However, since actual disturbed acreage is not known at this time, the following sampling scheme is proposed:

If the extension area acreage of the mapping unit exceeds 10% of the total permit area or 1,344 acres, 3 pedons will be sampled for analysis. If the combined acreage ranges from 5-10% of the total permit area, 2 pedons will be sampled, and, if that acreage is less than 5% of the total permit area, 1 pedon will be sampled.

All soils will be sampled and described by exposing the solum with a shovel and then sampling below this point with a bucket auger to a maximum depth of 60". The physical and, where possible, chemical nature of each horizon within the sampled profile will be described and recorded in the field using standard NRCS survey techniques. Soil backhoe pits will not be utilized for sampling.

Necessary sample locations for written profile descriptions will be marked on the topographic base map and marked in the field with steel fence posts. The sampled soil material will be placed in clean, labeled, polyethylene plastic bags, and kept sealed to limit sample drying. Samples will not be iced down but will be kept as cool as possible. In addition, samples will be forwarded to the laboratory as soon as possible after collection to limit chemical changes. At the end of the sampling program, the samples will be transported to Energy Laboratories in Gillette or left at the mine site for Energy Laboratories in Casper to obtain. Analytical information will following Guideline 1, Table 1-2, Topsoil Suitability.

This soil assessment methodology correctly documents previous agreements as stated above and is hereby approved.

_____

Lowell Spackman
WDEQ, Land Quality Division

Date:_____

Table 1. Soil Series Sample Summary for the Reynolds Ranch Extension Area.

Map Unit/ Soil Series	Reynolds Ranch Existing Permit Acreage (%)	No. of Chemical Analysis Locations
Aeric Haplaquept	16.76 (<1)	1
Bowbac	3797.74 (28)	3
Cambria	430.9 (3)	1
Cushman	2319.5 (17)	3
Clarkelen	56.2 (<1)	1
Dwyer	18.0 (<1)	1
Exposed Sandstone	98.5 (1)	0
Folkwood	500.3 (4)	1
Haverdad	54.8 (<1)	1
Hiland	983.2 (7)	2
Kishona	13.2 (<1)	1
Renohill	270.6 (2)	1
Shingle	95.0 (1)	1
Taluce	1995.5 (15)	3
Terro	1038.0 (8)	2
Tullock	540.5 (4)	1
Ulm	9.7 (<1)	1
Vonalee	268.5 (2)	1
Worf	933.2 (7)	2
TOTALS	13440 (100.00)	27

**NOTE: Disturbed acreage is not known at this time.

Date: Thu, 23 Oct 1997 11:43:38 -0600
From: Lowell Spackman <LSPACK@missc.state.wy.us>
To: schlad@vcn.com
Cc: gcash@missc.state.wy.us, jwagne@missc.state.wy.us
Subject: Review of Soil Sampling Methodology, Rio Algom Amendment, TFN
3 5/131 (e-mail)
Content-Disposition: inline
X-UIDL: 54fbb9028f7d2c87fae4a9fa4c04dc15

Dear Brenda (BKS Environmental Associates, INC):

I have reviewed the methodology for the Reynold's Ranch Property to be amended to the Rio Algom's Smith Ranch Permit. This methodology was outlined in your letter of October 15, 1997, to Matt Jankovsky.

I recently did an evaluation of the Smith Ranch permit soil survey information, to evaluate the effects of stripping only the upper four to six inches of the soil in the construction of access roads. There are no suitability data nor quality data in the permit for soils. My review suggested that each soil needs to be evaluated for quality. The quality of the soil will dictate how much of the soil will need to be stripped for each road. I think it is essential that soil suitability be evaluated for this insitu mine.

Without having a map and specifics on the disturbance boundary, I concur with your sampling scheme for the Reynolds Ranch Amendment area. The general scheme is acceptable and should meet the requirement of the Noncoal Rules and Regulations/Guideline No. 1. Thank you for the opportunity to comment on these methodologies before they are implemented.

Lowell K. Spackman

ADDENDUM 2
SUMMARY OF 1997 SOIL ANALYTICAL RESULTS

Aeric Haplaquept
(Location 23)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-12	36.0	20.8	43.2	C	5.71
12-24	38.0	21.8	40.2	C	4.96
24-33	43.0	23.8	33.2	CL	2.38
33-48	49.0	21.8	29.2	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-12	<0.2	0.007	13.8	80.1
12-24	<0.2	0.006	13.5	75.3
24-33	<0.2	0.009	13.7	67.5
33-48	<0.2	<0.002	19.0	64.1

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-12	7.40	0.25	0.99	0.59	0.13	0.14
12-24	7.37	0.19	0.75	0.39	0.14	0.19
24-33	7.66	0.25	1.36	0.65	0.23	0.23
33-48	7.81	0.22	1.14	0.54	0.22	0.22

NOTE: The saturation % at 0 -12" and the texture at 0 -12" and 12-24" are marginal according to WDEQ Guideline No. 1.

Bowbac
(Location 63)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	61.0	23.7	15.3	SL	<2.0
3-20	61.0	23.7	15.3	S L	<2.0
20-26	65.0	17.7	17.3	S L	<2.0
26-32	62.0	15.7	22.3	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.010	1.98	42.2
3-20	<0.2	0.008	7.36	51.1
20-26	<0.2	0.002	<1.0	42.8
26-32	<0.2	0.003	<1.0	38.7

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	8.13	0.51	4.45	1.62	0.09	0.05
3-20	8.00	0.52	3.60	1.32	0.19	0.12
20-26	7.97	0.82	5.85	2.00	0.23	0.11
26-32	8.02	0.49	3.50	1.23	0.19	0.12

Bowbac
(Location 78)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	65.0	18.7	16.3	S L	<2.0
3-20	75.0	8.70	16.3	SL	<2.0
20-28	80.0	5.70	14.3	S L	<2.0
28-36	77.0	12.7	10.3	S L	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.006	6.21	33.4
3-20	<0.2	0.003	2.80	42.8
20-28	<0.2	<0.002	<1.0	31.9
28-36	<0.2	<0.002	<1.0	42.7

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-3	7.78	0.44	3.15	1.42	0.11	0.07
3-20	7.79	0.41	2.65	1.08	0.17	0.13
20-28	7.50	0.82	5.00	2.25	0.34	0.18
28-36	7.93	0.69	4.20	2.33	0.40	0.22

Cambria
(Location 66)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	56.0	19.7	24.3	SCL	<2.0
3-15	44.0	22.7	33.3	CL	4.47
15-31	49.0	24.7	26.3	SCL	<2.0
31-48	54.0	24.7	21.3	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.012	7.55	42.6
3-15	<0.2	0.009	12.4	69.8
15-31	<0.2	<0.002	15.0	59.3
31-48	<0.2	<0.002	17.1	55.8

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-3	8.25	0.31	1.95	1.31	0.09	0.07
3-15	8.38	0.89	5.65	4.08	0.24	0.11
15-31	8.53	0.30	1.40	1.67	0.55	0.44
31-48	8.52	0.35	0.76	2.13	1.37	1.14

Note: The pH at 15-31" and 31-48" are marginal according to WDEQ Guideline No. 1.

Clarkelen
(Location 50)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	58.0	18.3	23.7	SCL	<2.0
3-15	60.0	20.3	19.7	S L	<2.0
15-32	77.0	10.3	12.7	S L	<2.0
32-38	76.0	10.3	13.7	SL	<2.0
38-60	85.0	5.3	9.70	LS	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.014	2.85	60.1
3-15	0.2	0.019	1.56	54.0
15-32	<0.2	0.013	<1.0	33.4
32-38	<0.2	0.007	1.15	32.5
38-60	<0.2	0.002	<1.0	25.7

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	8.03	1.30	11.0	2.92	0.30	0.12
3-15	8.21	1.01	8.70	2.25	0.13	0.06
15-32	8.19	1.26	10.1	3.08	0.52	0.20
32-38	8.11	1.22	9.35	2.92	0.53	0.21
38-60	8.20	0.82	5.65	2.08	0.35	0.18

Cushman
(Location 4)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-5	56.0	29.8	14.2	S L	<2.0
5-18	43.0	28.8	28.2	CL	<2.0
18-31	56.0	21.8	22.2	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-5	<0.2	0.012	26.3	46.8
5-18	<0.2	0.006	22.8	66.9
18-31	<0.2	<0.002	19.1	59.8

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-5	7.96	0.60	4.32	2.18	0.19	0.10
5-18	7.92	0.55	4.00	2.21	0.33	0.19
18-31	8.05	0.58	3.55	2.67	0.43	0.24

Cushman
(Location 49)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	45.0	22.4	32.6	CL	<2.0
3-10	42.0	19.4	38.6	CL	8.64
10-16	42.0	23.4	34.6	CL	3.16
16-27	43.0	21.4	35.6	CL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.012	9.06	52.4
3-10	<0.2	0.010	12.0	73.9
10-16	<0.2	0.007	9.79	69.5
16-27	<0.2	0.006	6.08	64.5

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-3	7.66	0.35	2.20	1.38	0.19	0.14
3-10	8.33	0.60	4.35	2.67	0.20	0.10
10-16	8.26	0.60	3.70	2.50	0.30	0.17
16-27	8.38	0.29	1.47	1.30	0.75	0.64

Cushman
(Location 60)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	59.0	21.7	19.3	SL	<2.0
3-15	58.0	20.7	21.3	SCL	<2.0
15-20	42.0	30.7	27.3	CL	5.48
20-36	50.0	24.7	25.3	SCL	2.39

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.003	3.52	44.6
3-15	<0.2	0.003	7.12	52.6
15-20	<0.2	0.002	8.88	60.1
20-36	<0.2	<0.002	13.5	57.3

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-3	8.00	0.37	2.55	1.15	0.07	0.05
3-15	8.15	0.49	4.00	1.38	0.10	0.06
15-20	8.19	0.46	3.65	1.31	0.11	0.07
20-36	8.29	0.25	1.65	1.08	0.13	0.11

Draknab
(Location 51)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-6	70.0	12.3	17.7	S L	2.44
6-14	63.0	13.3	23.7	SCL	7.54
14-30	88.0	3.30	8.70	LS	4.22
30-36	42.0	20.3	37.7	CL	6.33
36-44	88.0	3.30	8.70	LS	2.34
44-48	30.0	29.3	40.7	C	9.21

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-6	<0.2	0.029	<1.0	32.7
6-14	<0.2	0.022	<1.0	40.1
14-30	<0.2	0.004	<1.0	21.7
30-36	<0.2	0.047	2.81	66.3
36-44	<0.2	0.007	<1.0	20.9
44-48	<0.2	0.022	10.5	78.0

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-6	8.28	1.19	9.70	4.58	0.66	0.25
6-14	8.22	0.69	4.85	2.08	0.57	0.30
14-30	7.89	0.72	4.75	2.00	0.48	0.26
30-36	8.11	0.39	2.40	1.08	0.30	0.22
36-44	8.02	0.31	1.77	0.82	0.30	0.26
44-48	8.15	0.36	2.20	1.02	0.28	0.22

Note: The saturation % at 14-30'" and 36-44" and the texture at 44-48" are marginal according to WDEQ Guideline No. 1.

Dwyer
(Location 72)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-5	39.0	32.7	28.3	C L	2.06
5-20	62.0	20.7	17.3	S L	<2.0
20-30	81.0	6.70	12.3	S L	<2.0
30-60	85.0	5.70	9.30	LS	4.25

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-5	<0.2	0.006	5.94	64.4
5-20	<0.2	0.005	3.59	41.5
20-30	<0.2	0.002	<1.0	27.6
30-60	<0.2	<0.002	<1.0	20.1

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-5	8.16	0.80	6.70	1.92	0.07	0.03
5-20	8.09	0.57	4.80	1.14	0.10	0.06
20-30	8.03	0.55	4.25	1.25	0.16	0.10
30-60	8.17	0.43	3.10	1.24	0.31	0.21

Forkwood
(Location 48)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	44.0	31.4	24.6	L	<2.0
3-7	50.0	23.4	26.6	SCL	<2.0
7-26	45.0	22.4	32.6	CL	2.43
26-30	41.0	29.4	29.6	CL	4.93
30-45	34.0	30.4	35.6	CL	4.55
45-60	34.0	34.0	32.6	CL	2.44

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.011	7.42	52.1
3-7	<0.2	0.009	10.4	47.6
7-26	<0.2	0.012	14.3	62.3
26-30	<0.2	0.022	15.4	64.0
30-45	<0.2	<0.002	19.3	69.7
45-60	0.2	0.017	18.3	71.0

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	7.91	0.29	1.65	0.94	0.11	0.10
3-7	7.33	0.20	1.00	0.56	0.13	0.15
7-26	7.99	0.30	1.40	0.92	0.70	0.65
26-30	8.12	0.45	1.50	1.25	1.83	1.56
30-45	8.27	0.60	1.55	1.50	3.39	2.75
45-60	8.12	1.08	3.00	3.12	5.52	3.16

Hiland
(Location 7)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-4	77.0	15.8	7.20	SL	<2.0
4-18	76.0	14.8	9.20	SL	<2.0
18-26	68.0	16.8	15.2	SL	<2.0
26-34	68.0	19.8	12.2	SL	<2.0
34-54	78.0	12.8	9.20	SL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-4	<0.2	0.017	20.3	35.9
4-18	<0.2	0.006	20.6	36.9
18-26	<0.2	0.007	21.2	47.4
26-34	<0.2	0.002	24.2	52.6
34-54	<0.2	<0.002	22.1	44.5

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-4	8.3	0.87	5.75	2.13	0.13	0.07
4-18	7.8	0.41	3.40	1.33	0.12	0.08
18-26	7.6	0.40	2.85	1.23	0.19	0.13
26-34	7.53	0.35	2.38	1.03	0.17	0.13
34-54	8.01	0.31	2.10	1.11	0.18	0.14

Hiland
(Location 64)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	60.0	16.7	23.3	SCL	<2.0
3-10	60.0	18.7	21.3	SCL	<2.0
10-24	62.0	15.7	22.3	SCL	<2.0
24-30	60.0	16.7	23.3	SCL	<2.0
30-48	60.0	17.7	22.3	SCL	<2.0
48-60	60.0	18.7	21.3	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.006	1.60	43.4
3-10	<0.2	0.008	6.87	40.3
10-24	<0.2	0.006	8.61	53.6
64-30	<0.2	0.004	5.92	58.0
30-48	<0.2	0.002	9.24	52.8
48-60	<0.2	<0.002	11.5	59.0

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	7.67	0.47	2.55	1.21	0.11	0.08
3-10	7.60	0.36	2.10	0.86	0.07	0.06
10-24	8.10	0.35	2.15	0.91	0.13	0.11
24-30	8.25	0.49	3.40	1.21	0.17	0.11
30-48	8.34	0.40	3.15	1.13	0.17	0.11
48-60	8.33	0.26	1.90	1.03	0.16	0.13

Kishona
(Location 52)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-6	36.0	33.3	30.7	CL	2.55
6-19	30.0	38.3	31.7	CL	4.71
19-30	38.0	32.3	29.7	CL	<2.0
30-44	37.0	35.3	27.7	CL	<2.0
44-54	48.0	29.3	22.7	L	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-6	<0.2	0.006	8.31	59.4
6-19	<0.2	0.006	7.45	53.9
19-30	<0.2	<0.002	16.7	54.5
30-44	<0.2	<0.002	15.7	57.0
44-54	0.2	0.003	14.3	48.9

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-6	8.2	0.87	7.20	2.58	0.11	0.05
6-19	8.23	0.50	3.55	2.17	0.17	0.10
19-30	8.23	0.42	1.81	2.25	0.47	0.33
30-44	8.32	0.35	0.98	1.15	1.70	1.65
44-54	8.28	0.45	0.94	1.08	2.91	2.90

Renohill
(Location 58)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	55.0	25.7	19.3	SL	<2.0
3-20	48.0	21.7	30.3	SCL	2.0
20-26	42.0	28.7	29.3	CL	4.16
26-33	38.0	30.7	31.3	CL	4.53

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.012	7.30	42.9
3-20	<0.2	0.012	10.9	62.3
20-26	<0.2	0.003	14.3	58.4
26-33	<0.2	0.002	14.6	66.1

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	7.09	0.53	3.40	1.92	0.14	0.09
3-20	7.92	0.40	2.30	1.25	0.17	0.13
20-26	8.05	1.16	7.05	4.25	0.37	0.16
26-33	8.17	0.36	1.95	1.42	0.41	0.32

Shingle
(Location 1)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-6	43.0	29.8	27.2	CL	4.81

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-6	<0.2	0.009	22.7	69.1

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-6	8.09	0.965	8.00	2.58	0.18	0.08

Shingle
(Location 62)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	52.0	20.7	27.3	SCL	<2.0
3-18	48.0	23.7	28.3	SCL	2.42

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.007	5.40	56.1
3-18	<0.2	0.009	2.64	54.7

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-3	8.17	0.43	2.70	1.83	0.38	0.25
3-18	8.11	0.74	7.05	1.42	0.09	0.04

Taluce
(Location 29)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-6	81.0	8.80	10.2	LS	4.29

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-6	<0.2	0.007	6.18	32.0

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-6	7.93	0.88	8.50	1.23	0.14	0.07

Taluce
(Location 43)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-5	68.0	14.4	17.6	SL	3.96
5-16	60.0	18.4	21.6	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-5	<0.2	0.004	7.95	37.9
5-16	<0.2	0.007	7.38	44.9

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-5	8.09	1.14	10.1	2.92	0.18	0.07
5-16	8.24	0.43	3.90	1.25	0.17	0.11

Terro
(Location 40)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-5	71.0	16.8	12.2	S L	<2.0
5-20	70.0	14.4	15.6	S L	<2.0
20-38	68.0	13.4	18.6	S L	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-5	<0.2	0.011	15.4	37.7
5-20	<0.2	0.006	11.3	37.2
20-38	<0.2	0.002	5.46	41.4

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			---------meq/liter----------			
0-5	7.93	0.38	2.95	1.17	0.09	0.07
5-20	8.24	0.56	4.80	1.75	0.14	0.08
20-38	8.15	0.43	2.75	1.75	0.13	0.09

Terro
(Location 77)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	67.0	18.7	14.3	S L	<2.0
3-18	54.0	25.7	20.3	SCL	<2.0
18-27	70.0	16.7	13.3	S L	<2.0
27-40	83.0	6.70	10.3	LS	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.005	<1.0	38.9
3-18	<0.2	0.008	5.89	40.7
18-27	<0.2	0.005	2.26	29.0
27-40	<0.2	<0.002	<1.0	28.6

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			---------meq/liter----------			
0-3	7.78	0.48	3.25	1.16	0.09	0.06
3-18	8.09	0.45	3.50	1.00	0.08	0.06
18-27	8.21	0.34	2.80	0.83	0.10	0.07
27-40	8.03	0.67	5.05	1.58	0.13	0.07

Theedle
(Location 61)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	46.0	25.7	28.3	SCL	<2.0
3-12	42.0	29.7	28.3	C L	5.10
12-30	44.0	30.7	25.3	L	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.005	12.2	64.8
3-12	<0.2	0.005	17.6	66.0
12-30	<0.2	0.004	21.1	58.1

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			---------meq/liter----------			
0-3	8.14	0.55	4.50	1.32	0.07	0.04
3-12	8.11	0.58	4.50	1.67	0.11	0.06
12-30	8.30	0.30	1.40	1.83	0.27	0.21

Tullock
(Location 36)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-4	63.0	22.8	14.2	SL	<2.0
4-21	66.0	18.8	15.2	SL	<2.0
21-39	52.0	31.8	16.2	L	2.11

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-4	<0.2	0.005	21.0	41.7
4-21	<0.2	0.002	19.3	38.6
21-39	<0.2	<0.002	26.5	44.6

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			meq/liter			
0-4	7.51	0.70	6.80	2.08	0.17	0.08
4-21	7.79	0.44	3.55	1.17	0.19	0.12
21-39	8.18	0.67	3.26	2.55	1.57	0.92

Ulm
(Location 57)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-3	52.0	24.3	23.7	SCL	<2.0
3 -20	38.0	20.3	41.7	C	<2.0
20-24	38.0	22.3	39.7	CL	<2.0
24-42	34.0	25.3	40.7	C	2.97
42-48	51.0	10.3	38.7	SC	5.35

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-3	<0.2	0.009	2.42	43.0
3 -20	<0.2	0.003	6.94	73.9
20-24	<0.2	<0.002	11.2	75.8
24-42	<0.2	0.004	9.78	73.3
42-48	2.0	0.017	30.2	73.6

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			---------meq/liter----------			
0-3	7.78	0.77	4.80	3.17	0.16	0.08
3 -20	8.27	0.66	3.32	2.83	0.91	0.52
20-24	8.09	0.82	2.80	3.00	2.00	1.17
24-42	8.13	0.97	2.85	3.17	3.87	2.23
42-48	8.08	1.51	5.10	5.75	5.52	2.37

NOTE: The textures at 3-20" and 24-42" are marginal according to WDEQ Guideline No. 1.

Vonalee
(Location 45)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-4	62.0	19.4	18.6	SL	<2.0
4-17	59.0	19.4	21.6	SCL	2.41
17-28	51.0	22.4	26.6	SCL	2.95
28-42	50.0	25.4	24.6	SCL	<2.0
42-60	52.0	27.4	20.6	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-4	<0.2	0.029	9.59	40.2
4-17	<0.2	0.020	11.2	44.8
17-28	<0.2	0.015	24.1	60.0
28-42	<0.2	0.005	15.2	52.9
42-60	<0.2	0.0 19	15.6	54.6

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-4	7.88	0.90	8.60	3.00	0.23	0.10
4-17	8.12	0.53	4.55	1.60	0.24	0.14
17-28	8.15	0.45	3.55	1.42	0.29	0.18
28-42	8.13	0.34	2.20	1.53	0.31	0.23
42-60	8.13	0.52	2.55	3.10	0.81	0.48

Worf
(Location 2)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-2	55.0	22.8	22.2	SCL	<2.0
2- 6	50.0	24.8	25.2	SCL	<2.0
6-11	49.0	23.8	27.2	SCL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-2	<0.2	0.007	14.9	46.8
2- 6	<0.2	0.007	22.4	66.3
6-11	<0.2	0.006	23.4	62.9

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			----------meq/liter----------			
0-2	7.96	0.52	4.35	1.85	0.14	0.08
2- 6	8.04	0.68	6.35	2.67	0.17	0.08
6-11	8.01	0.67	5.20	2.78	0.24	0.12

Worf
(Location 47)

Mechanical Analysis

Depth (inches)	Sand %	Silt %	Clay %	Texture	Coarse Fragments
0-6	49.0	21.4	29.6	SCL	2.39
6-15	43.0	28.4	28.6	CL	<2.0

Depth (inches)	B ppm	Se ppm	Very Fine Sand %	Satur. %
0-6	<0.2	0.007	13.5	60.5
6-15	<0.2	0.005	10.8	53.6

Saturation Extract

Depth (inches)	pH S.U.	Elect. Cond. (mmhos/cm)	Cations			
			Ca	Mg	Na	SAR
			---------meq/liter----------			
0-6	8.13	0.79	6.65	2.08	0.12	0.06
6-15	8.15	0.63	4.55	2.18	0.21	0.11

ENERGY LABORATORIES

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SOIL ANALYSIS REPORT - GUIDELINE 1 TOPSOIL

Client: BKS Environmental, Inc.
Project: Rio Algom Reynold's Ranch
Report Date: December 17, 1997

Lab I.D. #	SAMPLE I.D.	pH, S.U.	Elec Cond mmho/cm	Sat., %	Ca, meq/l	Mg, meq/l	Na, meq/l	SAR	Boron, µg/g	Se, ABDTPA ext., µg/g	Texture	Very Fine Sand, %	Coarse Fragments, %	Sand, %	Silt, %	Clay, %
97- 67762	1 0-6'	8.09	0.96	69.1	8.00	2.58	0.18	0.08	< 0.20	0.009	CL	22.7	4.81	43.0	29.80	27.2
97- 67763	2 0-2'	7.96	0.52	46.8	4.35	1.85	0.14	0.08	< 0.20	0.007	SCL	14.9	< 2.00	55.0	22.80	22.2
97- 67764	2 2-6'	8.04	0.68	66.3	6.35	2.67	0.17	0.08	< 0.20	0.007	SCL	22.4	< 2.00	50.0	24.8	25.2
97- 67765	2 6-11'	8.01	0.67	62.9	5.20	2.78	0.24	0.12	< 0.20	0.006	SCL	23.4	< 2.00	49.0	23.8	27.2
97- 67766	4 0-5'	7.96	0.60	46.8	4.32	2.18	0.19	0.10	< 0.20	0.012	SL	26.3	< 2.00	56.0	29.8	14.2
97- 67767	4 5-18'	7.92	0.55	66.9	4.00	2.21	0.33	0.19	< 0.20	0.006	CL	22.8	< 2.00	43.0	28.8	28.2
97- 67768	4 18-31'	8.05	0.58	59.8	3.55	2.67	0.43	0.24	< 0.20	< 0.002	SCL	19.1	< 2.00	56.0	21.8	22.2
97- 67769	7 0-4'	8.30	0.87	35.9	5.75	2.13	0.13	0.07	< 0.20	0.017	SL	20.3	< 2.00	77.0	15.8	7.20
97- 67770	7 4-18'	7.80	0.41	36.9	3.40	1.33	0.12	0.08	< 0.20	0.006	SL	20.6	< 2.00	76.0	14.8	9.20
97- 67771	7 18-26'	7.60	0.40	47.4	2.85	1.23	0.19	0.13	< 0.20	0.007	SL	21.2	< 2.00	68.0	16.8	15.2
97- 67772	7 26-34'	7.53	0.35	52.6	2.38	1.03	0.17	0.13	< 0.20	0.002	SL	24.2	< 2.00	68.0	19.8	12.2
97- 67773	7 34-54'	8.01	0.31	44.5	2.10	1.11	0.18	0.14	< 0.20	< 0.002	SL	22.1	< 2.00	78.0	12.8	9 20
97- 67774	23 0-12'	7.40	0.25	80.1	0.99	0.59	0.13	0.14	< 0.20	0.007	C	13.8	5.71	36.0	20.8	43.2
97- 67775	23 12-24'	7.37	0.19	75.3	0.75	0.39	0.14	0.19	< 0.20	0.006	C	13.5	4.96	38.0	21.8	40.2
97- 67776	23 24-33'	7.66	0.25	67.5	1.36	0.65	0.23	0.23	< 0.20	0.009	CL	13.7	2.38	43.0	23.8	33.2
97- 67777	23 33-48'	7.81	0.22	64.1	1.14	0.54	0.22	0.24	< 0.20	< 0.002	SCL	19.0	< 2.00	49.0	21.8	29.2
97- 67778	29 0-6'	7.93	0.88	32.0	8.50	1.23	0.14	0.07	< 0.20	0.007	LS	6.18	4.29	81.0	8.80	10.2
97- 67779	36 0-4'	7.51	0.70	41.7	6.80	2.08	0.17	0.08	< 0.20	0.005	SL	21.0	< 2.00	63.0	22.8	14.2
97- 67780	36 4-21'	7.79	0.44	38.6	3.55	1.17	0.19	0.12	< 0.20	0.002	SL	19.3	< 2.00	66.0	18.8	15.2
97- 67781	36 21-39'	8.18	0.67	44.6	3.26	2.55	1.57	0.92	< 0.20	< 0.002	L	26.5	2.11	52.0	31.8	16.2
97- 67782	40 0-5'	7.93	0.38	37.7	2.95	1.17	0.09	0.07	< 0.20	0.011	SL	15.4	< 2.00	71.0	16.8	12.2
97- 67783	40 5-20'	8.24	0.56	37.2	4.80	1.75	0.14	0.08	< 0.20	0.006	SL	11.3	< 2.00	70.0	14.4	15.6
97- 67784	40 20-38'	8.15	0.43	41.4	2.75	1.75	0.13	0.09	< 0.20	< 0.002	SL	5.46	< 2.00	68.0	13.4	18.6
97- 67785	43 0-5'	8.09	1.14	37.9	10.1	2.92	0.18	0.07	< 0.20	0.004	SL	7.95	3.96	68.0	14.4	17.6
97- 67786	43 5-16'	8.24	0.43	44.9	3.90	1.25	0.17	0.11	< 0.20	0.007	SCL	7.38	< 2.00	60.0	18.4	21.6
97- 67787	45 0-4'	7.88	0.90	40.2	8.60	3.00	0.23	0.10	< 0.20	0.029	SL	9.59	< 2.00	62.0	19.4	18.6
97- 67788	45 4-17'	8.12	0.53	44.8	4.55	1.60	0.24	0.14	< 0.20	0.020	SCL	11.2	2.41	59.0	19.4	21.6
97- 67789	45 17-28'	8.15	0.45	60.0	3.55	1.42	0.29	0.18	< 0.20	0.015	SCL	24.1	2.95	51.0	22.4	26.6
97- 67790	45 28-42'	8.13	0.34	52.9	2.20	1.53	0.31	0.23	< 0.20	0.005	SCL	15.2	< 2.00	50.0	25.4	24.6
97- 67791	45 42-60'	8.13	0.52	54.6	2.55	3.10	0.81	0.48	< 0.20	0.019	SCL	15.6	< 2.00	52.0	27.4	20.6
97- 67792	47 0-6'	8.13	0.79	60.5	6.65	2.08	0.12	0.06	< 0.20	0.007	SCL	13.5	2.39	49.0	21.4	29.6
97- 67793	47 6-15'	8.15	0.63	53.6	4.55	2.18	0.21	0.11	< 0.20	0.005	CL	10.8	< 2.00	43.0	28.4	28.6
97- 67794	48 0-3'	7.91	0.29	52.1	1.65	0.94	0.11	0.10	< 0.20	0.011	L	7.42	< 2.00	44.0	31.4	24.6
97- 67795	48 3-7'	7.33	0.20	47.6	1.00	0.56	0.13	0.15	< 0.20	0.009	SCL	10.4	< 2.00	50.0	23.4	26.6
97- 67796	48 7-26'	7.99	0.30	62.3	1.40	0.92	0.70	0.65	< 0.20	0.012	CL	14.3	2.43	45.0	22.4	32.6
97- 67797	48 26-30'	8.12	0.45	64.0	1.50	1.25	1.83	1.56	< 0.20	0.022	CL	15.4	4.93	41.0	29.4	29.6
97- 67798	48 30-45'	8.27	0.60	69.7	1.55	1.50	3.39	2.75	< 0.20	< 0.002	CL	19.3	4.55	34.0	30.4	35.6
97- 67799	48 45-60'	8.12	1.08	71.0	3.00	3.12	5.52	3.16	0.20	0.017	CL	18.3	2.44	34.0	33.4	32.6

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SOIL ANALYSIS REPORT - GUIDELINE 1 TOPSOIL

Client: BKS Environmental, Inc.
Project: Rio Algom Reynold's Ranch
Report Date: December 17, 1997

Lab I.D. #	SAMPLE I.D.	pH, S.U.	Elec Cond mmho/cm	Sat., %	Ca, meq/l	Mg, meq/l	Na, meq/l	SAR	Boron, µg/g	Se, ABDTPA ext. µg/g	Texture	Very Fine Sand, %	Coarse Fragments, %	Sand, %	Silt, %	Clay, %
97- 67800	49 0-3'	7.66	0.35	52.4	2.20	1.38	0.19	0.14	< 0.20	0.012	CL	9.06	< 2.00	45.0	22.4	32.6
97- 67801	49 3-10'	8.33	0.60	73.9	4.35	2.67	0.20	0.10	< 0.20	0.010	CL	12.0	8.64	42.0	19.4	38.6
97- 67802	49 10-16'	8.26	0.60	69.5	3.70	2.50	0.30	0.17	< 0.20	0.007	CL	9.79	3.16	42.0	23.4	34.6
97- 67803	49 16-27'	8.38	0.29	64.5	1.47	1.30	0.75	0.64	< 0.20	0.006	CL	6.08	< 2.00	43.0	21.4	35.6
97- 67804	50 0-3'	8.03	1.30	60.1	11.0	2.92	0.30	0.12	< 0.20	0.014	SCL	2.85	< 2.00	58.0	18.3	23.7
97- 67805	50 3-15'	8.21	1.01	54.0	8.70	2.25	0.13	0.06	0.20	0.019	SL	1.56	< 2.00	60.0	20.3	19.7
97- 67806	50 15-32'	8.19	1.26	33.4	10.1	3.08	0.52	0.20	< 0.20	0.013	SL	< 1.00	< 2.00	77.0	10.3	12.7
97- 67807	50 32-38'	8.11	1.22	32.5	9.35	2.92	0.53	0.21	< 0.20	0.007	SL	1.15	< 2.00	76.0	10.3	13.7
97- 67808	50 38-60'	8.20	0.82	25.7	5.65	2.08	0.35	0.18	< 0.20	0.002	LS	< 1.00	< 2.00	85.0	5.30	9.70
97- 67809	51 0-6'	8.28	1.19	32.7	9.70	4.58	0.66	0.25	< 0.20	0.029	SL	< 1.00	2.44	70.0	12.3	17.7
97- 67810	51 6-14'	8.22	0.69	40.1	4.85	2.08	0.57	0.30	< 0.20	0.022	SCL	< 1.00	7.54	63.0	13.3	23.7
97- 67811	51 14-30'	7.89	0.72	21.7	4.75	2.00	0.48	0.26	< 0.20	0.004	LS	< 1.00	4.22	88.0	3.30	8.70
97- 67812	51 30-36'	8.11	0.39	66.3	2.40	1.08	0.30	0.22	< 0.20	0.047	CL	2.81	6.33	42.0	20.3	37.7
97- 67813	51 36-44'	8.02	0.31	20.9	1.77	0.82	0.30	0.26	< 0.20	0.007	LS	< 1.00	2.34	88.0	3.30	8.70
97- 67814	51 44-48'	8.15	0.36	78.0	2.20	1.02	0.28	0.22	< 0.20	0.022	C	10.5	9.21	30.0	29.3	40.7
97- 67815	52 0-6'	8.20	0.87	59.4	7.20	2.58	0.11	0.05	< 0.20	0.006	CL	8.31	2.55	36.0	33.3	30.7
97- 67816	52 6-19'	8.23	0.50	53.9	3.55	2.17	0.17	0.10	< 0.20	0.006	CL	7.45	4.71	30.0	38.3	31.7
97- 67817	52 19-30'	8.23	0.42	54.5	1.81	2.25	0.47	0.33	< 0.20	< 0.002	CL	16.7	< 2.00	38.0	32.3	29.7
97- 67818	52 30-44'	8.32	0.35	57.0	0.98	1.15	1.70	1.65	< 0.20	< 0.002	CL	15.7	< 2.00	37.0	35.3	27.7
97- 67819	52 44-54'	8.28	0.45	48.9	0.94	1.08	2.91	2.90	0.20	0.003	L	14.3	< 2.00	48.0	29.3	22.7
97- 67820	57 0-3'	7.78	0.77	43.0	4.80	3.17	0.16	0.08	< 0.20	0.009	SCL	2.42	< 2.00	52.0	24.3	23.7
97- 67821	57 3-20'	8.27	0.66	73.9	3.32	2.83	0.91	0.52	< 0.20	0.003	C	6.94	< 2.00	38.0	20.3	41.7
97- 67822	57 20-24'	8.09	0.82	75.8	2.80	3.00	2.00	1.17	< 0.20	< 0.002	CL	11.2	< 2.00	38.0	22.3	39.7
97- 67823	57 24-42'	8.13	0.97	73.3	2.85	3.17	3.87	2.23	< 0.20	0.004	C	9.78	2.97	34.0	25.3	40.7
97- 67824	57 42-48'	8.08	1.51	73.6	5.10	5.75	5.52	2.37	0.20	0.017	SC	30.2	5.35	51.0	10.3	38.7
97- 67825	58 0-3'	7.09	0.53	42.9	3.40	1.92	0.14	0.09	< 0.20	0.012	SL	7.30	< 2.00	55.0	25.7	19.3
97- 67826	58 3-20'	7.92	0.40	62.3	2.30	1.25	0.17	0.13	< 0.20	0.012	SCL	10.9	2.00	48.0	21.7	30.3
97- 67827	58 20-26'	8.05	1.16	58.4	7.05	4.25	0.37	0.16	< 0.20	0.003	CL	14.3	4.16	42.0	28.7	29.3
97- 67828	58 26-33'	8.17	0.36	66.1	1.95	1.42	0.41	0.32	< 0.20	0.002	CL	14.6	4.53	38.0	30.7	31.3
97- 67829	60 0-3'	8.00	0.37	44.6	2.55	1.15	0.07	0.05	< 0.20	0.003	SL	3.52	< 2.00	59.0	21.7	19.3
97- 67830	60 3-15'	8.15	0.49	52.6	4.00	1.38	0.10	0.06	< 0.20	0.003	SCL	7.12	< 2.00	58.0	20.7	21.3
97- 67831	60 15-20'	8.19	0.46	60.1	3.65	1.31	0.11	0.07	< 0.20	0.002	CL	8.88	5.48	42.0	30.7	27.3
97- 67832	60 20-36'	8.29	0.25	57.3	1.65	1.08	0.13	0.11	< 0.20	<0.002	SCL	13.5	2.39	50.0	24.7	25.3
97- 67833	61 0-3'	8.14	0.55	64.8	4.50	1.32	0.07	0.04	< 0.20	0.005	SCL	12.2	< 2.00	46.0	25.7	28.3
97- 67834	61 3-12'	8.11	0.58	66.0	4.50	1.67	0.11	0.06	< 0.20	0.005	CL	17.6	5.10	42.0	29.7	28.3
97- 67835	61 12-30'	8.30	0.30	58.1	1.40	1.83	0.27	0.21	< 0.20	0.004	L	21.1	< 2.00	44.0	30.7	25.3
97- 67836	63 0-3'	8.13	0.51	42.2	4.45	1.62	0.09	0.05	< 0.20	0.010	SL	1.98	< 2.00	61.0	23.7	15.3
97- 67837	63 3-20'	8.00	0.52	51.1	3.60	1.32	0.19	0.12	< 0.20	0.008	SL	7.36	< 2.00	61.0	23.7	15.3

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SOIL ANALYSIS REPORT - GUIDELINE 1 TOPSOIL

Client: BKS Environmental, Inc.
Project: Rio Algom Reynold's Ranch
Report Date: December 17, 1997

Lab I.D. #	SAMPLE I.D.	pH, S.U.	Elec Cond mmho/cm	Sat., %	Ca, meq/l	Mg, meq/l	Na, meq/l	SAR	Boron, µg/g	Se, ABDTPA ext. µg/g	Texture	Very Fine Sand, %	Coarse Fragments, %	Sand, %	Silt, %	Clay, %
97- 67838	63 20-26'	7.97	0.82	42.8	5.85	2.00	0.23	0.11	< 0.20	0.002	SL	< 1.00	< 2.00	65.0	17.7	17.3
97- 67839	63 26-32'	8.02	0.49	38.7	3.50	1.23	0.19	0.12	< 0.20	0.003	SCL	< 1.00	< 2.00	62.0	15.7	22.3
97- 67840	64 0-3'	7.67	0.47	43.4	2.55	1.21	0.11	0.08	< 0.20	0.006	SCL	1.60	< 2.00	60.0	16.7	23.3
97- 67841	64 3-10'	7.60	0.36	40.3	2.10	0.86	0.07	0.06	< 0.20	0.008	SCL	6.87	< 2.00	60.0	18.7	21.3
97- 67842	64 10-24'	8.10	0.35	53.6	2.15	0.91	0.13	0.11	< 0.20	0.006	SCL	8.61	< 2.00	62.0	15.7	22.3
97- 67843	64 24-30'	8.25	0.49	58.0	3.40	1.21	0.17	0.11	< 0.20	0.004	SCL	5.92	< 2.00	60.0	16.7	23.3
97- 67844	64 30-48'	8.34	0.40	52.8	3.15	1.13	0.17	0.11	< 0.20	0.002	SCL	9.24	< 2.00	60.0	17.7	22.3
97- 67845	64 48-60'	8.33	0.26	59.0	1.90	1.03	0.16	0.13	< 0.20	< 0.002	SCL	11.5	< 2.00	60.0	18.7	21.3
97- 67846	66 0-3'	8.25	0.31	42.6	1.95	1.31	0.09	0.07	< 0.20	0.012	SCL	7.55	< 2.00	56.0	19.7	24.3
97- 67847	66 3-15'	8.38	0.89	69.8	5.65	4.08	0.24	0.11	< 0.20	0.009	CL	12.4	4.47	44.0	22.7	33.3
97- 67848	66 15-31'	8.53	0.30	59.3	1.40	1.67	0.55	0.44	< 0.20	< 0.002	SCL	15.0	< 2.00	49.0	24.7	26.3
97- 67849	66 31-48'	8.52	0.35	55.8	0.76	2.13	1.37	1.14	< 0.20	< 0.002	SCL	17.1	< 2.00	54.0	24.7	21.3
97- 67850	72 0-5'	8.16	0.80	64.4	6.70	1.92	0.07	0.03	< 0.20	0.006	CL	5.94	2.06	39.0	32.7	28.3
97- 67851	72 5-20'	8.09	0.57	41.5	4.80	1.14	0.10	0.06	< 0.20	0.005	SL	3.59	< 2.00	62.0	20.7	17.3
97- 67852	72 20-30'	8.03	0.55	27.6	4.25	1.25	0.16	0.10	< 0.20	0.002	SL	< 1.00	< 2.00	81.0	6.70	12.3
97- 67853	72 30-60'	8.17	0.43	20.1	3.10	1.24	0.31	0.21	< 0.20	< 0.002	LS	< 1.00	4.25	85.0	5.70	9.30
97- 67854	77 0-3'	7.78	0.48	38.9	3.25	1.16	0.09	0.06	< 0.20	0.005	SL	< 1.00	< 2.00	67.0	18.7	14.3
97- 67855	77 3-18'	8.09	0.45	40.7	3.50	1.00	0.08	0.06	< 0.20	0.008	SCL	5.89	< 2.00	54.0	25.7	20.3
97- 67856	77 18-27'	8.21	0.34	29.0	2.80	0.83	0.10	0.07	< 0.20	0.005	SL	2.26	< 2.00	70.0	16.7	13.3
97- 67857	77 27-40'	8.03	0.67	28.6	5.05	1.58	0.13	0.07	< 0.20	< 0.002	LS	< 1.00	< 2.00	83.0	6.70	10.3
97- 67858	78 0-3'	7.78	0.44	33.4	3.15	1.42	0.11	0.07	< 0.20	0.006	SL	6.21	< 2.00	65.0	18.7	16.3
97- 67859	78 3-20'	7.79	0.41	42.8	2.65	1.08	0.17	0.13	< 0.20	0.003	SL	2.80	< 2.00	75.0	8.70	16.3
97- 67860	78 20-28'	7.50	0.82	31.9	5.00	2.25	0.34	0.18	< 0.20	< 0.002	SL	< 1.00	< 2.00	80.0	5.70	14.3
97- 67861	78 28-36'	7.93	0.69	42.7	4.20	2.33	0.40	0.22	< 0.20	< 0.002	SL	< 1.00	< 2.00	77.0	12.7	10.3

Quality Assurance:

Control Soil Analysis	8.27	3.01	73.2	18.2	11.2	12.3	3.21	< 0.20	0.15	CL	N/A	N/A	40.0	N/A	N/A
Target Range	7.82-8.39	2.54-3.53	54-76	15.5-25.0	8.51-14.1	8.24-18.9	2.20-4.53	0.1-1.2	0.03-0.13	N/A	N/A	N/A	34-42	N/A	N/A

Report Approved by:

Reviewed By:

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SOIL ANALYSIS REPORT - GUIDELINE 1 TOPSOIL

Client: BKS Environmental, Inc.
Report Date: December 22, 1997

Lab I.D. #	SAMPLE I.D.	pH, S.U.	Elec Cond mmho/cm	Sat., %	Ca, meq/l	Mg, meq/l	Na, meq/l	SAR	Boron, µg/g	Se, ABDTPA ext. µg/g	Texture	Very Fine Sand, %	Coarse Fragments, %	Sand, %	Silt, %	Clay, %
97- 68262	62 0-3'	8.17	0.43	56.1	2.70	1.83	0.38	0.25	< 0.20	0.007	SCL	5.400	< 2.00	52.0	20.7	27.3
97- 68263	62 3-18'	8.11	0.74	54.7	7.05	1.42	0.09	0.04	< 0.20	0.009	SCL	2.640	2.42	48.0	23.7	28.3

Quality Assurance:

Control Soil Analysis	8.27	3.01	73.2	18.2	11.2	12.3	3.21	< 0.20	0.15	CL	N/A	N/A	40.0	N/A	N/A
Target Range	7.82-8.39	2.54-3.53	54-76	15.5-25.0	8.51-14.1	8.24-18.9	2.20-4.53	0.1-1.2	0.03-0.13	N/A	N/A	N/A	34-42	N/A	N/A

Report Approved by:
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Reviewed By:

ADDENDUM 3
SOIL MAPPING UNIT DESCRIPTIONS

The following soil map units are based, in part, on the 1979 soil survey by Woodward-Clyde Associates on the Mill Site for Smith Ranch. These map units were utilized during 1978-1980 on various soil surveys related to the Smith Ranch Project. In order to maintain consistency with these earlier studies, the 1997 mapping of Reynold's Ranch utilized these map units with slight modifications, where appropriate for that specific area. The brief profile descriptions for the following map unit descriptions are based primarily on 1997 information.

Aeric Haplaquept, 0-3% (56)

The Aeric Haplaquept mapping unit consists of deep, poorly-drained soils that developed in calcareous recent alluvium derived from mixed sources. It occurs in depressions in the landscape at an elevation of approximately 5200. Slopes range from 0 to 3%.

A typical profile contains a 3 inch dark gray clay loam or clay surface layer with a relatively high amount of organic matter. The B subsoil is dark gray clay and is approximately 9 inches thick. The substratum is dark gray to brown clay to clay loam and extends to 48 inches in depth. The substratum is generally stratified.

Permeability of the Aeric Haplaquept soil is slow to moderate. Effective rooting depth is 60 inches or more. Average annual precipitation is 12 inches and mean annual air temperature is 46°F. Mean annual soil temperature is 49°F. The vegetation is western wheatgrass and salt-tolerant grasses.

Included in this map unit and making up about 15 percent of this unit are small areas of Forkwood clay loam and Cambria loam.

Bowbac Sandy Loam, 0-3% (23A); 3-6% (23B); 6-15% (23C)

This soil mapping unit consists of moderately deep, well drained soils on rolling upland ridges and backslopes. The soils have developed in residuum from calcareous sandstone. Slopes range from 0 to 15 percent. Elevation is about 5200 feet.

Typically, the Bowbac soil has a dark yellowish brown sandy loam surface layer about 3 inches thick. This is underlain by a dark yellowish brown to grayish brown sandy loam or sandy clay loam subsoil to approximately 26 inches. The substratum is a gray sandy clay loam which grades to shale and sandstone at 32 inches.

Permeability is moderate to moderately rapid. Effective rooting depth is 34 inches, although some roots do penetrate the shale and sandstone for a few inches. Average annual precipitation is 12 inches and the mean annual air temperature is about 46° F. Mean annual soil temperature is 49° F. The vegetation is needleandthread, yucca, big sagebrush and blue grama.

Included in the mapping and making up about 10 percent of the unit are small areas of Taluce sandy loam and Hiland sandy loam. The Taluce soils usually occur on ridgetops while the Hiland soils usually occur on the lower portions of the back slopes.

Cambria (Stoneham) Loam, 0-3% (15A); 3-6% (15B)

This soil mapping unit consists of deep well drained soils on gently sloping footslopes and toeslopes. The soil developed from gravelly, calcareous loamy parent material. Slopes range from 0 to 6 percent. Elevation is 5200 feet.

Typically, the Cambria soil has a yellowish brown heavy loam or loam surface layer about 3 inches thick. The subsoil is a pale brown or light gray loam or light clay loam about 16 inches thick. The substratum is a light brownish gray loam to approximately 60 inches thick.

Permeability is moderate. Effective rooting depth is more than 40 inches. Average annual precipitation is 12 inches. The mean annual temperature is 46° F, and the mean annual soil temperature is 49° F. The vegetation is typically big sagebrush and various cool-season grasses.

Included in the mapping and comprising 10 percent of the unit are small areas of Forkwood, Kishona and Cushman soils. Cushman soils usually occur above Cambria on the landscape, while Forkwood and Kishona soils are mixed; however, Kishona soils tend to be on less stable landscapes.

Clarkelen sandy clay loam, 0-3% (53A)

This soil mapping unit consists of deep, well or somewhat excessively drained soils formed in stratified recent stream alluvium on flood plains and terraces. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Clarkelen soil has a brown sandy clay loam surface layer about 3 inches thick. The subsoil is a brown sandy loam or loam about 12 inches thick. The substratum is a brown to pale brown sandy loam to loamy sand to approximately 60 inches thick.

Permeability is moderate. Effective rooting depth is more than 40 inches. Average annual precipitation is 12 inches. The mean annual temperature is 46° F, and the mean annual soil temperature is 49° F. The vegetation is various cool-season grasses and forbs with scattered silver sagebrush.

Included in the mapping and comprising 10 percent of the unit are small areas of Draknab and Haverdad soils. Both occur in association with the Clarkelen soils but differ in the texture of the control sections.

Cushman Sandy Loam, 0-3% (21A); 3-6% (21B); 0-6% (21AB).

This soil mapping unit consists of moderately deep, well drained soils on rolling upland ridges and sideslopes. The soils have formed from mixed mineralogy. Slopes range from 0 to 6 percent. Elevation is about 5250 feet.

Typically, the Cushman soil has a light brownish gray sandy loam or loam surface horizon about 4 inches thick. The subsoil is a yellowish brown clay loam about 11 inches thick. The substratum is a very pale brown loam about 13 inches thick which grades to a soft, partially weathered shale at 28 inches.

Permeability is moderate. Effective rooting depth is 28 inches, but some roots penetrate the soft bedrock for a few inches. Average annual precipitation is 12 inches and the mean annual air temperature is 46° F. Mean annual soil temperature is 49° F. Vegetation is big sagebrush, western wheatgrass, and blue grama.

Included in the mapping and making up about 10 percent of this unit are small areas of Shingle loam and Forkwood clay loam. The Shingle soil usually occurs on the ridgetops, while the Forkwood soil usually occurs on the lower portions of the side slopes.

Draknab sandy loam, 0-3% (51A)

This soil mapping unit consists of deep, excessively drained soils formed in stratified recent stream alluvium on flood plains and terraces. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Draknab soil has a brown sandy loam surface layer about 2 inches thick. The subsoil is a brown sandy clay loam about 4 inches thick. The substratum is a gray, grayish brown to light olive brown sandy loam to loamy sand to approximately 60 inches thick.

Permeability is moderate to rapid. Effective rooting depth is more than 40 inches. Average annual precipitation is 12 inches. The mean annual temperature is 46° F, and the mean annual soil temperature is 49° F. The vegetation is various cool-season grasses and forbs with scattered silver sagebrush.

Included in the mapping and comprising 10 percent of the unit are small areas of Dwyer, Clarkelen and Haverdad soils. Both occur in association with the Clarkelen soils but differ in the texture of the control sections.

Dwyer clay loam, 0-3% (18A)

This soil mapping unit consists of very deep, excessively drained soils that formed in eolian sand on slopes and alluvial terraces. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Dwyer soil has a brown clay loam surface layer about 5 inches thick. The subsoil is a brown sandy loam about 15 inches thick. The substratum is a brown sandy loam to approximately 60 inches thick.

Permeability is moderate to rapid. Effective rooting depth is more than 40 inches. Average annual precipitation is 12 inches. The mean annual temperature is 46° F, and the mean annual soil temperature is 49° F. The vegetation is various cool-season grasses and forbs with scattered silver sagebrush.

Included in the mapping and comprising 10 percent of the unit are small areas of Draknab and Hiland soils. Both occur in association with the Clarkelen soils but differ in the texture or textural arrangement of the control sections.

Forkwood (Fort Collins) Clay Loam, 0-3% (19A)

This soil mapping unit consists of deep, well drained soils on gently sloping to nearly level alluvial fans. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Forkwood soil has a pale brown clay loam (or fine sandy loam) surface layer about 4 inches thick. The subsoil is a light brownish gray to yellowish brown clay loam about 32 inches thick. The stratum is a light yellowish brown clay loam to loam that extends to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches. Average annual precipitation is 12 inches and the mean annual air temperature is 46° F. Mean annual soil temperature is 49° F. . Vegetation is blue grama, big sagebrush, western wheatgrass and Sandberg bluegrass.

Included in the mapping and comprising 10 percent of the unit is Cushman sandy loam. The Cushman soil usually occurs above the Forkwood soil on the landscape.

Haverdad sandy loam, 0-3% (52A)

This soil mapping unit consists of deep, well drained soils formed in loamy, recently deposited, stratified alluvium derived dominantly from sedimentary rock and is located on flood plains and terraces. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Haverdad soil has a grayish brown sandy loam surface layer about 6 inches thick. The underlying material is light brownish gray loam with lenses of clay loam and sandy loam to a depth of approximately 60 inches.

Permeability is moderate. Effective rooting depth is more than 40 inches. Average annual precipitation is 12 inches. The mean annual temperature is 46° F, and the mean annual soil temperature is 49° F. The vegetation is various cool-season grasses and forbs with scattered silver sagebrush.

Included in the mapping and comprising 10 percent of the unit are small areas of Clarkelen and Draknab soils. Both occur in association with the Haverdad soils but differ in the texture of the control sections.

Hiland (Olney) Sandy Loam, 0-3% (16A); 3-6% (16B)

This soil mapping unit consists of deep, well drained soils occurring on gently to moderately sloping uplands. The soils have formed in residuum from calcareous sandstone. Slopes range from 0 to 6 percent. Elevation is 5200 feet.

Typically, the Hiland soil has a brown fine sandy loam surface layer about 5 inches thick. The subsoil is a pale brown to very pale brown sandy loam (or sandy clay loam) about approximately 24 inches thick (Note: typical profile location to 48 inches if B3ca is included). The substratum is a light yellowish brown sandy loam that extends to 60 inches.

Permeability is moderate to moderately rapid. Effective rooting depth is 60 inches. Average annual precipitation is 12 inches and the mean annual air temperature is 46° F. Mean annual soil temperature is 49° F. The vegetation is big sagebrush, blue grama, needleandthread, and prairie junegrass.

Included in mapping and making up 10 percent of the unit are small areas of Bowbac sandy loam. The Bowbac soil occurs above the Hiland soil on the landscape.

Kishona (Kim) Loam, 0-3% (14A)

This mapping unit consists of deep, well drained soils occurring on nearly level alluvial fans to moderately steep sideslopes. The soils developed in mixed calcareous alluvial material. Slopes range from 0 to 3 percent.

Typically, the Kishona soil has a pale brown, mildly alkaline loam surface layer about 5 inches thick. The underlying soil is a light brownish gray to light yellowish brown, moderately alkaline light clay loam to loam that extends to 60 inches.

Permeability is moderate. Effective rooting depth is 60 inches. Average annual precipitation is 12 inches and the mean annual air temperature is 46° F. Mean annual soil temperature is 49° F. Vegetation is big sagebrush, blue grama, western wheatgrass, and prairie junegrass.

Included in mapping and comprising 15 percent of the unit are small areas of Theedle loam and Forkwood clay loam. The Theedle usually occurs above the Kishona soil on the landscape. The Forkwood soil occurs in association with the Kishona soil.

Renohill Clay Loam, 0-3% (22A)

This soil mapping unit consists of moderately deep, well drained soils on gently sloping upland hills and ridges. The soil developed in sediments weathered residually or which were locally transported from sedimentary bedrock. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Renohill soil has a light brownish gray clay loam surface layer about 4 inches thick. The subsoil is a light yellowish brown to light gray clay to heavy clay loam about 16 inches thick. The substratum is a pale brown clay loam that grades to weathered calcareous shale at 26 inches.

Permeability is slow. Effective rooting depth is 26 inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F and the mean annual soil temperature is 49° F. The vegetation is western wheatgrass, green needlegrass, and Wyoming big sagebrush.

Included in the mapping and comprising 10 percent of the unit are small areas of Heldt sandy clay loam and Shingle loam. The Heldt soil usually occurs below the Renohill soil on the landscape, while the Shingle soil occurs on the ridgetops or ridges above the Renohill soil.

Exposed Sandstone or Rock Outcrop (50)

Rock Outcrop occurs throughout the project area, mainly on ridgetops and sideslopes. The rock is primarily sandstone. Included in mapping and making up about 15 percent of the unit are small areas of Taluce and Lesset soils. These soils support yucca, pricklypear, and scattered sand dropseed.

Shingle Loam, 0-3% (30A)

This soil mapping unit consists of shallow, well drained soils that generally occur on upper sideslopes and ridgetops. Slopes range from 0 to 3 percent. Elevation ranges from 5200 to 5300 feet.

In a typical profile, the Shingle soil has a light brownish gray loam surface about 3 inches. The underlying soil is a light yellowish brown clay loam about 7 inches thick which grades into soft, calcareous shale at 10 inches.

Permeability is moderate. Effective rooting depth is 10 inches, but some roots penetrate the shale fragments. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F, and the mean annual soil temperature is 49° F. Vegetation is Wyoming big sagebrush, western wheatgrass, and some buffalograss.

Included in mapping and making up 15 percent of the unit are small areas of Cushman sandy loam, Taluce sandy loam and Rock Outcrop. The Cushman soil occurs on the sideslopes below the Shingle soil on the landscape. The Taluce soil and Rock Outcrop occur in association with the Shingle soil on ridgetops and upper sideslopes.

Taluce (Tassel) Sandy Loam, 0-3% (32A); 3-6% (32B); 6-15% (32C); 15-30% (32D)

This soil mapping unit consists of shallow, well drained soils occurring on sideslopes and ridgetops. Slopes range from 0 to 30 percent. This soil formed in residuum from calcareous sandstone. Elevations range from 5200 to 5300 feet.

Typically, the Taluce soil has a pale brown sandy loam surface layer about 4 inches thick. The underlying soil is a pale brown sandy loam about 7 inches thick. Sandstone bedrock occurs at 11 inches.

Permeability is moderate. Effective rooting depth is 11 inches, but some roots penetrate the weathered sandstone bedrock. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F, and the mean annual soil temperature is 49° F. Vegetation is yucca, pricklypear, sand dropseed, and needleandthread.

Included in mapping and making up 15 percent of the unit (about 5 percent each) are small areas of Tullock fine sandy loam and Rock Outcrop. The Rock Outcrop occurs in association with Taluce. The Tullock soil occurs on the sideslopes below the Taluce soil on the landscape.

Terro (Terry) Fine Sandy Loam, 0-3% (17A); 3-6% (17B); 6-15% (17C)

This soil mapping unit consists of moderately deep, well drained soil occurring on rolling uplands and sideslopes. The soils were formed in residuum from soft sandstone bedrock. Slopes range from 0 to 15 percent. Elevation is about 5200 feet.

Typically, the Terro soil has a light brownish gray fine sandy loam surface layer about 2 inches thick. The underlying subsoil is a pale brown or very pale brown fine sandy loam to sandy loam about 12 inches thick. The underlying substratum is a light brownish gray fine sandy loam which grades to calcareous sandstone at 28 inches.

Permeability is rapid. Effective rooting depth is 28 inches, but some roots penetrate the sandstone bedrock for a few inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F, and the mean annual soil temperature is 48° F. Vegetation is needleandthread, yucca, pricklypear, and blue grama.

Included in mapping and comprising 15 percent of the unit are small areas of Taluce sandy loam and Tullock fine sandy loam. The Taluce soil usually occurs on the ridgetops above the Terro soil. The Tullock soil occurs in association with the Terro soil.

Theedle (Thedalund) Loam, 0-3% (49A)

This soil mapping unit consists of moderately deep, well drained soils on gently to moderately sloping upland hills and ridges. The soil formed in alluvium from sedimentary rock. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Theedle soil has a very pale brown sandy loam about 3 inches thick. The underlying subsoil is a yellowish brown about 8 inches thick. The underlying substratum is a light gray loam about 23 inches thick which grades to mixed paralithic sources.

Permeability is moderate. Effective rooting depth is 34 inches, but some roots penetrate the weathered shale for a few inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F. and the mean annual soil temperature is 49° F. Vegetation is blue grama, western wheatgrass, and big sagebrush.

Included in mapping and comprising 10 percent of the unit are small areas of Shingle loam and Cushman sandy loam. The Shingle soil usually occurs above the Theedle soil on the ridgetops. The Cushman soil occurs in association with the Theedle soil.

Tullock Fine Sandy Loam, 0-3% (25A); 3-6% (25B)

This soil mapping unit consists of moderately deep, well drained soils occurring on sideslopes and ridges. The soils developed in residuum from weakly consolidated calcareous sandstone. Slopes range from 0 to 6 percent. Elevation is 5200 to 5300 feet.

Typically, the Tullock soil has a light brownish gray fine sandy loam surface layer about 4 inches thick. The underlying soil is a pale brown to pale gray fine sandy loam about 30 inches thick which grades to calcareous sandstone bedrock at 34 inches.

Permeability is rapid. Effective rooting depth is 34 inches, but some roots penetrate the sandstone bedrock for a few inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F. and the mean annual soil temperature is 49° F. Vegetation is yucca, pricklypear, sand dropseed, and needleandthread.

Included in mapping and comprising 15 percent of the unit are small areas of Taluce sandy loam and Terro sandy loam. The Taluce soil usually occur above the Tullock soils on the ridgetops. The Terro soil occurs in association with the Tullock soil.

Ulm Clay Loam, 0-3% (20A)

This soil mapping unit consists of a deep, well drained soil occurring on alluvial fans and valley filling foot slopes. The soil developed in alluvium mainly from sedimentary rock. Slopes range from 0 to 3 percent. Elevation is 5200 feet.

Typically, the Ulm soil has a light brownish gray loam (or clay loam) surface layer about 4 inches thick. The subsoil is a light brownish gray, brown, or grayish brown heavy loam or clay loam about 20 inches thick. The substratum is a light brownish gray light clay loam that extends to 60 inches.

Permeability is low to moderate. Effective rooting depth is 60 inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F. and the mean annual soil temperature is 49° F. Vegetation is western wheatgrass, green needlegrass, pricklypear, and blue grama.

Included in mapping and comprising 10 percent of the unit are small areas of Renohill clay loam. The Renohill soil usually occurs on the valley filling foot slopes above the Ulm soil.

Vonalee (Vona) Sandy Loam, 0-3% (13A); 3-6% (13B); 0-6% (13AB)

This soil mapping unit consists of a deep, well drained soil that occurs on sideslopes. Elevation is about 5200 feet. The soil developed in loamy, wind-worked residuum and local alluvium derived from mixed sources. Slopes range from 0 to 6%.

Typically, the Vonalee soil has a pale brown, sandy loam surface horizon about 4 inches thick. The subsoil is a light brownish gray to pale brown sandy loam or fine sandy loam about 18 inches thick. The substratum is a pale brown sandy loam that extends to 60 inches.

Permeability is rapid. Effective rooting depth is 60 inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F. and the mean annual soil temperature is 49° F. Vegetation is needleandthread, yucca, big sagebrush and sand dropseed.

Included in the mapping and making up about 10 percent of the unit are small areas of Terro sandy loam. The Terro soil usually occurs above the Vonalee soil on the landscape.

Worf Loam, 0-3% (31A); 3-6% (31B); 6-15% (31BC)

The Worf soil is a shallow, well drained soil on upland ridges and sideslopes. Elevation is 5200 feet. The soil developed in loamy residuum derived dominantly from interbedded shale and sandstone. Slopes range from 0 to 15%.

In a typical profile, the surface layer is a light yellowish brown loam about 4 inches thick. The underlying subsoil is a pale brown clay loam about 5 inches thick. The substratum is a pale brown loam 7 inches thick grading to partially weathered calcareous shale at 16 inches.

Permeability is moderate. Effective rooting depth is 16 inches, but some roots penetrate the bedrock for a few inches. Average annual precipitation is 12 inches. The mean annual air temperature is 46° F. and the mean annual soil temperature is 49° F. Vegetation is blue grama, prairie junegrass and big sagebrush.

Included in the mapping and comprising about 15 percent of the unit are small areas of Shingle loam, Cushman sandy loam and Rock Outcrop. The Shingle soil occurs in association with the Worf soil. The Cushman soil usually occurs below the Worf soil on the landscape. The Rock Outcrop occurs on the ridgetops or just below them.

ADDENDUM 4
1997 SOIL SERIES DESCRIPTIONS

The following soil series descriptions are based on sampling conducted on the proposed Reynold's Ranch Extension Area in 1997. The Haverdad series was not included in the 1997 sampling; however; that corresponding map unit consists of less than one percent of the proposed extension area.

AERIC HAPLAQUEPT

Soil Mapping Unit 56
Typical Pedon: Aeric Haplaquept, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark gray (10YR 4/1) clay, dark gray (10YR 4/1) moist; strong, coarse angular blocky structure parting to strong medium granular; hard, firm, sticky, plastic; mildly alkaline (pH 7.40), noneffervescent.

B - 3-12 inches. Dark gray (10YR 4/1) clay, dark gray (10YR 4/1); strong, coarse angular blocky structure parting to strong medium granular; hard, firm, sticky, plastic; mildly alkaline (pH 7.40), noneffervescent.

C1 - 12-24 inches. Dark gray (10YR 4/1) clay, dark gray (10YR 4/1) moist; massive; hard, firm, very sticky and very plastic, mildly alkaline (pH 7.37), noneffervescent.

C2 - 24-33 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; massive; hard, firm, very sticky, very plastic; mildly alkaline (pH 7.66), noneffervescent.

C3 - 33-48 inches. Light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive, hard, firm, sticky, plastic; mildly alkaline (pH 7.81), noneffervescent.

Type Location - 10 (23 on the map)

Range in Soil Characteristics - Depth of bedrock ranges from 40 to 60 plus inches. Coarse fragments are generally less than 5 percent. Clay content of the control section ranges from 35 to 45 percent. The control section texture is clay. When dry, surface cracks extend to depths of 12 inches or more.

Taxonomic Class - fine, montmorillonitic, mesic Aeric Haplaquept.

Suitability for Topsoil - The Aeric Haplaquept series is generally not suitable for topsoil due to high clay content and the approximate recommended stripping depth is 0 foot. The Aeric Haplaquept series rates poor according to Wyoming Department of Environmental Quality Guideline 1.

BOWBAC SERIES

Soil Mapping Unit 23A, 23B, 23AB, 23C
Typical Pedon: Bowbac sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark yellowish brown (10YR 3/6) sandy loam, dark yellowish brown (10YR 3/4) moist; weak fine and very fine granular structure; soft, very friable, nonsticky, nonplastic; moderately alkaline (pH 8.13), noneffervescent.

B1 - 3-12 inches. Dark yellowish brown (10YR 3/6) sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.00), noneffervescent.

B2 - 12-20 inches. Dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.00), noneffervescent.

Bk - 20-26 inches. Grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak subangular blocky; soft, friable, slightly sticky, slightly plastic; CaCO3 threads; moderately alkaline (pH 7.97), slightly effervescent.

C - 26-32 inches. Gray (10YR 6/1) sandy clay loam, gray (10YR 5/1) moist; partially weathered sandstone; moderately alkaline (pH 8.02), moderately effervescent.

Type Location - 21 (63 on map)

Range in Soil Characteristics - Depth to a paralithic contact ranges from 20 to 40 inches. More than 60 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 2 percent. Texture of the control section is a sandy loam. Clay content of the control section ranges from 15 to 17 percent which is generally less than what is typical for the series.

Taxonomic Class - fine-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Bowbac sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Bowbac series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

BOWBAC SERIES

Soil Mapping Unit 23A, 23B, 23AB, 23C
Typical Pedon: Bowbac sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-3 inches. Dark brown (7.5YR 3/2) sandy loam, very dark brown (7.5YR 2/2) moist; weak fine and very fine granular structure; soft, very friable, nonsticky, nonplastic; mildly alkaline (pH 7.78), noneffervescent.

BA - 3-6 inches. Dark brown (7.5YR 3/2) sandy loam, very dark brown (7.5YR 2/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.79), noneffervescent.

B - 6-20 inches. Brown (7.5YR 4/4) sandy loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.79), noneffervescent.

Bk - 20-28 inches. Light brownish gray (10YR 6/2) sandy loam, grayish brown (10YR 5/2) moist; massive; soft, friable, slightly sticky, nonplastic; $CaCO_3$ threads; mildly alkaline (pH 7.50), slightly effervescent.

C - 28-36 inches. Light gray (10YR 7/1) sandy loam, gray (10YR 6/1) moist; massive; slightly hard, friable, nonsticky, nonplastic; moderately alkaline (pH 7.93), slightly effervescent.

Cr - 36+ inches. Soft sandstone.

Type Location - 26 (78 on the map)

Range in Soil Characteristics - Depth to a paralithic contact ranges from 20 to 40 inches. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is a sandy loam. Clay content of the control section ranges from 13 to 17 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Bowbac sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Bowbac series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

CAMBRIA (STONEHAM) SERIES

Soil Mapping Unit 15A, 15B
Typical Pedon: Cambria (Stoneham) clay loam, rangeland
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark yellowish brown (10YR 3/6) sandy clay loam, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; soft, very friable; slightly sticky, slightly plastic; moderately alkaline (pH 8.25), noneffervescent.

AB - 3-6 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate coarse subangular structure parting to weak fine granular; soft, very friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.38), noneffervescent.

Bt - 6-13 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; strong coarse prismatic structure parting to moderate medium subangular structure; slightly hard, friable, sticky, plastic; moderately alkaline (pH 8.38), noneffervescent.

Bk - 13-15 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky, plastic; seams and nodules of CaCO3; strongly alkaline (pH 8.38), strongly effervescent.

Ck - 15-31 inches. Light gray (10YR 7/1) sandy clay loam, gray (10YR 6/1) moist; massive; soft, very friable, slightly sticky, slightly plastic; seams and nodules of CaCO3; strongly alkaline (pH 8.52), strongly effervescent.

C - 31-48 inches. Light gray (10YR 7/1) sandy clay loam, gray (10YR 6/1) moist; massive; soft, very friable, slightly sticky, slightly plastic; seams and nodules of CaCO3; strongly alkaline (pH 8.52), strongly effervescent.

Type Location - 23 (66 on the map)

Range in Soil Characteristics - Depth to a paralithic contact is more than 40 inches. Content of coarse fragments ranges from 0 to 5 percent. Texture of the control section is a clay loam or sandy clay loam. Clay content of the control section ranges from 25 to 35 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Cambria loam soil is suitable for topsoil and the recommended stripping depth is 4 feet. The Cambria series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

CLARKELEN SERIES

Soil Mapping Unit 53A
Typical Pedon: Clarkelen sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, medium granular structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.03), noneffervescent.

AC - 3-15 inches. Brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; weak, medium blocky structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.21), noneffervescent.

C1- 15-32 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; massive; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.19), noneffervescent.

C2 - 32-38 inches. Brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; loose structure; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.11), slightly effervescent.

C3 - 38-60 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; loose structure; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.20), slightly effervescent.

Type Location - 14 (50 on the map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of control section is a sandy loam.

Taxonomic Class - coarse-loamy, mixed, calcareous, mesic Ustic Torrifluvent.

Suitability for Topsoil - The Clarkelen series is generally suitable for topsoil to approximately 30-42 inches and the recommended stripping depth is 3 feet depending upon the stratification of lower horizons. The Clarkelen series rates fair according to Wyoming Department of Environmental Quality Guideline 1.

CUSHMAN SERIES

Soil Mapping Unit 21
Typical Pedon: Cushman sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-5 inches. Brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak, fine granular structure; soft, very friable, nonsticky, nonplastic; moderately alkaline (pH 7.96), noneffervescent.

B2t - 5-18 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium angular blocky structure; slightly hard, friable, sticky, plastic; moderately alkaline (pH 7.92), noneffervescent.

Cca - 18-31 inches. Brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) moist; weak, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic wet; seams of CaCO3, moderately alkaline (pH 8.05), strongly effervescent.

Cr - 31 inches plus. Soft, partially weathered shale.

Type Location - 3 (4 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a clay loam or sandy clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed mesic Ustic Haplargid.

Suitability for Topsoil - The Cushman series is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Cushman series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

CUSHMAN SERIES

Soil Mapping Unit 21
Typical Pedon: Cushman sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark yellowish brown (10YR 3/4) clay loam, dark brown (10YR 3/3) moist; weak, fine granular structure; soft, very friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.66), noneffervescent.

Bt - 3-10 inches. Dark yellowish brown (10YR 3/4) clay loam, dark brown (10YR 3/3) moist; moderate, medium angular blocky structure; slightly hard, slightly friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.33), noneffervescent.

Bk - 10-16 inches. Brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; seams of CaCO3, moderately alkaline (pH 8.26), moderately effervescent.

C - 16-27 inches. Grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, slightly friable, sticky, plastic; moderately alkaline (pH 8.38), strongly effervescent.

Cr - 27 inches plus. Soft, partially weathered shale.

Type Location - 12 (49 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is generally less than 5 percent. Texture of control section is a clay loam or sandy clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed mesic Ustic Haplargid.

Suitability for Topsoil - The Cushman series is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Cushman series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

CUSHMAN SERIES

Soil Mapping Unit 21A, 21B, 21AB
Typical Pedon: Cushman sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark brown (10YR 3/3) sandy loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.00), noneffervescent.

AB - 3-8 inches. Dark brown (10YR 3/3) sandy clay loam, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to moderate medium subangular; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.15), noneffervescent.

Bt - 8-15 inches. Brown (10YR 4/3) sandy clay loam, very dark brown (10YR 3/3) moist; moderate, coarse prismatic structure parting to strong medium angular blocky; hard, firm, sticky, plastic; moderately alkaline (pH 8.15), moderately effervescent.

Btk - 15-20 inches. Brown (10YR 4/3) clay loam, very dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate fine and very fine subangular blocky; hard, firm, sticky, plastic; seams of CaCO3, moderately alkaline (pH 8.19), slightly effervescent.

Ck - 20-36+ inches. Light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; soft, thickly stratified gray and brown calcareous shale; moderately alkaline (pH 8.29), strongly effervescent.

Type Location - 19 (60 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is generally less than 5 percent. Texture of control section is a clay loam or sandy clay loam. Clay content of control section ranges from 21 to 28 percent.

Taxonomic Class - fine-loamy, mixed mesic Ustic Haplargid.

Suitability for Topsoil - The Cushman series is suitable for topsoil and the recommended stripping depth is 2.5 feet, although this location could be deeper. The Cushman series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

DRAKNAB SERIES

Soil Mapping Unit 51
Typical Pedon: Draknab sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-2 inches. Brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; moderate, medium granular structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.28), slightly effervescent.

AC - 2-6 inches. Brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak, medium blocky structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.28), slightly effervescent.

C1- 6-14 inches. Grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.22), slightly effervescent.

C2 - 14-30 inches. Grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; loose structure; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 7.89), noneffervescent.

C3 - 30-36 inches. Gray (10YR 5/1) clay loam, gray (10YR 5/1) moist; massive structure; hard, firm, sticky, plastic; moderately alkaline (pH 8.11), noneffervescent.

C4 - 36-44 inches. Brown (10YR 5/3) loamy sand, brown (10YR 5/3) moist; loose structure; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.02), noneffervescent.

C5 - 44-48 inches. Light olive brown (2.5Y 5/3) clay, light olive brown (2.5Y 5/3) moist; massive structure; hard, firm, sticky, plastic; moderately alkaline (pH 8.15), noneffervescent.

Type Location - 15 (51 on the map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is varied and can exceed 5 percent. Texture of control section is a sandy loam. Stratification in lower horizons is common and varied.

Taxonomic Class - sandy, mixed, mesic Ustic Torrifluvent.

Suitability for Topsoil - The Draknab series is generally suitable for topsoil to approximately 1 foot and the recommended stripping depth is 1 foot depending upon the stratification of lower horizons. The Draknab series rates poor according to Wyoming Department of Environmental Quality Guideline 1.

DWYER SERIES

Soil Mapping Unit 18A
Typical Pedon: Dwyer loam, grassland
(Colors are for dry soil unless otherwise indicated)

A- 0-5 inches. Brown (10YR 4/3) clay loam, very dark brown (10YR 3/3) moist; weak fine granular; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.16), slightly effervescent.

C1 - 5-20 inches. Brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; massive; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.09), slightly effervescent.

C2 - 20-30 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; massive; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.03), slightly effervescent.

C3 - 30-60 inches. Pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; loose single grain; moderately alkaline (pH 8.17), slightly effervescent.

Type Location - 24 (72 on the map)

Range in Soil Characteristics - Depth to a paralithic contact is more than 60 inches. Content of coarse fragments ranges from 0 to 5 percent. Texture of the control section is a sandy loam. Clay content of the control section ranges from 11 to 20 percent. The texture of the A horizon is slightly heavier than typical for the series.

Taxonomic Class - mixed, mesic Ustic Torripsamment

Suitability for Topsoil - The Dwyer loam soil is suitable for topsoil and the recommended stripping depth is approximately 1 foot. The Dwyer series rates fair according to Wyoming Department of Environmental Quality Guideline 1.

FORKWOOD (FT. COLLINS) SERIES

Soil Mapping Unit 19
Typical Pedon: Forkwood (Ft. Collins) clay loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Pale brown (10YR 6/3) loam, grayish brown (10YR 5/2) moist; weak, medium granular structure; soft, very friable, slightly sticky, slightly plastic; moderately alkaline (pH 7.91), noneffervescent.

AB - 3-7 inches. Light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; weak, medium angular blocky structure; slightly hard, friable, sticky and plastic; neutral (pH 7.33), noneffervescent.

Bt - 7-26 inches. Yellowish brown (10YR 5/4) clay loam, dark grayish brown (10YR 4/2); moderate, medium angular blocky structure; hard, slightly friable, sticky, plastic; moderately alkaline (pH 7.99), noneffervescent.

Bk - 26-30 inches. Light yellowish brown (10YR 6/4) clay loam, brown (10YR 5/3); moderate, medium angular blocky structure; slightly hard, slightly friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.12), slightly effervescent.

Ck - 30-45 inches. Light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; seams and nodules of CaCO3; moderately alkaline (pH 8.27), strongly effervescent.

C - 45-60 inches. Light yellowish brown (2.5Y 6/3) clay loam, light yellowish brown (2.5Y 6/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.12), strongly effervescent

Type Location - 11 (48 on the map)

Range in Soil Characteristics - There is generally no bedrock present within 60 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Forkwood series is suitable for topsoil and the recommended stripping depth is 5 feet. The Forkwood series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

HILAND (OLNEY) SERIES

Soil Mapping Unit 12
Typical Pedon: Hiland (Olney) sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-4 inches. Dark brown (10YR 3/3) sandy loam, dark brown (10YR 3/3) moist; moderate, medium granular structure; soft, very friable, nonsticky, nonplastic when wet; moderately alkaline (pH 8.30), noneffervescent.

AB - 4-8 inches. Dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate, medium granular structure; soft, very friable, nonsticky, nonplastic when wet; mildly alkaline (pH 7.80), noneffervescent.

Bt1- 8-18 inches. Brown (10YR 4/3) sandy loam, brown (10YR 3/3) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.80), noneffervescent.

Bt2 - 18-26 inches. Yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.6), noneffervescent.

Bk - 26-34 inches. Brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.53), slightly effervescent.

C - 34-54 inches. Light olive brown (2.5YR 5/4) sandy loam, olive brown (10YR 4/4) moist; massive structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.03), slightly effervescent.

Type Location - 8 (7 on the map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of control section is a sandy clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Hiland sandy loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The Hiland series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

HILAND (OLNEY) SERIES

Soil Mapping Unit 16A, 16B
Typical Pedon: Hiland (Olney) sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark brown (10YR 3/3) sandy clay loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.67), noneffervescent.

AB - 3-10 inches. Dark brown (10YR 3/3) sandy loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; mildly alkaline (pH 7.60), noneffervescent.

Bt - 10-24 inches. Dark yellowish brown (10YR 4/4) sandy clay loam, dark yellowish brown (10YR 3/4) moist; strong medium prismatic structure parting to moderate medium angular blocky; hard, firm, sticky, plastic; moderately alkaline (pH 8.10), noneffervescent.

Bk - 24-30 inches. Yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky, plastic; seams and nodules of CaCO3; moderately alkaline (pH 8.25), moderately effervescent.

Ck - 30-48 inches. Grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, slightly sticky, slightly plastic; threads of CaCO3; moderately alkaline (pH 8.34), strongly effervescent.

C - 48-60 inches. Light brownish gray (2.5Y 6/2) sandy clay loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.33), strongly effervescent.

Type Location - 22 (64 on the map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 60 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of control section is a sandy clay loam. Clay content of control section ranges from 20 to 24 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Hiland sandy loam soil is suitable for topsoil and the recommended stripping depth is 4 feet. The Hiland series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

KISHONA (KIM) SERIES

Soil Mapping Unit 14
Typical Pedon: Kishona (Kim) loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-6 inches. Brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate, fine granular structure; soft, friable, slightly sticky slightly plastic; moderately alkaline (pH 8.20), slightly effervescent.

AC - 6-19 inches. Dark yellowish brown (10YR 4/6) clay loam, dark yellowish brown (10YR 3/6); moderate, medium subangular blocky structure; slightly hard, friable, sticky, slightly plastic; moderately alkaline (pH 8.23), moderately effervescent.

Cl - 19-44 inches. Pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; slightly hard, slightly friable, slightly sticky, slightly plastic; seams of CaCO3; moderately alkaline (pH 8.23), strongly effervescent.

C2 - 44-54 inches. Light yellowish brown (10YR 6/4) loam, brown (10YR 5/3) moist; massive; soft, friable, slightly sticky, slightly plastic; seams of CaCO3; moderately alkaline (pH 8.28), strongly effervescent.

Type Location - 16 (52 on the map)

Range in Soil Characteristics - Depth to bedrock will vary from 40 to 60 inches plus. Content of coarse fragments is less than 5 percent. Texture of control section is a clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed (calcareous), mesic Ustic Torriorthent.

Suitability for Topsoil - The Kishona loam soil is suitable for topsoil and the recommended stripping depth is 4 feet. The C horizon suitability may have a poor rating due to a high content of calcium carbonate. However, this property is not believed to be of serious concern to the overall topsoil suitability. Otherwise, the Kishona series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

RENOHILL SERIES

Soil Mapping Unit 22A
Typical Pedon: Renohill loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; strong fine granular structure; soft, very friable, nonsticky, nonplastic; neutral (pH 7.09), noneffervescent.

AB - 3-8 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure parting to moderate medium angular; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 7.92), noneffervescent.

Bt - 8-20 inches. Dark brown (10YR 3/3) sandy clay loam, very dark brown (10YR 2/2) moist; moderate, medium prismatic parting to moderate medium angular blocky; very hard, firm, sticky, plastic; moderately alkaline (pH 7.92), noneffervescent.

Bk - 20-26 inches. Brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; massive; very hard, firm, sticky, plastic; threads of CaCO3; moderately alkaline (pH 8.05), moderately effervescence.

C - 26-33 inches. Light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weathered soft calcareous shale; moderately alkaline (pH 8.17), strongly effervescent.

Type Location - 18 (58 on map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of control section is sandy clay loam or clay loam. Clay content of control section ranges from 35 to 50 percent. Texture of the A horizon is lighter than typical for the series.

Taxonomic Class - fine, smectitic, mesic Ustic Haplargid

Suitability for Topsoil - The Renohill clay loam soil is suitable for topsoil and the recommended stripping depth is approximately 2 feet. All soil parameters of Renohill rate fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

SHINGLE SERIES

Soil Mapping Unit 30
Typical Pedon: Shingle loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate, fine granular structure; soft, very friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.09), moderately effervescent.

C - 3-6 inches. Light yellowish brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium granular structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.09), strongly effervescent.

Cr - 6 inches plus. Soft calcareous gray shale.

Type Location - 1 (1 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 6 to 20 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - loamy, mixed (calcareous) mesic, shallow Ustic Torriorthent.

Suitability for Topsoil - The Shingle loam soil is suitable for topsoil and the approximate recommended stripping depth is 1 foot. The Shingle series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TALUCE (TASSEL) SERIES

Soil Mapping Unit 32
Typical Pedon: Taluce (Tassel) sandy loam, Rangeland.

A1 - 0-5 inches. Dark yellowish brown (10YR 4/4) sandy loam, dark yellowish brown (10YR 3/4) moist; weak, fine granular structure; loose, friable, slightly sticky, nonplastic; moderately alkaline (pH 8.09), noneffervescent.

C - 5-16 inches. Yellowish brown (10YR 5/4) sandy clay loam, brown (10YR 4/3) moist; weak, subangular blocky structure; soft, friable, slightly sticky, slightly plastic; $CaCO_3$ threads throughout; moderately alkaline (pH 8.24), strongly effervescent.

Cr- 16 inches plus. Calcareous sandstone.

Typic Location - 6 (43 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 6 to 20 inches. More than 35 percent of the sand fraction is fine or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is sandy loam.

Taxonomic Class - fine, mixed, mesic, shallow Ustic Torriorthent.

Suitability for Topsoil - The Taluce sandy loam soil is suitable for topsoil and the recommended stripping depth is generally 0.5 to 1 foot. The Taluce series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TALUCE (TASSEL) SERIES

Soil Mapping Unit 32
Typical Pedon: Taluce (Tassel) sandy loam, Rangeland.

A - 0-3 inches. Olive brown (2.5Y 4/3) sandy loam, dark olive brown (10YR 3/3) moist; weak, fine granular structure; loose, friable, nonsticky, nonplastic; moderately alkaline (pH 7.93), slightly effervescent.

C - 3-6 inches. Light olive brown (2.5Y 5/4) loamy sand, olive brown (2.5Y 4/4) moist; loose, coarse granular structure; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 7.93), moderately effervescent.

Cr- 6 inches plus. Calcareous sandstone.

Typic Location - 13 (29 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 6 to 20 inches. More than 35 percent of the sand fraction is fine or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is sandy loam.

Taxonomic Class - fine, mixed, mesic, shallow Ustic Torriorthent.

Suitability for Topsoil - The Taluce sandy loam soil is suitable for topsoil and the recommended stripping depth is generally 0.5 to 1 foot. The Taluce series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TERRO (TERRY) SERIES

Soil Mapping Unit 24
Typical Pedon: Terro (Terry) fine sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-5 inches. Dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate, fine granular structure; soft, very friable, nonsticky, nonplastic; moderately alkaline (pH 7.93), noneffervescent.

Bt - 5-14 inches. Yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; moderate, medium angular structure; slightly hard, friable, slightly sticky and slightly plastic; moderately alkaline (pH 8.24), noneffervescent.

BCk - 14-20 inches. Yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; moderately alkaline (pH 8.24), strongly effervescent.

Ck - 20-38 inches. Light brownish gray (10YR 6/3) sandy loam, brown (10YR 5/3) moist; massive structure; slightly hard, friable, slightly sticky and slightly plastic; moderately alkaline (pH 8.15), strongly effervescent.

C - 38 inches. Calcareous sandstone.

Type Location - 5 (40 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is sandy loam. Clay content of the control section ranges from 7 to 18 percent.

Taxonomic Class - coarse-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Terro sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Terro series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TERRO (TERRY) SERIES

Soil Mapping Unit 17A, 17B, 17AB, 17BC
Typical Pedon: Terro (Terry) fine sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark brown (10YR 3/3) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky, nonplastic; mildly alkaline (pH 7.78), noneffervescent.

Bt - 3-8 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.09), noneffervescent.

Btk - 8-18 inches. Yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; seams and nodules of CaCO3; moderately alkaline (pH 8.09), slightly effervescent.

Bk - 18-27 inches. Yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; massive structure; slightly hard, friable, slightly sticky, slightly plastic; seams and nodules of CaCO3; moderately alkaline (pH 8.21), slightly effervescent.

C - 27-40 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; massive; soft, friable, nonsticky, nonplastic; moderately alkaline (pH 8.03), slightly effervescent.

Cr - 40+ inches. Soft calcareous sandstone.

Type Location - 25 (77 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is sandy clay loam to sandy loam. Clay content of the control section ranges from 12 to 20 percent.

Taxonomic Class - coarse-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Terro sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Terro series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

THEEDLE (THEDALUND) SERIES

Soil Mapping Unit 49A
Typical Pedon: Theedle (Thedalund) loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Dark brown (7.5YR 3/3) sandy clay loam, very dark brown (7.5YR 2/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.14), slightly effervescent.

AC - 3-12 inches. Grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak moderate subangular structure; slightly hard, friable, sticky, plastic; moderately alkaline (pH 8.11), moderately effervescent.

Ck - 12-30 inches. Light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, sticky, nonplastic; CaCO3 seams; moderately alkaline (pH 8.30), strongly effervescent.

C - 30-32+ inches. Light gray (10YR 7/1), gray (10YR 6/1) moist; soft calcareous mixed sandstone and shale.

Type Location - 20 (61 on map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches but is typically less than 32 inches. Content of coarse fragments is less than 6 percent. Texture of the control section is clay loam or loam. Clay content of the control section ranges from 25 to 28 percent.

Taxonomic Class - fine-loamy, mixed, calcareous, mesic Ustic Torriorthent.

Suitability for Topsoil - The Theedle loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Theedle series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TULLOCK SERIES

Soil Mapping Unit 25
Typical Pedon: Tullock sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Dark yellowish brown (10YR 4/4) sandy loam, dark yellowish brown (10YR 3/4) moist; weak, fine crumb structure; soft, friable, nonsticky, nonplastic; mildly alkaline (pH 7.51), noneffervescent.

C1 - 4-21 inches. Yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; massive structure; soft, friable, nonsticky, nonplastic; mildly alkaline (pH 7.79), noneffervescent.

C2 - 21-39 inches. Pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak fine crumb structure; soft, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.18), slightly effervescent.

Cr - 39 inches. Weakly consolidated calcareous sandstone.

Type Location - 4 (36 on the map)

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of the control section is sandy loam.

Taxonomic Class - mixed, mesic Ustic Torripsamments.

Suitability for Topsoil - The Tullock fine sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Tullock series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

ULM SERIES

Soil Mapping Unit 20A
Typical Pedon: Ulm clay loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-3 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; strong fine granular structure; slightly hard, friable, sticky, plastic; mildly alkaline (pH 7.78), noneffervescent.

AB - 3-10 inches. Brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; strong medium coarse angular blocky; very hard, very firm, very sticky, very plastic; moderately alkaline (pH 8.27), noneffervescent.

Bt - 10-20 inches. Dark brown (10YR 3/3) clay, very dark brown (10YR 2/2) moist; strong coarse prismatic structure parting to strong medium coarse angular blocky; very hard, very firm, very sticky, very plastic; moderately alkaline (pH 8.27), noneffervescent.

Bk - 20-24 inches. Dark brown (10YR 3/3) clay loam, very dark brown (10YR 2/2) moist; moderate medium prismatic parting to strong medium angular blocky structure; very hard, firm, very sticky, very plastic; calcium carbonate mostly disseminated with CaCO3 threads; moderately alkaline (pH 8.09), moderately effervescent.

Ck - 24-42 inches. Very dark grayish brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; massive; hard, firm, sticky, plastic; seams and streaks of CaCO3; moderately alkaline (pH 8.13), strongly effervescent.

C - 42-48 inches. Dark brown (10YR 3/3) sandy clay, very dark brown (10YR 2/2) moist; massive; hard, firm, sticky, plastic; moderately alkaline (pH 8.08), strongly effervescent.

Type Location - 17 (57 on map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. Coarse fragments are less than 5 percent. The control section is a clay. Clay content of the control section ranges from 40 to 42 percent.

Taxonomic Class - fine, smectitic, mesic Ustic Haplargid.

Suitability for Topsoil - The Ulm clay loam soil is suitable for topsoil and the recommended stripping depth is 4 feet. The suitability rating for texture from 3-20 and 24-42 inches is marginal due to a high clay content which limits soil workability. However, this property is not believed to be of serious concern to the overall topsoil suitability.

VONALEE (VONA) SERIES

Soil Mapping Unit 13
Typical Pedon: Vonalee (Vona) sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-4 inches. Dark yellowish brown (10YR 4/4) sandy loam, dark yellowish brown (10YR 3/4) when moist; weak, fine crumb structure; loose consistence, very friable, nonsticky and nonplastic; moderately alkaline (pH 7.88), noneffervescent.

Bt1 - 4-17 inches. Dark yellowish brown (10YR 4/4) sandy clay loam, dark yellowish brown (10YR 3/4) moist; moderate, medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; moderately alkaline (pH 8.12), noneffervescent.

Bt2 - 17-28 inches. Yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.15), slightly effervescent.

Bk1 - 28-42 inches. Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; moderate, medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; moderately alkaline (pH 8.13), moderately effervescent.

Bk2 - 42-60 inches. Light yellowish brown (10YR 6/4) sandy clay loam, brown (10YR 5/3) moist; massive structure; slightly hard, friable, slightly sticky and slightly plastic; moderately alkaline (pH 8.13), slightly effervescent.

Type Location - 7 (45 on map)

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of sand fraction is fine sand or coarser. Coarse fragments are less than 5 percent. The control section is sandy clay loam with a clay content ranging from 21 to 26 percent.

Taxonomic Class - coarse-loamy, mixed, mesic Ustic Haplargid.

Suitability for Topsoil - The Vonalee sandy loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The Vonalee series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

WORF SERIES

Soil Mapping Unit 31
Typical Pedon: Worf loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-2 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, fine granular structure; soft, friable, sticky, plastic; moderately alkaline (pH 7.96), noneffervescent.

Bt - 2-6 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3); moderate, medium angular blocky structure; slightly hard, friable, sticky, plastic; moderately alkaline (pH 8.04), noneffervescent.

Bk - 6-11 inches. Brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; seams of CaCO3 throughout horizon, moderately alkaline (pH 8.01), strongly effervescent.

Cr - 11 inches. Calcareous shale.

Type Location - 2 (2 on the map)

Range in Soil Characteristics - Depth of bedrock ranges from 10 to 20 inches. Coarse fragments are less than 5 percent. Clay content of the control section ranges from 18 to 35 percent. The control section texture is clay loam to sandy clay loam.

Taxonomic Class - loamy, mixed, mesic, shallow Ustic Haplargid.

Suitability for Topsoil - The Worf series is suitable for topsoil and the approximate recommended stripping depth is 1 foot. The Worf series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

WORF SERIES

Soil Mapping Unit 31
Typical Pedon: Worf loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A - 0-2 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, fine granular structure; soft, friable, sticky, plastic; moderately alkaline (pH 8.13), noneffervescent.

Bt - 2-6 inches. Brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3); moderate, medium angular blocky structure; slightly hard, friable, sticky, plastic; moderately alkaline (pH 8.13), noneffervescent.

Bk - 6-15 inches. Brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; seams of CaCO3 throughout horizon, moderately alkaline (pH 8.15), strongly effervescent.

Cr - 15 inches. Calcareous shale.

Type Location - 9 (47 on the map)

Range in Soil Characteristics - Depth of bedrock ranges from 10 to 20 inches. Coarse fragments are less than 5 percent. Clay content of the control section ranges from 18 to 35 percent. The control section texture is clay loam to sandy clay loam.

Taxonomic Class - loamy, mixed, mesic, shallow Ustic Haplargid.

Suitability for Topsoil - The Worf series is suitable for topsoil and the approximate recommended stripping depth is 1 foot. The Worf series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

ADDENDUM 5
1979 SOIL SERIES DESCRIPTIONS

The following soil series descriptions are based, in part, on the 1979 soil survey by Woodward-Clyde Associates on the Mill Site for Smith Ranch. These series descriptions were utilized during 1978-1980 on various soil surveys related to the Smith Ranch Project. Note that much of the taxonomic nomenclature is no longer accepted, e.g., B3ca is now Bk.

BOWBAC SERIES

Soil Mapping Unit 23A, 23B, and 23C
Typical Pedon: Bowbac sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) when moist; moderate fine granular structure; soft consistency when dry, very friable when moist, slightly sticky when wet; mildly alkaline (pH7.7), noneffervescent.

B2t - 4-16 inches. Pale brown (10YR 6/3) sandy loam, grayish brown (10YR 5/2) when moist; moderate medium angular blocky structure; slightly hard consistence when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.7), noneffervescent.

B3ca - 16-25 inches. Pale brown (10YR 6/4) sandy loam, brown (10YR 5/3) when moist; medium subangular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; moderately alkaline (pH 8.0), strongly effervescent.

Cca - 25-34 inches. Light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown when moist; medium subangular blocky structure; hard consistence when dry, firm when moist, slightly sticky when wet; moderately alkaline (pH 8.4), strongly effervescent.

Cr - 34 inches. Shale and sandstone.

Range in Soil Characteristics - Depth to a paralithic contact ranges from 20 to 40 inches. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is a sandy clay loam. Clay content of the control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Bowbac sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Bowbac series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

CAMBRIA (STONEHAM) LOAM

Soil Mapping Unit 15A and 15B
Typical Pedon: Cambria (Stoneham) loam, rangeland
(Colors are for dry soil unless otherwise indicated)

A1 - 0-3 inches. Yellowish brown (10YR 5/4), heavy loam, dark grayish brown (10YR 4/2) when moist; moderate medium granular structure; soft consistence when dry, very friable when moist; sticky and plastic when wet; mildly alkaline (pH 7.7), noneffervescent.

B2t - 3-8 inches. Pale brown (10YR 6/3) loam, brown (10YR 5/3) when moist; moderate subangular blocky structure; slightly hard consistence when dry, firm when moist, slightly sticky, slightly plastic when wet; mildly alkaline (pH 7.8), noneffervescent.

B3ca - 8-19 inches. Light gray (10YR 7/2) loam, brown (10YR 5/3) when moist; moderate subangular blocky structure; slightly hard consistence when dry, firm when moist, slightly sticky, slightly plastic when wet; strongly alkaline (pH 8.6), strongly effervescent.

Cca - 19-60 inches. Light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) when moist; massive structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; strongly alkaline (pH 8.6), strongly effervescent.

Range in Soil Characteristics - Depth to a paralithic contact is more than 40 inches. Content of coarse fragments ranges from 0 to 15 percent. Texture of the control section is a clay loam or sandy clay loam. Clay content of the control section ranges from 15 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Cambria loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The Cambria series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

CUSHMAN SERIES

Soil Mapping Unit 21A, 21B, and 21C
Typical Pedon: Cushman sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light brownish gray (10YR 6/2) loam, Yellowish brown (10YR 5/4) when moist; weak, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; mildly alkaline (pH 7.8), noneffervescent.

B2t - 4-15 inches. Yellowish brown (10YR 5/4) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; mildly alkaline (pH 7.6), noneffervescent.

Cca - 15-28 inches. Very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; weak, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; seams of CaCO3, strongly alkaline (pH 8.8), strongly effervescent.

Cr2 - 28 inches. Soft, partially weathered shale.

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a sandy clay loam. Clay content of control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed mesic family Ustollic Haplargid.

Suitability for Topsoil - The Cushman sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Cushman series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

FORKWOOD (FT. COLLINS) SERIES.

Soil Mapping Unit 10A, 10B, and 10C (19 is 1997 designation)
Typical Pedon: Forkwood (Ft. Collins) clay loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Pale brown (10YR 6/3) fine sandy loam, grayish brown (10YR 5/2) when moist; weak, medium granular structure; soft consistence when dry, very friable when moist, slightly sticky when wet; mildly alkaline (pH 7.4), noneffervescent.

B2t - 4-27 inches. Light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; moderate medium angular blocky structure; slightly hard consistence when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.7), noneffervescent.

B3ca - 27-36 inches. Yellowish brown (10YR 5/4) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; moderately alkaline (pH 8.0), strongly effervescent.

C1ca - 36-49 inches. Light yellowish brown (10YR 6/4) loam, brown (10YR 5/3) when moist; moderate medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; seams of CaCO3; moderately alkaline (pH 8.2), strongly effervescent.

C2ca - 49-60 inches. Light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) when moist; massive structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; seams and nodules of CaCO3; moderately alkaline (pH 8.3), strongly effervescent.

Range in Soil Characteristics - There is no bedrock present within 60 inches. Content of coarse fragments is less than 5 percent. Texture of control section ranges from clay loam to a loam. Clay content of control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Forkwood clay loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The Forkwood series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

HILAND (OLNEY) SERIES

Soil Mapping Unit 12A, 12B, and 12CD (16 is 1997 designation)
Typical Pedon: Hiland (Olney) sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-5 inches. Brown (10YR 5/3) fine sandy loam, brown (10YR 5/3) when moist; moderate, medium granular structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; mildly alkaline (pH 7.7), noneffervescent.

B2t - 5-29 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; strongly alkaline (pH 8.6), strongly effervescent.

B3ca - 29-48 inches. Very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; strongly alkaline (pH 8.6), strongly effervescent.

Cca - 48-60 inches. Light yellowish brown (10YR 6/4) sandy loam, brown (10YR 5/3) when moist; massive structure; slightly hard consistence when dry, friable when moist, slightly sticky when wet; strongly alkaline (pH 8.4), strongly effervescent.

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of control section is a sandy clay loam. Clay content of control section ranges from 18 to 35 percent.

Taxonomic Class - fine-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Hiland sandy loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The Hiland series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

KISHONA (KIM) SERIES

Soil Mapping Unit 14A and 14B
Typical Pedon: Kishona (Kim) loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-5 inches. Pale brown (10YR 6/3) loam, grayish brown (10YR 5/2) when moist; moderate, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky slightly plastic when wet; moderately alkaline (pH 8.2), strongly effervescent.

C1 - 5-13 inches. Light brownish gray (10YR 6/2) light clay loam, brown (10YR 5/3) when moist; moderate, medium subangular blocky structure; slightly hard consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; moderately alkaline (pH 8.2), strongly effervescent.

C1ca - 13-60 inches. Light yellowish brown (10YR 6/4) loam, brown (10YR 5/3) when moist; massive structure; soft consistence when dry, friable when moist, slightly sticky when wet; seams of CaCO3; strongly alkaline (pH 8.8), violently effervescent.

Range in Soil Characteristics - There is no bedrock present within 60 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a heavy loam or light clay loam. Clay content of control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed (calcareous), mesic Ustic Torriorthent.

Suitability for Topsoil - The Kishona loam soil is suitable for topsoil and the recommended stripping depth is 5 feet. The C1ca horizon suitability is given a poor rating due to a high content of calcium carbonate. This property is not believed to be of serious concern to the overall topsoil suitability. Otherwise, the Kishona series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1.

RENOHILL SERIES

Soil Mapping Unit 22A, 22B, and 22C
Typical Pedon: Renohill clay loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light brownish gray (10YR 6/2) clay loam, brown (10YR 5/3) when moist; moderate, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; neutral (pH 7.1), noneffervescent.

B2t - 4-14 inches. Light yellowish brown (10YR 6/4) clay, yellowish brown when moist; strong, coarse angular blocky to prismatic structure; very hard consistence when dry, very firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.6), noneffervescent.

B3ca - 14-20 inches. Light gray (10YR 7/2) heavy clay loam, pale brown (10YR 6/3) when moist; strong subangular blocky structure; very hard consistence when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 8.1), strong effervescence.

Cca - 20-26 inches. Pale brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) when moist; massive structure; very hard consistence when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 8.1), strongly effervescent.

C - 26 inches. Calcareous shale.

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of control section is clay or a heavy clay loam. Clay content of control section ranges from 35 to 50 percent. There is no evidence of a water table.

Taxonomic Class - fine, montmorillonitic mesic Ustollic Haplargid

Suitability for Topsoil - The Renohill clay loam soil is suitable for topsoil and the recommended stripping depth is 2 feet. The suitability rating for observed dry consistence is poor below the top 4 inches. This property is not believed to be of a serious concern to the overall topsoil suitability. All other soil parameters of Renohill rate fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

SHINGLE LOAM

Soil Mapping Unit 30B
Typical Pedon: Shingle loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-3 inches. Light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine granular structure; soft consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; moderately alkaline (pH 8.0), strongly effervescent.

C1 - 3-10 inches. Light yellowish brown (10YR 6/4) clay loam, brown (10YR 5/3) when moist; moderate, medium granular structure; soft consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; moderately alkaline (pH 8.4), strongly effervescent.

C2r - 10 inches. Soft calcareous shale.

Range in Soil Characteristics - Depth to paralithic contact ranges from 10 to 20 inches. Content of coarse fragments is less than 5 percent. Texture of control section is a clay loam. Clay content of control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - loamy, mixed (calcareous) mesic Ustic Torriorthent, shallow.

Suitability for Topsoil - The Shingle loam soil is suitable for topsoil and the recommended stripping depth is 1 foot. The Shingle series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TALUCE (TASSEL) SERIES

Soil Mapping Unit 32B and 32C
Typical Pedon: Taluce (Tassel) sandy loam, Rangeland.

A1 - 0-4 inches. Pale brown (10YR 6/3) sandy loam, yellowish brown (10YR 5/4) when moist; weak, fine granular structure; loose consistence when dry, friable when moist, slightly sticky nonplastic when wet; mildly alkaline (pH 7.6), strongly effervescent.

C - 4-11 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; weak, subangular blocky structure; soft consistence when dry, friable when moist, slightly sticky, slightly plastic when wet.

Cr- 11 inches. Calcareous sandstone.

Range in Soil Characteristics - Depth to paralithic contact ranges from 10 to 20 inches. More than 35 percent of the sand fraction is fine or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine, mixed, mesic Ustic Torriorthent, shallow.

Suitability for Topsoil - The Taluce sandy loam soil is suitable for topsoil and the recommended stripping depth is 1 foot. The Taluce series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TERRO (TERRY) SERIES

Soil Mapping Unit 24C (17 is 1997 designation)
Typical Pedon: Terro (Terry) fine sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-2 inches. Light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky, nonplastic when wet; neutral (pH 7.1), noneffervescent.

B2t - 2-8 inches. Pale brown (10YR 6/3) fine sandy loam, dark grayish brown (10YR 5/4) when moist; moderate, medium angular structure; slightly hard consistence when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.1), noneffervescent.

B3ca - 8-14 inches. Very pale brown (10YR 7/3) sandy loam, pale brown (10YR 6/3) when moist; weak medium, subangular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.9), strongly effervescent.

Cca - 14-28 inches. Light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; massive structure; slightly hard consistence when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.0), strongly effervescent.

C - 28 inches. Calcareous sandstone.

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. More than 35 percent of the sand fraction is fine sand or coarser. Content of coarse fragments is less than 5 percent. Texture of the control section is fine sandy loam. Clay content of the control section ranges from 7 to 18 percent. There is no evidence of a water table.

Taxonomic Class - coarse-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Terro sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Terro series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

THEEDLE (THEDALUND) SERIES

Soil Mapping Unit 26B and 26C (49 is 1997 designation)
Typical Pedon: Theedle (Thedalund) loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-3 inches. Very pale brown (10YR 7/3) sandy loam, light brownish gray (10YR 6/2) when moist; weak, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; mildly alkaline (pH 8.0), strongly effervescent.

AC - 3-11 inches. Yellowish brown (10YR 5/4) loam, dark grayish brown when moist; moderate, fine subangular blocky structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; moderately alkaline (pH 8.0), strongly effervescent.

Cca - 11-34 inches. Light gray (10YR 7/2) loam, pale brown (10YR 6/3) when moist; massive structure; soft consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; strongly alkaline (pH 8.5), strongly effervescent.

Cr - 34 inches. Sandstone.

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of the control section is clay loam. Clay content of the control section ranges from 18 to 35 percent. There is no evidence of a water table.

Taxonomic Class - fine-loamy, mixed, (calcareous), mesic Ustic Torriorthent.

Suitability for Topsoil - The Theedle loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Theedle series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

TULLOCK SERIES

Soil Mapping Unit 25C
Typical Pedon: Tullock fine sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine crumb structure; soft consistence when dry, friable when moist, nonsticky, nonplastic when wet; neutral (pH 7.0), noneffervescent.

C1 - 4-24 inches. Pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive structure; soft consistence when dry, friable when moist, nonsticky, nonplastic when wet; mildly alkaline (pH 7.4), slightly effervescent.

C2 - 24-34 inches. Pale gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak fine crumb structure; soft consistence when dry, friable when moist, nonsticky, nonplastic when wet; neutral (pH 7.0), noneffervescent.

Cr - 34 inches. Weakly consolidated calcareous sandstone.

Range in Soil Characteristics - Depth to paralithic contact ranges from 20 to 40 inches. Content of coarse fragments is less than 5 percent. Texture of the control section is loamy fine sand to a light sandy loam.

Taxonomic Class - mixed, mesic Ustic Torripsamments.

Suitability for Topsoil - The Tullock fine sandy loam soil is suitable for topsoil and the recommended stripping depth is 2.5 feet. The Tullock series rates fair or better according to Wyoming Department of Environmental Quality Guideline 1. Depth of stripping would be limited by bedrock material.

ULM CLAY LOAM

Soil Mapping Unit 11 (20 is 1997 designation)
Typical Pedon: Ulm clay loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, granular structure; soft consistence when dry, very friable when moist, sticky and plastic when wet; neutral (pH 7.2), noneffervescent.

B1 - 4-9 inches. Light brownish gray (10YR 6/2) heavy loam, dark grayish (10YR 4/2) when moist; moderate, subangular blocky structure; slightly hard consistence when dry, very friable when moist, sticky and plastic when wet; neutral (pH 7.2), noneffervescent.

B2t - 9-15 inches. Brown (10YR 5/3) clay loam, brown to dark brown (10YR 4/3) when moist; moderate, fine prismatic structure; very hard consistence when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.7), noneffervescent.

B3ca - 15-24 inches. Grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, subangular blocky structure; very hard consistence when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 8.0), strongly effervescent.

C1ca - 24-46 inches. Light brownish gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2) when moist; massive structure; hard consistence when dry, friable when moist, sticky and plastic when wet; moderately alkaline (pH 8.4), violently effervescent.

C2ca - 46-60 inches. Light brownish gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2) when moist; massive structure; hard consistence when dry, very friable when moist, sticky and plastic when wet; moderately alkaline (pH 8.4), violently effervescent.

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. Coarse fragments are less than 5 percent. The control section is a heavy clay loam or clay. Clay content of the control section ranges from 35 to 50 percent. There is no evidence of a water table.

Taxonomic Class - fine, montmorillonitic mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Ulm clay loam soil is suitable for topsoil and the recommended stripping depth is 4 feet. The suitability rating for texture from 46 to 60 inches deep is poor due to a high clay content which limits soil workability. Stripping depth should be kept above this zone. The suitability rating for observed dry consistence is poor in the B2t and B3ca soil horizons. This property is not believed to be of serious concern to the overall topsoil suitability.

VONALEE (VONA) SERIES

Soil Mapping Unit 13
Typical Pedon: Vonalee (Vona) sandy loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; weak, fine crumb structure; loose consistence when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.0), noneffervescent.

B1 - 4-7 inches. Light brownish gray (10YR 6/2) sandy loam, brown (10YR 5/3) when moist; moderate, medium subangular blocky structure; soft consistence when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.0), noneffervescent.

B2t - 7-14 inches. Pale brown (10YR 6/3) fine sandy loam, grayish brown (10YR 5/2) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; neutral (pH 7.2), noneffervescent.

B3ca - 14-22 inches. Pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; moderate, medium subangular blocky structure; slightly hard consistence when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.8), strongly effervescent.

Cca - 22-60 inches. Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; massive structure; slightly hard consistence when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.6), slightly effervescent.

Range in Soil Characteristics - There is no bedrock present within 60 inches of the surface. More than 35 percent of sand fraction is fine sand or coarser. Coarse fragments are less than 5 percent. The control section is sandy loam with a clay content ranging from 7 to 18 percent. There is no evidence of a water table.

Taxonomic Class - coarse-loamy, mixed, mesic Ustollic Haplargid.

Suitability for Topsoil - The Vonalee soils are deep, somewhat excessively drained soils formed in eolian and partially reworked alluvial parent materials. The mean annual precipitation is about 12 inches and the mean annual air temperature is 46° F.

WORF SERIES

Soil Mapping Unit 31
Typical Pedon: Worf loam, rangeland.
(Colors are for dry soil unless otherwise indicated)

A1 - 0-4 inches. Light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/3) when moist; moderate, fine granular structure; soft consistence when dry, very friable when moist, slightly sticky, slightly plastic when wet; neutral (pH 7.2), noneffervescent.

B2t - 4-9 inches. Pale brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; moderate, medium angular blocky structure; slightly hard consistence when dry, friable when moist, slightly sticky, slightly plastic when wet; seams of CaCO3 throughout horizon, mildly alkaline (pH 7.8), strongly effervescent.

(9-16 inch interval information not available)

C2r - 16 inches. Calcareous shale.

Range in Soil Characteristics - Depth of bedrock ranges from 10 to 20 inches. Coarse fragments are less than 5 percent. Clay content of the control section ranges from 18 to 35 percent. The control section texture is loam or light clay loam. There is no evidence of a water table.

Taxonomic Class - loamy, mixed, mesic Ustollic Haplargid, shallow.

Suitability for Topsoil - The Worf soils are shallow, well drained soils formed residually from sedimentary rock on upland hills and ridges. The mean annual precipitation is about 12 inches and the mean annual air temperature is 46° F.

APPENDIX D-8

VEGETATION

REYNOLDS RANCH AMENDMENT AREA
CONVERSE COUNTY WYOMING

1.0 General

Vegetation at Reynolds Ranch amendment area is typical northern plains short grass prairie forage characteristic of areas of low annual precipitation. Two primary native vegetation types occur within the amendment area. Well drained, upland areas are characterized by grassland on ridgetops and flat areas with sagebrush/grassland on sloped areas and drainages. Grassland is the dominant native vegetation type (approximately 54%), followed by Sagebrush/Grassland (approximately 45%).

2.0 Soil Baseline Studies

A baseline vegetation study was performed for the Reynolds Ranch amendment area by BKS Environmental Associates, Inc. in 1997 for Rio Algom Mining Corporation. This study is contained in Addendum D8-1. The proposed amendment area has been reduced since the time of the study. Therefore, the study covered a larger area than what is currently proposed as the Reynolds Ranch amendment area.

An area vegetation map was developed as part of the 1997 study. However, PRI has been unable to locate and obtain a copy of this map. Therefore, a vegetation map is not included.

ADDENDUM D7-8

REYNOLDS RANCH BASELINE VEGETATION ASSESSMENT, 1997

BKS ENVIRONMENTAL ASSOCIATES, INC.

(Prepared for Rio Algom Mining Corporation)

Baseline Vegetation Assessment

of the

Reynolds Ranch Area

Prepared for:

RIO ALGOM MINING CORPORATION
P.O. Box 1390
Glenrock, WY 82637

Prepared by:
BKS ENVIRONMENTAL ASSOCIATES, INC.
P.O. Box 3467
Gillette, WY 82717-3467

December 1998

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LIST OF ADDENDA

a. INTRODUCTION

Vegetation inventories have been conducted on the Smith Ranch Project Area since 1976. Early studies were performed by consultants for the Kerr-McGee South Powder Basin Uranium Project under Wyoming Permit No. 304C. Following acquisition of the mine by the Rio Algom Mining Corporation (RAMC), additional vegetation surveys were conducted within the current Permit No. 633 boundary during 1990 and 1992. The following summary of these historical vegetation surveys is paraphrased from the current Appendix D-8:

Woodward-Clyde Consultants, 1976. Original vegetation surveys of the Permit No. 304C area were conducted by Woodward-Clyde Consultants in 1976. Three areas were surveyed: site V-1, a proposed surface mine in the Hornbuckle area located to the north of the current permit area; site V-2, a proposed site for a uranium milling operation located in the northern portion of the permit area; and site V-3, located in the southern most portion of the original 304C permit area. Vegetation surveys included quantitative analysis of dominant vegetation types using line intercept transects to measure cover, circular plots to measure density, and quadrats to measure production. A list of plant species observed or expected to occur on the original Permit 304C area was also compiled.

Woodward-Clyde Consultants, 1978. During 1978, Woodward-Clyde Consultants performed additional vegetation studies for the 304C permit area in compliance with Wyoming Department of Environmental Quality (WDEQ) Land Quality Division Guideline No. 2. The final report for this site was submitted to WDEQ under Permit 304C; however, the sampled area is not applicable to the current Permit No. 633 area.

Woodward-Clyde Consultants, 1979. In April and September, 1979, vegetation assessments continued at site V-2 and the associated surface mine area. Vegetation measurements included cover, annual productivity and shrub height. In addition, control areas were established for future comparison to areas disturbed by mining. Results from 1979 sampling of site V-2 and the middle pit area indicated that the study area was primarily grassland, with sagebrush/grassland vegetation scattered throughout the affected area.

Beartooth Environmental, 1990. During the summer of 1990, vegetation mapping was conducted on RAMC's permit area 633. Aerial photographs and ground truthing were used to complete the mapping. Mapping units included: Sagebrush/Grassland, Grassland, Impoundment, Reclaimed, Disturbed, Hay Meadow, Road Right of Way, Playa, Ranch Yard, Cottonwood/ Willow, and Shelterbelt. Results of this mapping determined that the Smith Ranch project is located in a short-grass prairie region with a regional climate characterized by having wide ranges in temperature and relatively low annual precipitation (12-14 inches). Vegetation was dominated by grasses such as various wheatgrasses and blue grama, with big sagebrush as codominant in many areas. Isolated cottonwood/willow stands occurred along local drainages. Sagebrush/ Grassland vegetation was clearly the dominant vegetation type,

occupying 82% of the permit area. Grassland accounted for 15% of the permit area, with the other vegetation and land use units comprising the remaining 13%.

BKS Environmental Associates, Inc., 1992. BKS Environmental Associates, Inc. was contracted in 1992 to perform a baseline vegetation inventory in compliance with Condition 2 of Permit No. 633. Vegetative sampling was performed according to the WDEQ/LQD methodology letter dated January 21, 1992. The original BKS report summarizing these findings was dated October 1, 1992. A subsequent rewrite in 1996 addresses WDEQ comments dated November 2, 1992.

BKS Environmental Associates, Inc. was contracted in 1997 to perform a baseline vegetation inventory on a proposed permit extension to the Smith Ranch Permit No. 633, i.e., Reynold's Ranch. Vegetative sampling was performed according to the WDEQ/LQD methodology letter dated April 10, 1997.

b. METHODOLOGY

The following information is derived primarily from written correspondence to the WDEQ/LQD dated April 10, 1997, and Rich Vincent's reply to Matt Jankovsky on April 29, 1997. This letter was compiled based on the September 1996 meeting between Rio Algom, WDEQ, and BKS Environmental personnel.

i) Vegetative Type Determination and Mapping

Preliminary baseline vegetation mapping of the Rio Algom Mining Corporation's Reynold's Ranch Property was conducted in the Fall of 1996. Mapping unit acreages were derived by planimetering the mapping units on the vegetation map. Table 1 was then constructed.

Photographs of native vegetation types (ie. Grassland and Sagebrush/Grassland) taken during 1997 fieldwork are included in Addendum 2 and photo locations illustrated on the vegetation map.

(ii) Species Composition

Plant identification was confirmed by the Rocky Mountain Herbarium in Laramie, WY. All scientific nomenclature followed current nomenclature in use at the Herbarium during 1997 with the exception of the genus Agropyron. Refer to Addendum 3, 1997 Species List.

Any encountered federally designated threatened and endangered species, state plants of concern, noxious weeds and primary selenium indicators were identified.

(iii) Study Area Sampling Design

All sampling procedures were designed according to the Wyoming Department of Environmental Quality, Land Quality Division, Rules and Regulations for Coal, Appendix A (August, 1994) and modified for WDEQ/LQD, Rules and Regulation for Non-Coal (1993), wherever applicable. Sampling locations were randomly determined by placing a grid over the 1"-500' vegetation map. The x-axis was generally east-west, while the y-axis generally ran north and south. Grid interval at the scale utilized was approximately 50 feet on the ground. Sampling location coordinates were randomly generated by the HP32S hand calculator. Sample point selection was repeated until the desired number of points for each vegetation type was attained. All sample locations are plotted on the vegetation map.

Since the exact mine disturbance limit was not known at the time of the 1997 assessment, the extended reference area approach was utilized in order to minimize the total number of sample points. Sample points were located within the entire proposed Reynold's Ranch extension area by vegetation type regardless of the location of the proposed affected area. Data summarization was not separated for affected area and the extended reference area, i.e., the data was treated as one set. Summarization by vegetation type was performed, i.e., Grassland, Sagebrush/Grassland, and Rock Outcrop. Summarization for playas was dropped since those areas contained excess water and biased any sampling results; dropping of this data and substituting subjective descriptions was discussed with Rich Vincent, WDEQ/LQD.

(iv) Time of Sampling

Sampling occurred for all communities at various intervals mid-August, 1997. The late season sampling was possible due to above-normal precipitation in July and August.

(v) Measurements

Collection and Analysis of Cover Data

A minimum of 50 transects for cover were sampled within the Grassland and Sagebrush/Grassland vegetation types, while a minimum of 15 were sampled within the Rock Outcrop type. Playa was initially sampled but data summarization was dropped due to foreseen biases in the data due to excess water. If statistical adequacy was not obtained, as defined in the WDEQ Rules and Regulations, Appendix A, August, 1994, additional transects were sampled, in increments, up to the maximum number of 100 for Grassland and Sagebrush/Grassland and 30 for Rock Outcrop.

Sample locations for cover within the study area were chosen by randomly selecting points within a grid. Grid intervals did not exceed 100 feet on the ground. Random sample location coordinates were plotted on a map and located in the field by pacing from a known location. Random numbers between 1 and 360 were generated to orient the transect. A compass was then used in the field to orient the transect to the nearest 1/8 of 360 degrees.

Sample hits were read at 1 meter intervals along the entire length of the 50 meter transect. First hit (50) readings constituted the absolute cover values for total vegetation and total cover. The first hit information was used to compile the overall plant list for the study areas. Litter, rock, and bare ground percentages were recorded. Transects that exceeded designated vegetation boundaries were randomly reoriented to be within the sampled vegetation type.

In the cover tables, "importance value" (I.V.) is the sum of relative cover and relative frequency, giving the overall importance in a vegetation community. Lichen was included in cover sampling and is included in the summarization of total vegetation cover and total cover but not sum of species cover. Total vegetation equals sum of species cover plus lichen. Total cover equals total vegetation cover plus litter/rock.

Collection and Analysis of Production Data

As per the April 10, 1997 written methodology, no production data was necessary for the 1997 assessment.

Collection and Analysis of Shrub Density Data

Even though shrub density sampling is not required for non-coal sites, this data will be taken at the time of cover sampling to ensure adequate use of field time. However, it is assumed that this area is not part of any wildlife critical winter range.

Study area shrub density data were collected in conjunction with cover transects. All shrubs, full or half, were counted within 50 centimeters on either side of the 50 meter cover transect (ie. 1 meter x 50 meter belt transect). Sample adequacy was not calculated on shrub density transects; the number of belt transects equaled the number of cover transects for a given vegetation type. No shrub height measurements were collected.

Tree Density

Due to the general sparsity of trees, a complete census was taken during the 1997 fieldwork within the study area. All tree locations within the study area were plotted on the vegetation map, if necessary. The survey for possible trees took place during cover sampling. Tree height was measured by use of a clinometer, if necessary, but was generally estimated. Tree diameter at breast height was determined by using a diameter tape, if necessary, but was generally estimated.

(vi) Cropland and Prime Farmland Productivity

No cropland or prime farmland were noted within the study area.

c. RESULTS

(i) Description of Vegetation Types

Two primary native vegetation types occur within the study area. Well drained, upland areas are characterized by Grassland on ridgetops and flat areas with Sagebrush/Grassland on sloped areas and drainages. The Playa map unit is found on poorly drained, upland areas. Rock Outcrop areas are generally sandstone.

Table 1 lists acreage for each vegetation mapping unit within the study area which totals 13,400 acres. Grassland is the dominant native vegetation type (7,295 acres or 54.4 %), followed by Sagebrush/Grassland (6,045 acres or 45.1%). Rock Outcrops and Playas encompass 82 acres (0.6%) and 17 acres (0.1%), respectively. Although a jurisdictional wetland survey was not conducted as part of the baseline assessment, no possible areas were observed in the field, based on vegetative characteristics alone.

Grassland

Within the study area, flat or gently rolling upland terrain is characterized by the Grassland vegetation type with limited shrub cover. This native vegetation type covers 7,295 acres within the study area. Dominant perennial grasses include blue grama (*Bouteloua gracilis*), threadleaf sedge (*Carex filifolia*), and needle-and-thread (*Stipa comata*). Small sand blowout areas, too small to be mapped at the current scale, were located on shoulderslopes of ridges.

Sagebrush/Grassland

Within the study area, sloped areas and drainages are characterized by the Sagebrush/Grassland vegetation type. This native vegetation type covers 6,045 acres within the study area. Shrub cover varies with big sagebrush (*Artemisia tridentata*) on sloped areas to silver sagebrush (*Artemisia cana*) in drainages and on toeslopes. Dominant perennial grasses include blue grama, threadleaf sedge, and needle-and-thread.

Rock Outcrop

Within the study area, the Rock Outcrop map unit is located on ridges and hilltops and occupies 82 acres. Dominant perennial grasses or grasslike plants include blue grama, threadleaf sedge and needle-and-thread. The dominant rock is sandstone but small areas of ironstone are interspersed within this type.

Playa

Within the study area, poorly drained upland areas are characterized by the Playa vegetation type. This native vegetation type occupies approximately 17 acres within the study area. The majority of

these areas are pocket depressions that hold seasonal precipitation. Dominant perennial grasses include western wheatgrass (*Agropyron smithii*) and foxtail barley (*Hordeum jubatum*).

Disturbed Land

Within this study area, particular features of human disturbance have been mapped in order to document pre-mining conditions. These previously disturbed areas include the Ross Road Highway (old and current construction) and ranch related structures and facilities. These areas were not sampled.

(ii) Vegetation Map

Study area vegetation types and sampling sites are outlined on the vegetation map.

(iii) Weeds, Selenium Indicators, Endangered or Threatened Species

Encountered species cited as "noxious" weeds in the Agricultural Experiment Station, University of Wyoming, 1979, Bulletin 498, "Weeds of Wyoming" include Canada thistle (*Cirsium arvense*). However, it had a low frequency with extremely limited cover. Primary selenium indicator species identified during the 1997 survey include twogrooved milkvetch (*Astragalus bisulcatus*).

None of the plants identified on the study area appear on the U.S. Department of Interior's "Endangered and Threatened Species Plants", as published in the Federal Register. Legal coordinates for the study area were run through the Wyoming Natural Diversity Database in Laramie, Wyoming (April, 1997). No previously encountered plants of concern were found on record. Refer to Addendum 1, Correspondence.

(iv) Species Composition

Addendum 3 lists species of plants encountered during this baseline survey. This list is arranged by lifeform.

(v) Native Vegetation Type Cover Analysis

All native vegetation types were quantitatively sampled to determine composition and cover.

Grassland

Absolute total vegetation cover (62.84 percent) was dominated by cool season perennial grasses (48.92 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 31.89 percent of relative species cover, and was dominated by blue grama. Perennial forbs comprised 7.56 percent of relative cover. Annual grasses and annual forbs comprised 5.27 and 1.09

percent of relative cover, respectively. Shrub species provided 2.05 percent relative species cover, while halfshrubs contributed 2.60 percent relative species cover. Succulents provided 0.41 percent relative species cover. Bare soil and litter/rock percentages were 19.20 and 17.96, respectively.

Utilizing the minimum sample number formula outlined in WDEQ, LQD Rules and Regulations, Appendix A (August, 1994), sample adequacy was attained for total vegetation and total cover. Based on sample data, 9 and 11 points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 2 for a summary of the Grassland study area cover data. Refer to Table 10 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Sagebrush/Grassland

Absolute total vegetation cover (66.64 percent) was dominated by cool season perennial grasses (35.63 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 14.40 percent of relative species cover, and was dominated by blue grama (Bouteloua gracilis). Perennial forbs comprised 6.73 percent of relative cover. Annual grasses provided 13.68 percent of relative cover, while annual forbs provided 2.26 percent. Shrub species, dominated by big sagebrush, provided 24.09 percent relative species cover. Halfshrubs, primarily fringed sagewort (*Artemisia frigida*), contributed 2.01 percent relative species cover. Succulents provided less than one percent relative species cover. Bare soil and litter/rock percentages were 15.04 and 18.64, respectively.

Utilizing the minimum sample number formula outlined in WDEQ, LQD Rules and Regulations, Appendix A (August, 1994), sample adequacy was attained for total vegetation and total cover. Based on sample data, 7 and 4 points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 3 for a summary of the Sagebrush/Grassland study area cover data. Refer to Table 10 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Rock Outcrop

Absolute total vegetation cover (52.25 percent) was dominated by cool season perennial grasses (39.16 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 30.73 percent of relative species cover, and was dominated by blue grama. One introduced perennial grass, Kentucky bluegrass (*Poa pratensis*) and annual grasses accounted for 0.50 and 3.97 percent of relative species cover, respectively. Perennial forbs comprised 12.14 percent of relative cover. Shrub species, dominated by skunkbush sumac (*Rhus trilobata*), provided 6.20 percent relative species cover. Halfshrubs contributed 3.35 percent relative species cover. Succulents

these areas are pocket depressions that hold seasonal precipitation. Dominant perennial grasses include western wheatgrass (*Agropyron smithii*) and foxtail barley (*Hordeum jubatum*).

Disturbed Land

Within this study area, particular features of human disturbance have been mapped in order to document pre-mining conditions. These previously disturbed areas include the Ross Road Highway (old and current construction) and ranch related structures and facilities. These areas were not sampled.

(ii) Vegetation Map

Study area vegetation types and sampling sites are outlined on the vegetation map.

(iii) Weeds, Selenium Indicators, Endangered or Threatened Species

Encountered species cited as "noxious" weeds in the Agricultural Experiment Station, University of Wyoming, 1979, Bulletin 498, "Weeds of Wyoming" include Canada thistle (*Cirsium arvense*). However, it had a low frequency with extremely limited cover. Primary selenium indicator species identified during the 1997 survey include twogrooved milkvetch (*Astragalus bisulcatus*).

None of the plants identified on the study area appear on the U.S. Department of Interior's "Endangered and Threatened Species Plants", as published in the Federal Register. Legal coordinates for the study area were run through the Wyoming Natural Diversity Database in Laramie, Wyoming (April, 1997). No previously encountered plants of concern were found on record. Refer to Addendum 1, Correspondence.

(iv) Species Composition

Addendum 3 lists species of plants encountered during this baseline survey. This list is arranged by lifeform.

(v) Native Vegetation Type Cover Analysis

All native vegetation types were quantitatively sampled to determine composition and cover.

Grassland

Absolute total vegetation cover (62.84 percent) was dominated by cool season perennial grasses (48.92 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 31.89 percent of relative species cover, and was dominated by blue grama. Perennial forbs comprised 7.56 percent of relative cover. Annual grasses and annual forbs comprised 5.27 and 1.09

percent of relative cover, respectively. Shrub species provided 2.05 percent relative species cover, while halfshrubs contributed 2.60 percent relative species cover. Succulents provided 0.41 percent relative species cover. Bare soil and litter/rock percentages were 19.20 and 17.96, respectively.

Utilizing the minimum sample number formula outlined in WDEQ, LQD Rules and Regulations, Appendix A (August, 1994), sample adequacy was attained for total vegetation and total cover. Based on sample data, 9 and 11 points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 2 for a summary of the Grassland study area cover data. Refer to Table 10 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Sagebrush/Grassland

Absolute total vegetation cover (66.64 percent) was dominated by cool season perennial grasses (35.63 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 14.40 percent of relative species cover, and was dominated by blue grama (Bouteloua gracilis). Perennial forbs comprised 6.73 percent of relative cover. Annual grasses provided 13.68 percent of relative cover, while annual forbs provided 2.26 percent. Shrub species, dominated by big sagebrush, provided 24.09 percent relative species cover. Halfshrubs, primarily fringed sagewort (*Artemisia frigida*), contributed 2.01 percent relative species cover. Succulents provided less than one percent relative species cover. Bare soil and litter/rock percentages were 15.04 and 18.64, respectively.

Utilizing the minimum sample number formula outlined in WDEQ, LQD Rules and Regulations, Appendix A (August, 1994), sample adequacy was attained for total vegetation and total cover. Based on sample data, 7 and 4 points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 3 for a summary of the Sagebrush/Grassland study area cover data. Refer to Table 10 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Rock Outcrop

Absolute total vegetation cover (52.25 percent) was dominated by cool season perennial grasses (39.16 percent of relative cover for individual lifeform sub-totals). Major cool season perennial species included threadleaf sedge and needle-and-thread. Warm season perennial grasses accounted for 30.73 percent of relative species cover, and was dominated by blue grama. One introduced perennial grass, Kentucky bluegrass (*Poa pratensis*) and annual grasses accounted for 0.50 and 3.97 percent of relative species cover, respectively. Perennial forbs comprised 12.14 percent of relative cover. Shrub species, dominated by skunkbush sumac (*Rhus trilobata*), provided 6.20 percent relative species cover. Halfshrubs contributed 3.35 percent relative species cover. Succulents

provided 2.73 percent relative species cover. Bare soil and litter/rock percentages were 33.00 and 14.75, respectively.

Utilizing the minimum sample number formula outlined in WDEQ, LQD Rules and Regulations, Appendix A (August, 1994), sample adequacy was attained for total vegetation cover and total cover. Based on sample data, 14 and 10 points were required to attain adequacy for total vegetation and total cover, respectively. The maximum of sixteen points, as outlined in the WDEQ rules and regulations, was actually sampled.

Refer to Table 4 for a summary of the Rock Outcrop study area cover data. Refer to Table 10 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Playa

Summarization for playas was dropped since those areas contained excess water and biased any sampling results; dropping of this data and substituting subjective descriptions was discussed with Rich Vincent, WDEQ/LQD. See Addendum 1, Correspondence.

(vi) Trees, Shrubs, Stock Ponds, Disturbed, and Developed Sites

Trees

Scattered plains cottonwood (*Populus deltoides*) are present in the region but not within the boundaries of the study area. Often individuals are partially dead and trunks are twisted and deformed. Peachleaf willow (*Salix amygdaloides*), with a characteristic clumped growth habit (several tree trunks sprouting from a central root system), are present in the region also but not within the study area.

Shrubs

Shrub density information was collected on the study area. Raw data are presented in Tables 7 through 9.

Within the Grassland study area, an average of 6,340.00 shrubs/hectare was determined. Fringed sagewort was the most frequently encountered shrub (of the half and full shrubs), followed by silver sagebrush (*Artemisia cana*) and birdsfoot sagewort (*Artemisia pedatifida*). Refer to Table 7.

Within the Sagebrush/Grassland study area, an average of 7,452.00 shrubs/hectare was determined. Big sagebrush was the most frequently encountered shrub (of the half and full shrubs), followed by fringed sagewort and silver sagebrush. Refer to Table 8.

Within the Rock Outcrop study area, an average of 6,675.00 shrubs/hectare was determined. Fringed sagewort was the most frequently encountered shrub (of the half and full shrubs), followed by silver sagebrush and skunkbush sumac (*Rhus trilobata*). Refer to Table 9 .

(vii) Sample Adequacy

Sample adequacy was tested for each of the study area vegetation types using the following formula:

$$n_{min} \geq \frac{2(sz)^2}{(dx)^2}$$

Where n_{min} = minimum number of sampled line transects or clipping quadrats needed to adequately represent a given vegetation type.
s = sample standard deviation,
z = the z statistic (see table below),
d = amount of reduction desired (see table below),
x = sample mean for cover and production,

Note Standard deviation presented in all the tables uses "n" in the denominator rather than "n-1". The more recent handheld calculators use "n-1" while the LOTUS program, used to derive the table figures, uses "n". This applies to all cover, production, and density summary tables.

z Statistic and d Table

	z	d
Productivity, grasslands	0.84	0.2
Productivity, shrublands	0.84	0.2
Cover, grasslands	1.28	0.1
Cover, shrublands	1.28	0.1

d. DISCUSSION.

Within the study area, transition between the two major vegetation types is dynamic and boundaries are often obscure. It should be noted that map boundaries are often gross estimations of actual boundaries due to transition zones between community types. In addition, small inclusions of vegetation types were not mapped.

Locations of the major vegetation types were often linked to existing geologic features, topography and resulting soil formation. Flatter topography and open uplands with generally deeper soils were more characteristic of the west side of the study area, with the exception of Highland flats. These areas and some ridgetops often contained sandy soil material and were associated with the Grassland

vegetation type. Within these areas, sand blowout inclusions, both open (unvegetated) and healing (sparsely vegetated), were noted and occasionally sampled. The loamy or clay loamy soils located in the varied topography of the east side supported more deeply rooted species and resulted in more expanses of the Sagebrush/Grassland vegetation type. The Silver sagebrush phase was often associated with deeper soils and was more frequently found in open drainages present along the west side of the study area. The Sagebrush/Grassland type displayed the highest cover values of the community types evaluated while Rock Outcrop displayed the lowest cover values. Rock Outcrop was primarily located on the far east side of the study area. These areas contained a higher percentage of bare ground due to their eroded nature; however, because of the rocky and sandy substrate, the plant diversity of the study area was expanded.

Although production was not sampled, general productivity was noted as good. The study area is used as a cattle range. Areas along the Flats displayed lower productivity, likely due to higher cattle concentrations. In addition, specific areas along the flats, indicative of some type of disturbance, contained annual grasses and weedy perennial forbs (i.e., curlycup gumweed). Drainages displayed higher productivity levels while ridges and upland slopes and hilltops displayed lower productivity levels.

Shrub density, dominated by full shrubs, was generally higher in the Sagebrush/Grassland vegetation type. In addition, the density of big sagebrush was nearly twice that of silver sagebrush. The rock outcrop vegetation type demonstrated a high shrub density with both half shrubs and full shrubs well represented. Within the Grassland vegetation type, half shrub values (i.e., fringed sagebrush) were much higher than full shrub density values. Birdsfoot sagebrush was very common on some upland ridges; however, the frequency at which these dense patches were encountered was uncommon

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Table 1. 1997 Sampled Parameters.

Area	Cover	Production	Shrub Density	Acreage
Grassland	50	0	50	7,295
Sagebrush/Grassland	50	0	50	6,045
Rock Outcrop	16	0	16	82
Playa	N/A	N/A	N/A	17

Table 2 Cover Summary for 1997 Reynolds Ranch Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	3.76	6.43	0 - 24	68.00	8.63	15.06	5
Agropyron smithii	3.00	5.13	0 - 28	54.00	6.85	11.98	6
Carex filifolia	9.52	16.28	0 - 24	92.00	11.68	27.96	2
Koeleria macrantha	3.24	5.54	0 - 8	78.00	9.90	15.44	4
Oryzopsis hymenoides	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Poa fendleriana	0.44	0.75	0 - 6	14.00	1.78	2.53	14
Poa sandbergii	0.52	0.89	0 - 4	22.00	2.79	3.68	10
Stipa comata	8.00	13.68	0 - 26	74.00	9.39	23.08	3
Stipa viridula	0.08	0.14	0 - 4	2.00	0.25	0.39	29
Sub-total	28.60	48.92					
WARM SEASON PERENNIAL GRASSES							
Aristida purpurea	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Bouteloua curtipendula	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Bouteloua gracilis	18.44	31.54	0 - 54	92.00	11.68	43.22	1
Calamovilfa longifolia	0.08	0.14	0 - 2	4.00	0.51	0.64	27
Sporobolus cryptandrus	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Sub-total	18.64	31.89					
INTRODUCED PERENNIAL GRASSES							
Agropyron cristatum	0.12	0.21	0 - 6	2.00	0.25	0.46	28
Sub-total	0.12	0.21					
ANNUAL GRASSES							
Bromus japonicus	0.80	1.37	0 - 14	8.00	1.02	2.38	15
Bromus tectorum	0.36	0.62	0 - 8	6.00	0.76	1.38	21
Festuca octoflora	1.92	3.28	0 - 16	26.00	3.30	6.58	7
Sub-total	3.08	5.27					
PERENNIAL FORBS							
Arenaria hookeri	0.24	0.41	0 - 6	6.00	0.76	1.17	24

Table 2(cont'd). Cover Summary for 1997 Reynolds Ranch Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Astragalus bisulcatus	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Astragalus spatulatus	0.08	0.14	0 - 2	4.00	0.51	0.64	27
Cerastium arvense	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Gaura coccinea	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Grindelia squarrosa	0.56	0.96	0 - 10	16.00	2.03	2.99	13
Heterotheca villosa	0.16	0.27	0 - 4	6.00	0.76	1.04	25
Hymenopappus polycephalus	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Lygodesmia juncea	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Machaeranthera grindelioides	0.16	0.27	0 - 6	4.00	0.51	0.78	26
Machaeranthera tanacetifolia	0.24	0.41	0 - 4	10.00	1.27	1.68	19
Oenothera coronopifolia	0.08	0.14	0 - 2	4.00	0.51	0.64	27
Penstemon sp.	0.14	0.24	0 - 2	8.00	1.02	1.25	23
Phlox hoodii	1.12	1.92	0 - 14	28.00	3.55	5.47	9
Psoralea tenuiflora	0.96	1.64	0 - 18	12.00	1.52	3.16	12
Sphaeralcea coccinea	0.24	0.41	0 - 2	12.00	1.52	1.93	17
Thermopsis rhombifolia	0.24	0.41	0 - 4	10.00	1.27	1.68	19
Sub-total	4.42	7.56					
ANNUAL AND BIENNIAL FORBS							
Alyssum alyssoides	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Alyssum desertorum	0.52	0.89	0 - 4	20.00	2.54	3.43	11
Camelina microcarpa	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Plantago patagonica	0.04	0.07	0 - 2	2.00	0.25	0.32	30
Sub-total	0.64	1.09					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	1.04	1.78	0 - 10	30.00	3.81	5.59	8
Eriogonum microthecum	0.12	0.21	0 - 6	2.00	0.25	0.46	28
Gutierrezia sarothrae	0.20	0.34	0 - 4	8.00	1.02	1.36	22
Leptodactylon pungens	0.16	0.27	0 - 4	4.00	0.51	0.78	26
Sub-total	1.52	2.60					

Table 2(cont'd). Cover Summary for 1997 Reynolds Ranch Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
SHRUBS							
Artemisia cana	0.24	0.41	0 - 4	8.00	1.02	1.43	20
Artemisia pedatifida	0.48	0.82	0 - 10	10.00	1.27	2.09	16
Artemisia tridentata	0.48	0.82	0 - 10	8.00	1.02	1.84	18
Sub-total	1.20	2.05					
CACTI AND SUCCULENTS							
Opuntia polyacantha	0.24	0.41	0 - 2	12.00	1.52	1.93	17
Sub-total	0.24	0.41					
SUM OF SPECIES COVER	58.46						
Lichens	4.12		0 - 18	72.00			
TOTAL VEGETATION	62.84 +/-	10.07					
LITTER/ROCK	17.96 +/-	9.93					
BARE SOIL	19.20 +/-	8.65					
TOTAL COVER	80.60 +/-	8.92					
Number of Species/sample	7.88						

Table 3 Cover Summary for 1997 Reynolds Ranch Sagebrush/Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	3.52	5.53	0 - 18	56.00	5.74	11.27	8
Agropyron riparium	0.44	0.69	0 - 10	8.00	0.82	1.51	22
Agropyron smithii	2.68	4.21	0 - 12	60.00	6.15	10.36	9
Carex eleocharis	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Carex filifolia	6.36	10.00	0 - 32	74.00	7.58	17.58	3
Koeleria macrantha	3.22	5.06	0 - 14	68.00	6.97	12.03	6
Oryzopsis hymenoides	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Poa compressa	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Poa fendleriana	0.12	0.19	0 - 2	6.00	0.61	0.80	28
Poa sandbergii	0.20	0.31	0 - 4	8.00	0.82	1.13	25
Sitanion hystrix	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Stipa comata	4.64	7.30	0 - 24	64.00	6.56	13.85	4
Stipa viridula	1.28	2.01	0 - 14	22.00	2.25	4.27	13
Sub-total	22.66	35.63					
WARM SEASON PERENNIAL GRASSES							
Aristida purpurea	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Bouteloua gracilis	8.48	13.33	0 - 20	92.00	9.43	22.76	2
Calamovilfa longifolia	0.56	0.88	0 - 10	16.00	1.64	2.52	16
Sporobolus cryptandrus	0.08	0.13	0 - 4	2.00	0.20	0.33	31
Sub-total	9.16	14.40					
INTRODUCED PERENNIAL GRASSES							
Agropyron cristatum	0.20	0.31	0 - 8	4.00	0.41	0.72	29
Agropyron intermedium	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Poa pratensis	0.20	0.31	0 - 6	6.00	0.61	0.93	26
Sub-total	0.44	0.69					
ANNUAL GRASSES							
Bromus japonicus	0.76	1.19	0 - 10	16.00	1.64	2.83	15

Table 3(cont'd). Cover Summary for 1997 Reynolds Ranch Sagebrush/Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Bromus tectorum	6.14	9.65	0 - 41	36.00	3.69	13.34	5
Festuca octoflora	1.80	2.83	0 - 20	30.00	3.07	5.90	10
Sub-total	8.70	13.68					
PERENNIAL FORBS							
Achillea millefolium	0.32	0.50	0 - 4	10.00	1.02	1.53	21
Antennaria sp.	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Arenaria hookeri	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Artemisia ludoviciana	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Aster paludosus	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Astragalus bisulcatus	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Astragalus spatulatus	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Cerastium arvense	0.24	0.38	0 - 4	8.00	0.82	1.20	24
Dalea purpurea	0.52	0.82	0 - 10	8.00	0.82	1.64	20
Gaura coccinea	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Grindelia squarrosa	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Heterotheca villosa	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Lygodesmia juncea	0.08	0.13	0 - 4	2.00	0.20	0.33	31
Machaeranthera tanacetifolia	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Penstemon albidus	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Penstemon sp.	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Phlox hoodii	0.80	1.26	0 - 12	22.00	2.25	3.51	14
Psoralea tenuiflora	0.44	0.69	0 - 6	14.00	1.43	2.13	19
Ratibida columnaris	0.36	0.57	0 - 4	16.00	1.64	2.21	18
Solidago missouriensis	0.08	0.13	0 - 4	2.00	0.20	0.33	31
Sphaeralcea coccinea	0.40	0.63	0 - 4	18.00	1.84	2.47	17
Taraxacum officinale	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Thermopsis rhombifolia	0.24	0.38	0 - 4	8.00	0.82	1.20	24
Vicia americana	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Sub-total	4.28	6.73					
ANNUAL AND BIENNIAL FORBS							
Alyssum alyssoides	0.04	0.06	0 - 2	2.00	0.20	0.27	32

Table 3(cont'd). Cover Summary for 1997 Reynolds Ranch Sagebrush/Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Alyssum desertorum	1.08	1.70	0 - 8	28.00	2.87	4.57	12
Camelina microcarpa	0.16	0.25	0 - 4	6.00	0.61	0.87	27
Gnaphalium palustre	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Polygonum species	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Tragopogon dubius	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Sub-total	1.44	2.26					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	0.96	1.51	0 - 8	34.00	3.48	4.99	11
Eriogonum microthecum	0.08	0.13	0 - 2	4.00	0.41	0.54	30
Gutierrezia sarothrae	0.20	0.31	0 - 4	8.00	0.82	1.13	25
Leptodactylon pungens	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Sub-total	1.28	2.01					
SHRUBS							
Artemisia cana	4.00	6.29	0 - 22	50.00	5.12	11.41	7
Artemisia pedatifida	0.44	0.69	0 - 6	14.00	1.43	2.13	19
Artemisia tridentata	10.84	17.04	0 - 34	80.00	8.20	25.24	1
Chrysothamnus viscidiflorus	0.04	0.06	0 - 2	2.00	0.20	0.27	32
Sub-total	15.32	24.09					
CACTI AND SUCCULENTS							
Opuntia polyacantha	0.32	0.50	0 - 10	8.00	0.82	1.32	23
Sub-total	0.32	0.50					
SUM OF SPECIES COVER	63.60						
Mosses	0.08		0 - 4	2.00			
Lichens	2.32		0 - 14	46.00			
TOTAL VEGETATION	66.64 +/-	9.16					
LITTER/ROCK	18.64 +/-	6.38					

Table 3(cont'd). Cover Summary for 1997 Reynolds Ranch Sagebrush/Grassland.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
BARE SOIL	15.04 +/-	8.88					
TOTAL COVER	85.28 +/-	9.13					
Number of Species/sample	9.76						

Table 4 Cover Summary for 1997 Reynolds Ranch Rock Outcrop.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	0.88	1.73	0 - 6	31.25	3.16	4.90	9
Carex filifolia	10.38	20.57	0 - 20	93.75	9.49	30.06	2
Juncus balticus	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Koeleria macrantha	1.63	3.22	0 - 6	50.00	5.06	8.29	7
Poa fendleriana	0.38	0.74	0 - 4	12.50	1.27	2.01	16
Poa sandbergii	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Stipa comata	5.88	11.65	0 - 20	81.25	8.23	19.88	3
Stipa viridula	0.38	0.74	0 - 2	18.75	1.90	2.64	15
Sub-total	19.75	39.16					
WARM SEASON PERENNIAL GRASSES							
Bouteloua gracilis	10.50	20.82	2 - 18	100.00	10.13	30.94	1
Calamovilfa longifolia	5.00	9.91	0 - 14	68.75	6.96	16.88	4
Sub-total	15.50	30.73					
INTRODUCED PERENNIAL GRASSES							
Poa pratensis	0.25	0.50	0 - 4	6.25	0.63	1.13	18
Sub-total	0.25	0.50					
ANNUAL GRASSES							
Bromus japonicus	0.25	0.50	0 - 4	6.25	0.63	1.13	18
Bromus tectorum	1.38	2.73	0 - 8	37.50	3.80	6.52	8
Festuca octoflora	0.38	0.74	0 - 2	18.75	1.90	2.64	15
Sub-total	2.00	3.97					
PERENNIAL FORBS							
Arenaria hookeri	0.25	0.50	0 - 4	6.25	0.63	1.13	18
Dalea candida	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Dalea purpurea	0.75	1.49	0 - 10	12.50	1.27	2.75	14
Eriogonum sp.	0.38	0.74	0 - 2	18.75	1.90	2.64	15

Table 4(cont'd). Cover Summary for 1997 Reynolds Ranch Rock Outcrop.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Gaura coccinea	0.38	0.74	0 - 4	12.50	1.27	2.01	16
Haplopappus armerioides	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Heterotheca villosa	2.38	4.71	0 - 6	62.50	6.33	11.04	5
Lygodesmia juncea	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Oenothera coronopifolia	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Oxytropis sp.	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Phlox hoodii	0.25	0.50	0 - 2	12.50	1.27	1.76	17
Psoralea tenuiflora	0.25	0.50	0 - 4	6.25	0.63	1.13	18
Ratibida columnaris	0.25	0.50	0 - 4	6.25	0.63	1.13	18
Thermopsis rhombifolia	0.50	0.99	0 - 2	25.00	2.53	3.52	11
Zigadenus venenosus	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Sub-total	6.13	12.14					
ANNUAL AND BIENNIAL FORBS							
Alyssum desertorum	0.50	0.99	0 - 4	18.75	1.90	2.89	13
Cynoglossum officinale	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Sub-total	0.63	1.24					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Eriogonum microthecum	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Eriogonum ovalifolium	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Eriogonum pauciflorum	0.50	0.99	0 - 4	18.75	1.90	2.89	13
Gutierrezia sarothrae	0.38	0.74	0 - 4	12.50	1.27	2.01	16
Leptodactylon pungens	0.44	0.87	0 - 2	25.00	2.53	3.40	12
Sub-total	1.69	3.35					
SHRUBS							
Artemisia cana	0.50	0.99	0 - 2	25.00	2.53	3.52	11
Artemisia pedatifida	0.13	0.25	0 - 2	6.25	0.63	0.88	19
Artemisia tridentata	0.25	0.50	0 - 2	12.50	1.27	1.76	17
Chrysothamnus viscidiflorus	0.25	0.50	0 - 2	12.50	1.27	1.76	17

Table 4(cont'd). Cover Summary for 1997 Reynolds Ranch Rock Outcrop.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Rhus trilobata	2.00	3.97	0 - 10	50.00	5.06	9.03	6
Sub-total	3.13	6.20					
CACTI AND SUCCULENTS							
Opuntia polyacantha	0.50	0.99	0 - 2	25.00	2.53	3.52	11
Yucca glauca	0.88	1.73	0 - 8	18.75	1.90	3.63	10
Sub-total	1.38	2.73					
SUM OF SPECIES COVER	50.44						
Lichens	1.63		0 - 4	56.25			
TOTAL VEGETATION	52.25 +/-	10.66					
LITTER/ROCK	14.75 +/-	5.70					
BARE SOIL	33.00 +/-	9.83					
TOTAL COVER	67.00 +/-	9.83					
Number of Species/sample	9.88						

Table 5. Comparison of 1997 Major Vegetative Parameters.

Area	Sample Parameter: Total Vegetation (% Absolute)	Total Cover (% Absolute)
Grassland	62.84	80.60
Sagebrush/ Grassland	66.64	85.28
Rock Outcrop	52.25	67.00

Table 6. Comparison of Relative Vegetation Cover Data, by Lifeform, between Areas.

Area	Annual Grasses	Perennial+ Grasses	Annual* Forbs	Perennial Forbs	Shrubs**	Cacti & Succulents
Grassland	5.27	81.02	1.09	7.56	4.65	0.41
Sagebrush/ Grassland	13.68	50.72	2.33	6.67	26.10	0.50
Rock Outcrop	3.97	70.39	1.24	11.90	9.79	2.73

+Includes cool season, warm season, and introduced grasses

*Includes annual and biennial forbs.

**Includes semi or half, and full shrubs.

Table 7. -1997 Reynolds Ranch Grassland Shrub Density Data Summary.

Project Name: Rio Algom
Vegetation Type: Baseline
Area Name: Grassland
Vegetation Parameter: Shrub Density

CATEGORY/SPECIES	SAMPLE NUMBER										MEAN	STANDARD DEVIATION
	1	2	3	4	5	6	7	8	9	10		
	11	12	13	14	15	16	17	18	19	20		
	21	22	23	24	25	26	27	28	29	30		
	31	32	33	34	35	36	37	38	39	40		
	41	42	43	44	45	46	47	48	49	50		
Half Shrubs												
Artemisia frigida	319	114	42	3	232	12	9	9	337	31	64.64	81.97
	30	3	5	149	11	38	85	81	16	33		
	1	199	2	22	7	218	7	4	61	1		
	13	9	3	31	36	76	46	4	3	90		
	16	137	148	16	10	172	94	35	163	49		
Eriogonum microthecum	0	0	0	0	0	0	0	6	0	0	0.38	1.62
	0	0	1	0	0	0	0	0	0	1		
	0	0	1	0	0	0	10	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
Gutierrezia sarothrae	0	0	0	0	0	0	0	2	0	0	0.98	4.62
	0	0	0	0	32	0	6	0	0	0		
	0	0	0	0	0	0	1	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
	7	0	0	0	0	1	0	0	0	0		
Leptodactylon pungens	0	0	0	0	0	0	0	0	0	0	1.20	4.15
	11	0	0	0	0	0	0	0	0	1		
	0	0	10	0	0	0	0	0	2	0		
	0	0	0	9	0	0	0	0	0	0		
	0	1	25	0	0	0	0	1	0	0		
TOTAL HALF SHRUBS	319	114	42	3	232	12	9	17	337	31	67.20	81.65
	41	3	6	149	43	38	91	81	16	35		
	1	199	13	22	7	218	18	4	63	1		
	13	9	3	40	36	76	46	4	3	90		
	23	138	173	16	10	173	94	35	163	49		
Full Shrubs												
Artemisia cana	0	9	59	2	0	46	2	0	3	41	13.14	22.24
	36	0	0	83	0	2	45	12	0	3		
	0	0	0	0	0	2	7	1	6	0		
	0	0	32	0	40	1	17	0	0	2		
	6	79	12	0	3	4	0	29	73	0		
Artemisia pedatifida	17	4	0	2	0	0	108	0	0	0	10.92	32.07
	0	0	0	0	3	3	0	0	2	0		
	0	0	0	0	157	18	0	1	0	0		
	128	0	0	0	15	60	0	6	0	0		
	4	0	0	0	7	11	0	0	0	0		
Artemisia tridentata	0	1	0	0	0	1	11	0	3	1	3.28	7.57
	1	2	0	0	1	23	10	1	1	0		
	1	2	0	10	1	0	0	0	0	0		
	12	0	1	0	9	1	0	0	2	42		
	0	0	0	0	1	0	1	2	23	0		
TOTAL FULL SHRUBS	17	14	59	4	0	47	121	0	6	42	27.34	37.68
	37	2	0	83	4	28	55	13	3	3		
	1	2	0	10	158	20	7	2	6	0		
	140	0	33	0	64	62	17	6	2	44		
	10	79	12	0	11	15	1	31	96	0		

TOTAL SHRUBS	336	128	101	7	232	59	130	17	343	73	94.54	89.27
	78	5	6	232	47	66	146	94	19	38		
	2	201	13	32	165	238	25	6	69	1		
	153	9	36	40	100	138	63	10	5	134		
	33	217	185	16	21	188	95	67	259	49		

TOTAL SHRUBS/HECTACRE:
6340.00

Table 8. 1997 Reynolds Ranch Sagebrush/Grassland Shrub Density Data Summary.
Project Name: Rio Algom
Vegetation Type: Baseline
Area Name: Sagebrush/Grassland
Vegetation Parameter: Shrub Density

CATEGORY/SPECIES	SAMPLE NUMBER										MEAN	STANDARD DEVIATION
	1	2	3	4	5	6	7	8	9	10		
	11	12	13	14	15	16	17	18	19	20		
	21	22	23	24	25	26	27	28	29	30		
	31	32	33	34	35	36	37	38	39	40		
	41	42	43	44	45	46	47	48	49	50		
Half Shrubs												
Artemisia frigida	0	33	47	0	37	31	47	67	45	58	32.70	37.41
	25	72	15	12	3	55	21	53	0	2		
	1	35	32	11	65	136	17	2	0	20		
	1	8	133	14	8	10	2	81	12	19		
	2	31	0	76	26	1	18	30	34	177		
Ceratoides lanata	0	0	0	0	0	0	0	0	0	0	0.04	0.28
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	2	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
Eriogonum microthecum	0	0	1	0	0	0	0	0	0	0	0.08	0.44
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	3	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
Gutierrezia sarothrae	3	8	0	1	0	23	1	0	3	6	4.76	14.38
	0	0	2	12	0	0	6	0	0	0		
	2	0	0	0	0	0	0	0	0	0		
	0	3	1	62	0	3	0	0	0	0		
	0	80	0	3	0	0	0	0	0	19		
Leptodactylon pungens	2	0	0	0	0	1	0	0	0	0	0.56	2.82
	0	0	0	0	0	0	20	2	0	0		
	0	0	0	0	0	0	0	0	0	1		
	0	0	0	0	0	0	0	0	0	0		
	0	2	0	0	0	0	0	0	0	0		
TOTAL HALF SHRUBS	5	41	48	1	37	55	48	67	48	64	38.14	40.82
	25	72	17	24	3	55	47	55	0	2		
	3	35	32	11	65	136	17	2	2	21		
	1	11	137	76	8	13	2	81	12	19		
	2	113	0	79	26	1	18	30	34	196		
Full Shrubs												
Artemisia cana	0	3	28	5	85	3	24	5	0	0	30.86	37.82
	62	0	1	0	38	13	20	77	68	62		
	4	90	5	2	143	2	126	81	4	22		
	53	7	0	12	7	13	69	0	100	2		
	75	0	72	0	21	0	78	3	58	0		
Artemisia pedatifida	19	0	0	0	0	44	0	0	2	0	4.66	12.86
	0	1	0	41	0	0	0	0	0	0		
	0	0	0	0	0	50	0	0	0	0		
	0	2	0	45	0	0	0	0	0	0		
	0	29	0	0	0	0	0	0	0	0		
Artemisia tridentata	115	57	20	106	0	82	93	128	108	122	57.96	43.95
	2	119	155	94	28	74	31	1	0	0		
	57	19	71	74	0	71	9	0	65	39		
	34	61	46	99	38	81	10	107	8	64		
	0	82	0	153	68	74	80	40	31	122		
Chrysothamnus nauseosus	0	0	0	0	0	0	0	0	0	0	0.10	0.70
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		

	0	0	0	5	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
Chrysothamnus viscidiflorus	0	0	0	0	0	1	0	0	0	2	1.22	3.97
	0	0	0	0	0	0	13	25	0	0		
	0	0	0	0	0	0	3	4	0	0		
	0	3	0	0	0	1	4	0	0	0		
	2	0	3	0	0	0	0	0	0	0		
Rosa woodsii	0	0	0	0	0	0	0	0	0	0	0.06	0.42
	0	0	0	0	0	0	0	0	3	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0		
TOTAL FULL SHRUBS	134	60	48	111	85	130	117	133	110	124	94.86	31.52
	64	120	156	135	66	87	64	103	71	62		
	61	109	76	76	143	123	138	85	69	81		
	87	73	46	161	45	95	83	107	106	55		
	77	91	75	153	89	74	138	43	89	122		
TOTAL SHRUBS	139	101	96	112	122	185	165	200	158	188	133.00	58.49
	89	192	173	159	89	142	111	168	71	54		
	64	144	108	87	208	259	155	87	71	82		
	88	84	183	237	53	108	85	188	120	85		
	79	204	75	232	115	75	156	73	123	318		

TOTAL SHRUBS/HECTACRE:
7452.00

Table 9. 1997 Reynolds Ranch Rock Outcrop Shrub Density Data Summary.
Project Name: Rio Algom
Vegetation Type: Baseline
Area Name: Rock Outcrop
Vegetation Parameter: Shrub Density

CATEGORY/SPECIES	SAMPLE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STANDARD DEVIATION
	11	12	13	14	15	16						
Half Shrubs												
Artemisia frigida	9	52	1	8	29	9	39	21	35	6	17.50	13.85
	21	9	6	10	11	14						
Eriogonum microthecum	0	0	0	1	0	0	0	0	0	4	0.81	1.33
	0	3	2	0	3	0						
Eriogonum pauciflorum	0	5	0	0	11	0	0	0	1	18	2.63	4.99
	0	1	0	0	6	0						
Gutierrizia sarothrae	0	3	27	3	2	0	4	0	1	2	5.25	6.83
	2	7	1	13	7	12						
Leptodactylon pungens	16	1	0	11	8	0	13	3	20	20	9.81	9.17
	18	0	0	9	32	6						
TOTAL HALF SHRUBS	25	53	1	19	37	9	52	24	55	26	27.31	16.84
	39	9	6	19	43	20						
Full Shrubs												
Artemisia cana	1	27	0	11	37	5	19	3	51	5	15.63	14.73
	35	17	0	14	5	20						
Artemisia pedatifida	0	0	17	0	0	10	0	0	0	0	2.44	5.23
	0	0	12	0	0	0						
Artemisia tridentata	1	0	0	0	0	0	2	4	5	1	1.38	1.87
	1	6	0	1	1	0						
Chrysothamnus viscidiflorus	2	0	0	0	11	0	8	2	1	0	2.13	3.72
	0	0	0	0	0	10						
Rosa woodsii	6	0	0	0	0	7	0	0	0	0	0.81	2.16
	0	0	0	0	0	0						
Rhus trilobata	0	24	0	11	21	0	42	29	0	16	10.38	12.49
	14	2	0	4	2	1						
TOTAL FULL SHRUBS	10	51	17	22	69	22	71	38	57	22	32.75	20.05
	50	25	12	19	8	31						
TOTAL SHRUBS	35	104	18	41	106	31	123	62	112	48	60.06	33.90
	89	34	18	38	51	51						

TOTAL SHRUBS/HECTACRE:
6675.00

Table 10. Sample Adequacy of Derived Data.

AREA	MEAN	STANDA DEVIATIO	SAMPLE ADEQUAC	Z VALUE	ACTUAL SAMPLE	CONFIDENC LEVEL ACHIEVED
Grassland						
VEGETATION CO	62.84	10.07	8.41	N/A	50.00	N/A
TOTAL COVER	83.30	15.96	12.03	N/A	50.00	N/A
Sagebrush/Grassland						
VEGETATION CO	56.64	9.16	6.19	N/A	50.00	N/A
TOTAL COVER	85.28	9.13	3.76	N/A	50.00	N/A
Rock Outcrop						
VEGETATION CO	52.25	10.65	13.64	N/A	16.00	N/A
TOTAL COVER	67.00	9.83	7.05	N/A	16.00	N/A

Addendum 1

Correspondence

To: Rich Vincent, LQD
From: Paige Wolken, BKS
RE: FYI - Summarization of Rio Algom Baseline Vegetation Sampling for Reynolds Ranch

Sample adequacy was obtained for cover within the minimum 50 samples for each major vegetation type, Grassland and Sagebrush Grassland. The number of shrub density transects equalled the number of cover transects regardless of sample adequacy.

Two minor vegetation types, Rock Outcrop and Playa were also sampled for cover and shrub density. Sample adequacy was achieved at 16 samples for cover in the Rock Outcrop vegetation type (a minimum of 15 samples were required). Contrary to approved methodology, the minimum 15 cover/shrub samples were collected for the Playa vegetation type regardless of sample adequacy due to the following reasons:

1) During the sampling process, vegetation types previously mapped in the fall of 1996 were confirmed or adjusted. Playa acreage was previously estimated at 17.36 acres; however, based on detailed field observations, a total of seven playas were noted. The playas observed were small upland pockets, the largest of which was approximately 1 acre in size. The actual sizes of these scattered sites (likely averaging 0.4 to 0.5 acres each; 3.5 acres total) within an expansive study area were, at best, inclusions.

2) In two or three cases, 50 meter transects were placed in areas 40 to 50 meters in diameter. The smaller acreages involved did not lend themselves to higher sampling numbers.

3) Due to frequent precipitation events, five of the seven playas contained muddy standing water. Cover transects were sampled; however, much of the data was biased by standing water obscuring visual hits below the water level. Water was noted as a separate cover category in these cases.

RICH VON PLAYAS (RIO ALG) 9-23-97 @1030hr phone
- KEEP DATA BUT DON'T SUMMARIZE
- DESCRIBE IN TEXT

MEMORANDUM

TO: Matt Jankovsky, District I Senior Analyst

FROM: Richard Vincent, Support Staff Senior Analyst RV

DATE: April 29, 1997

SUBJECT: Review Comments for TFN 3 5/131, Rio Algom, 1997 Vegetation Baseline Sampling

I have reviewed the information submitted in the four page proposal pertaining to the 1997 vegetation baseline sampling. I thought that Brenda had said during our 4/10/97 telephone conversation that she was proposing to sample production. I recall that during July and September of 1996 we discussed omitting sampling for vegetation production. Since this plan applies only to sampling of this particular amendment area and only to baseline sampling, I concur with the sampling plan and recommend approval so 1997 field sampling can proceed. If you have questions about my conclusions please contact me.

The Nature Conservancy
Wyoming Natural Diversity Database
1604 Grand Ave., Suite 2 • Laramie, Wyoming 82070 • (307) 745-5026

April 23, 1997

Vera A. Finch and Paige M. Wolken
BKS Environmental Associates, Inc.
P.O. Box 3467
Gillette, WY 82717-3467

Dear Vera and Paige:

Per your letter of April 11, 1997, requesting data on plant species located in townships 36-37N and ranges 73-74W for the Rio Algom Baseline Vegetation project, I have searched our database and no records were retrieved. However, for the following reasons, this does not mean that species of concern are not located within the specified townranges: 1. Both plant and animal populations are mobile, and occurrences in neighboring areas may have moved into your target area; 2. This area of Wyoming has not been recently surveyed for **all** T/E species that may occur; 3. Suitable habitat may be present in the target area for species found immediately outside its boundaries. Therefore, adequate pre-project TES screening for plants requires site surveys with collecting visits scheduled throughout the growing season.

Please feel free to call myself or Walt with any questions you may have regarding this letter.

Sincerely,

Laura Gianakos
Administrative and Database Assistant

Rio Algom Mining Corp.

Smith Ranch Uranium Project

Pamela S. French
Supervisor, Radiation Safety & Environmental Affairs

April 14, 1997

Mr. Matt Jankovsky
WDEQ/LQD
Herschler Building
122 West 25th Street
Cheyenne, WY 82002

Re: Reynolds Ranch Vegetation Sampling

Dear Matt:

Please find attached the "methodology letter for the vegetation sampling" for the Reynolds Ranch area. Brenda Schladweiler and Rich Vincent have discussed the approach as outlined, and Rich seemed comfortable with the approach.

I apologize for the time it has taken to get this together. As we have discussed, the methodology does not include production sampling.

If you have questions or concerns, please feel free to contact me at (307) 358-3744.

Sincerely,

Pamela S. French
Supervisor, Radiation Safety &
Environmental Affairs

cc: F. W. Ferdinand
M. D. Freeman
B. K. Schladweiler (BKS Environmental)

P.O. Box 1390 • Glenrock, Wyoming 82637 762 Ross Road • Douglas, Wyoming 82633
Phone (307) 358-3744 or (307) 266-2449 • Fax (307) 358-9201

BKS ENVIRONMENTAL
ASSOCIATES, INC.

P.O. Box 3467
Gillette, WY 82717-3467
(307) 682-3810
Fax (307) 682-0125

P.O. Box 6021
Laramie, WY 82070-6021
(307) 721-5179
Fax (307) 721-5179

April 10, 1997

Mr. Matt Jankovsky
WDEQ-LQD
Herschler Building
122 West 25th
Cheyenne, WY 82001

Dear Matt:

Per our previous discussions, attached is the proposed vegetation methodology for the fieldwork associated with the Reynold's Ranch baseline vegetation assessment for Rio Algom Mining Corporation. This methodology does not include production sampling, per our previous discussions and your subsequent discussion with Pam French, Rio Algom Mining Corporation.

I would appreciate any "short turn-around" comments you may have by May 1 since we are formulating spring/summer 1997 fieldwork plans. Thank you for your input. If you have any questions, please feel free to contact me in Laramie at (307)721-5179.

Sincerely,

Brenda K Schladweiler

Brenda K. Schladweiler
BKS ENVIRONMENTAL ASSOCIATES, INC.

cc. Pam French, Rio Algom Mining Corporation
Paige Wolken, BKS - Gillette

1997 Vegetation Sampling Methodology
Rio Algom Mining Corporation's Reynold's Ranch Property
April 10, 1997

General

Preliminary baseline vegetation mapping of the Rio Algom Mining Corporation's Reynold's Ranch Property was conducted in the Fall of 1996. Based on the September 1996 meeting between Rio Algom, WDEQ, and BKS Environmental personnel, as well as subsequent phone conversations, the following proposed vegetation sampling methodology is proposed. BKS Environmental Associates, Inc. will conduct the 1997 sampling.

Mapping

All vegetation community types were delineated on a topographic base map at a scale of 1":500'. Small areas of mapping will be refined during cover/shrub density sampling in 1997, if necessary. A tabular summary of the approximate acreage of each vegetation mapping unit within the proposed permit extension area, based on this preliminary mapping, is as follows:

Vegetation Type	Permit Extension Acreage
Grassland	7,295.35
Sagebrush Grassland	6,044.86
Rock Outcrop	82.44
Playa	17.36
TOTAL	**13,440.00**

Species List

A species list for the 1997 study area will be compiled. All nomenclature will follow that currently in use at the Rocky Mountain Herbarium in Laramie, Wyoming. Any encountered federally designated threatened and endangered species, state plants of concern, noxious weeds, and primary selenium indicators will be identified. A computer search of the Wyoming Natural Heritage database will be conducted prior to fieldwork to determine possible habitat for rare species.

1997 Vegetation Sampling Methodology
Rio Algom Mining Corporation's Reynold's Ranch Property (cont.)
April 10, 1997

Reference Area

Since the exact mine disturbance limit is not known at this time, during the 1997 assessment, the extended reference area approach will be utilized in order to minimize the total number of sample points. Sample points will be located within the entire proposed Reynold's Ranch permit area by vegetation type regardless of the location of the proposed affected area. This approach is different than the 1992 study area which consisted of the disturbed area plus a 2000' buffer. Data summarization will not be separated for affected area and the extended reference area, i.e., the data will be treated as one set. Summarization by vegetation type, however, will be performed, i.e., four vegetation types.

Qualitative Description

All disturbed areas within the 1997 proposed permit area will be qualitatively described. Possible "wetlands", too small to be mapped at the current scale, will be delineated on the vegetation map, wherever located. Small, unmappable pockets within ephemeral drainages will be described in the text only and will not be included in any vegetation sampling.

Quantitative Description

Four vegetation types will be sampled within the 1997 proposed permit area: Grassland, Sagebrush Grassland, Rock Outcrop and Playa. Both the extended reference area and affected area will be sampled in 1997 as one unit. Minimum and maximum sample numbers for this project will follow those discussed during the September 1996 meeting and will be as outlined in the table below.

Cover

A minimum of 50 transects for cover will be sampled within each of the Grassland and Sagebrush Grassland vegetation types within the combined affected area/extended reference area. A minimum of 15 transects for cover will be sampled within each of the Rock Outcrop and Playa vegetation types within the combined affected area/extended reference area. If statistical adequacy is not obtained with the minimum number, additional samples will be collected in increments up to the maximum number of 100, if necessary, for the Grassland and Sagebrush Grassland vegetation types. The maximum number for Rock Outcrop and Playa vegetation types will be 30. All field sampling for cover will occur after June 15, 1997, depending upon overall weather conditions.

Cover (cont.)

Vegetation Type	Combined AFFA and EXREFA Number of Cover and Shrub Density Transects	
	Minimum	Maximum
Grassland	50	100
Sagebrush Grassland	50	100
Rock Outcrop	15	30
Playa	15	30
TOTAL	**130**	**260**

Note: Maximum number may be less, based on sample adequacy calculations.

Sample locations for cover will be chosen by randomly selecting points within a grid of the 1997 proposed permit area. Grid intervals will not exceed 100 feet on the ground. Random sample location coordinates will be plotted on a map and located in the field by pacing from known localities. Random numbers between 1 and 360 will be generated to orient the transect. A compass will then be used in the field to orient the transect to the nearest 1/8 of 360 degrees.

Sample hits will be read at 1 meter intervals along the entire length of the 50 meter transect. These first hit (50) readings will constitute the absolute cover values for total vegetation and total cover. In addition, litter, rock and bare ground percentages will be recorded. Transects that exceed designated vegetation boundaries will be randomly reoriented to be within the sampled type.

Production

No production sampling will be necessary for the 1997 baseline vegetation assessment.

Shrub Density

Even though shrub density sampling is not required for non-coal sites, this data will be taken at the time of cover sampling to ensure adequate use of field time. However, it is assumed that this area is not part of any wildlife critical winter range.

Shrub Density (cont.)

Shrub density data will be collected in conjunction with randomly selected cover transects, wherever possible. All shrubs, full or half, will be counted within 50 centimeters either side of the 50 meter cover transect (1 meter x 50 meter belt transect). Sample adequacy will not be calculated on shrub density transects; the number of belt transects will equal the number of cover transects for a given vegetation type. No shrub height measurements will be collected.

Tree Density

Due to the general sparsity or lack of tree individuals within the proposed permit area, a complete census will be taken, where appropriate. Tree height will be determined by use of a clinometer, where appropriate. Tree diameter at breast height will be determined by a diameter tape, where appropriate. All tree locations (individuals or groups) within the proposed permit area will be plotted on the vegetation map.

This vegetation sampling methodology correctly documents previous discussion as stated above and is hereby approved.

Matt Jankovsky
WDEQ, Land Quality Division

Addendum 2

Photographs of Vegetation Types

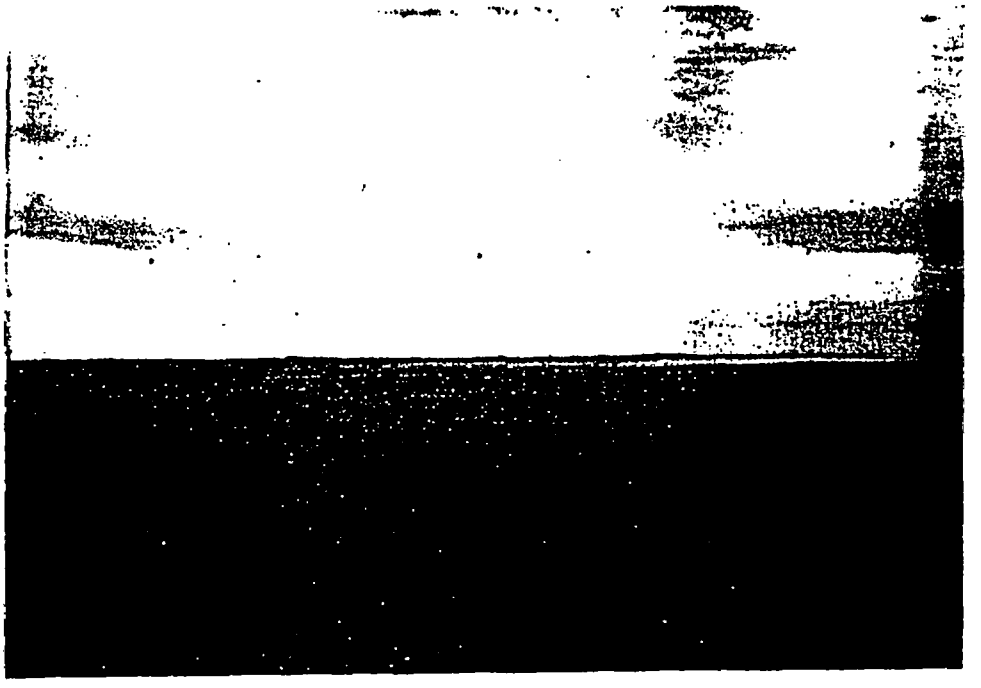

Photo 1. Grassland

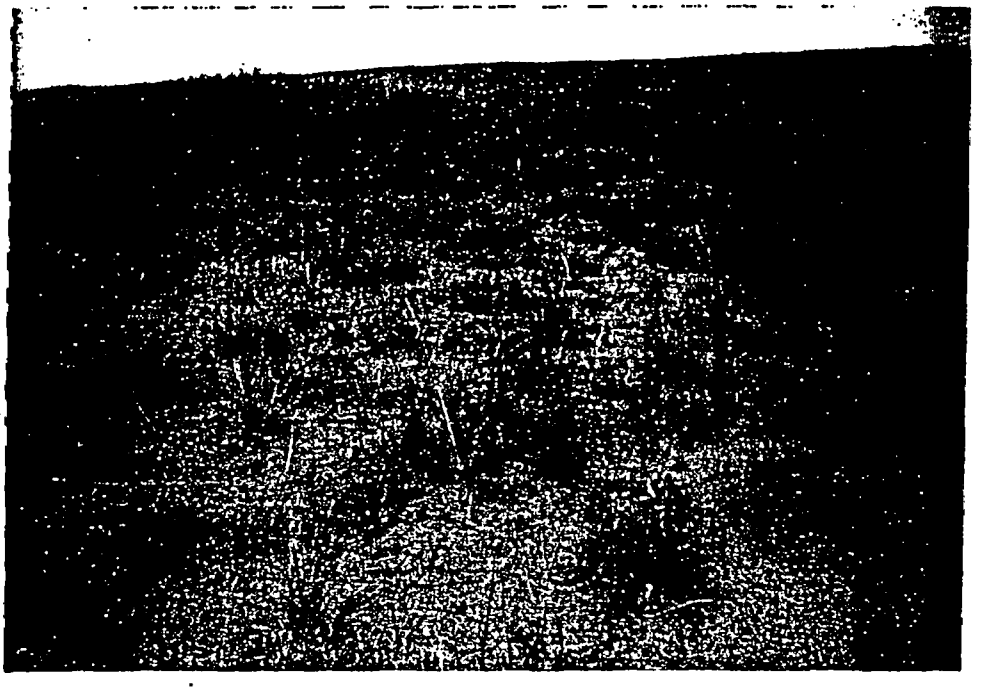

Photo 2. Grassland Sand Blowout Inclusion

Photo 3. Sagebrush/Grassland

Photo 4. Rock Outcrop

Addendum 3

1997 Plant Species List

1997 Plant Species Encountered during the Rio Algom Reynolds Ranch Baseline Sampling.

Scientific Name	Common Name	Family Name
COOL SEASON PERENNIAL GRASSES		
Agropyron dasystachyum	Thickspike Wheatgrass	Poaceae
Agropyron riparium	Streambank Wheatgrass	Poaceae
Agropyron smithii	Western Wheatgrass	Poaceae
Carex eleocharis	Sedge	Cyperaceae
Carex filifolia	Threadleaf Sedge	Cyperaceae
Hordeum jubatum	Foxtail Barley	Poaceae
Juncus balticus	Baltic Rush	Juncaceae
Koeleria macrantha	Prairie Junegrass	Poaceae
Orysopsis hymenoides	Indian Ricegrass	Poaceae
Poa compressa	Canada Bluegrass	Poaceae
Poa fendleriana	Bluegrass	Poaceae
Poa sandbergii	Sandberg Bluegrass	Poaceae
Sitanion hystrix	Big Squirrel Tail	Poaceae
Stipa comata	Needle-and-thread Grass	Poaceae
Stipa viridula	Green Needle Grass	Poaceae
WARM SEASON PERENNIAL GRASSES		
Aristida longiseta	Three-awn	Poaceae
Aristida purpurea	Purple Three-awn	Poaceae
Bouteloua curtipendula	Side Oats Grama	Poaceae
Bouteloua gracilis	Blue Grama	Poaceae
Calamovilfa longifolia	Prairie Sandreed	Poaceae
Sporobolus cryptandrus	Sand Dropseed	Poaceae
INTRODUCED PERENNIAL GRASSES		
Agropyron cristatum	Crested Wheatgrass	Poaceae
Agropyron intermedium	Intermediate Wheatgrass	Poaceae
Poa pratensis	Kentucky Bluegrass	Poaceae
ANNUAL GRASSES		
Bromus japonicus	Japanese Brome	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Festuca octoflora	Fescue	Poaceae

1997 Plant Species Encountered during the Rio Algom Reynolds Ranch Baseline Sampling (cont.)

Scientific Name	Common Name	Family Name
PERENNIAL FORBS		
Achillea millefolium	Common Yarrow	Asteraceae
Antennaria sp.	Pussytoes	Asteraceae
Arenaria hookeri	Hooker Sandwort	Caryophyllaceae
Artemisia ludoviciana	Louisiana Sagewort	Asteraceae
Aster paludosus	Singlestem Aster	Asteraceae
Astragalus bisulcatus	Two-grooved Milkvetch	Fabaceae
Astragalus spatulatus	Milkvetch	Fabaceae
Cerastium arvense	Mouse-ear Chickweed	Caryphyllaceae
Dalea candida	Whte Prairie Clover	Fabaceae
Dalea purpurea	Purple Prairie Clover	Fabaceae
Eriogonum sp.	Daisy	Polygonaceae
Gaura coccinea	Scarlet Gaura	Onagraceae
Grindelia squarrosa	Curlycup Gumweed	Asteraceae
Haplopappus armerioides	Thrifty Goldenweed	Asteraceae
Heterotheca villosa	Golden Aster	Asteraceae
Hymenopappus polycephalus	L'Her	Asteraceae
Lygodesma juncea	Skeleton Plant	Asteraceae
Machaeranthera grindelioides	Goldenweed	Asteraceae
Machaetanthera tanacetifolia	Tansy Aster	Asteraceae
Oenothera coronopifolia	Evening Primrose	Onagraceae
Oxytropis sp.	Locoweed	Fabaceae
Penstemon albidus	White Beardtongue	Scrophulariaceae
Penstemon sp.	Penstemon	Scrophulariaceae
Plox hoodii	Hood's Phlox	Polemoniaceae
Psoralea tenuiflora	Slimflower Scurfpea	Fabaceae
Ratibida columnaris	Prairie Coneflower	Asteraceae
Solidago missouriensis	Prairie Goldenrod	Asteraceae
Sphaeralcea coccinea	Scarlet Globe Mallow	Malvaceae
Taraxacum officinale	Common Dandelion	Asteraceae
Thermopsis rhombifolia	Golden Banner	Fabaceae
Vicia americana	American vetch	Fabaceae
Zigadenus venenosus	Meadow Death Camas	Iridaceae

1997 Plant Species Encountered during the Rio Algom Reynolds Ranch Baseline Sampling (cont.)

Scientific Name	Common Name	Family Name
ANNUAL AND BIENNIAL FORBS		
Alyssum alyssoides	Pale alyssum	Brassicaceae
Alyssum desertorum	Desert Alyssum	Brassicaceae
Camelina microcarpa	Littleseed Falseflax	Brassicaceae
Cynoglossum officinale	Hound's Tongue	Boraginaceae
Gnaphalium palustre	Diffuse Cudweed	Asteraceae
Plantago patagonica	Pursh's Plantain	Plantaginaceae
Polgonum sp.	Knotweed	Polygonaceae
Tragopogon dubius	Yellow Salsify	Asteraceae
SEMI-SHRUBS OR HALF SHRUBS		
Artemisia frigida	Fringed Sagewort	Asteraceae
Ceratoides lanata	Winterfat	Chenopidiaceae
Eriogonum microthecum	Slenderbush Wild Buckwheat	Polygonaceae
Erigonum ovalifolium	Cushion Wild Buckwheat	Polygonaceae
Eriogonum pauciflorum	Wild Buckwheat	Polygonaceae
Gutierrizia sarothrae	Broom Snakeweed	Asteraceae
Leptodactylon pungens	Prickly Gilia	Polemoniaceae
SHRUBS		
Artemisia cana	Silver Sagebrush	Asteraceae
Artemisia nova	Black Sagebrush	Asteraceae
Artemisia pedatifida	Birdfoot Sagebrush	Asteraceae
Artemisia tridentata	Big Sagebrush	Asteraceae
Chrysothamnus nauseosus	Rubber Rabbitbrush	Asteraceae
Chrysothmnus viscidiflorus	Douglas Rabbitbrush	Asteraceae
Rhus trilobata	Skunkbush Sumac	Anacardiaceae
Rosa woodsii	Woods Rose	Rosaceae
CACTI AND SUCCULENTS		
Opuntia polyacantha	Plains Prickleypear	Cactaceae
Yucca glauca	Spanish Bayonet	Agavaceae
LICHENS AND MOSSES		
Lichens		
Mosses		

1997 Plant Species Encountered during the Rio Algom Reynolds Ranch Baseline Sampling (cont.)

NOTE: According to nomenclature in use at the Rocky Mountain Herbarium in Laramie, Wyoming, the following species of Agropyron have been changed to the following taxonomic descriptions:

Agropyron dasystachyum= Elymus lanceolatus var. lanceolatus
Agropyron riparium= Elymus lanceolatus var. riparius
Agropyron smithii= Elymus smithii
Agropyron spicatum= Elymus spicatus
Agropyron trachycaulum= Elymus trachycaulus var. trachycaulus