

## **APPENDIX 3.3-A**

### **Baseline Soils Assessment**

This page intentionally left blank

2007 BASELINE SOILS ASSESSMENT  
POWERTECH USA, INC.  
DEWEY-BURDOCK URANIUM PROJECT  
REGULAR MINE PERMIT APPLICATION

Submitted to:

POWERTECH (USA) INC  
5575 DTC Parkway, Suite 140  
Greenwood Village, Colorado 80111

Submitted by:

BKS ENVIRONMENTAL ASSOCIATES, INC.  
P.O. Box 3467  
Gillette, Wyoming 82717-3467

January 5, 2009

This page intentionally left blank

## TABLE OF CONTENTS

<b>Description</b>	<b>Page</b>
D-7.1 EXECUTIVE SUMMARY .....	D7-1
D-7.2 INTRODUCTION .....	D7-1
D-7.3 METHODOLOGY .....	D7-2
D-7.3.1 Review of Existing Literature .....	D7-2
D-7.3.2 Project Participants .....	D7-2
D-7.3.3 Soil Survey .....	D7-2
D-7.3.4 Field Sampling .....	D7-2
D-7.3.5 Laboratory Analysis .....	D7-3
D-7.4 RESULTS AND DISCUSSION .....	D7-3
D-7.4.1 Soil Survey - General .....	D7-3
D-7.4.2 Soil Mapping Unit Interpretation .....	D7-3
D-7.4.3 Analytical Results .....	D7-3
D-7.4.4 Evaluation of Soil Suitability as a Plant Growth Medium .....	D7-4
D-7.4.5 Topsoil Volume Calculations .....	D7-4
D-7.4.6 Soil Erosion Properties and Impacts .....	D7-4
D-7.4.7 Prime Farmland Assessment .....	D7-4
D-7.5 REFERENCES .....	D7-5

<b>List of Tables</b>	<b>Page</b>
Table D-7.1.1 Soil Mapping Unit Acreages .....	D7-7
Table D-7.1.2 Soil Series Sample Summary .....	D7-9
Table D-7.1.3 Soil Sample Locations .....	D7-10
Table D-7.1.4 Summary of Marginal and Unsuitable Parameters within Sampled Profiles ..	D7-11
Table D-7.1.5 Summary of Trends in Marginal and Unsuitable Parameters for Soil Series..	D7-15
Table D-7.1.6 Summary of Approximate Soil Salvage Depths .....	D7-16
Table D-7.1.7 Summary of Wind and Water Erosion Hazards .....	D7-17

<b>Addenda</b>	<b>Page</b>
Addendum D-7-A Dewey-Burdock Tables .....	D7-6
Addendum D-7-B Soil Mapping Unit Descriptions .....	D7-18
Addendum D-7-C Sampled Soil Series Descriptions .....	D7-57
Addendum D-7-D Original Laboratory Data Sheets .....	D7-135
Addendum D-7-E Prime Farmland Designation .....	D7-150
Addendum D-7-F Photographs .....	D7-169
Addendum D-7-G Maps .....	D7-197

## **D-7 SOILS**

### **D-7.1 EXECUTIVE SUMMARY**

The Powertech Dewey-Burdock Uranium permit area was evaluated by BKS Environmental Associates, Inc., Gillette, Wyoming in 2007. A total of 10,557.03 acres were included in the final soil mapping of the Dewey-Burdock Uranium permit area. Soils mapped by BKS Environmental Associates, Inc. are illustrated in Addendum D-7-G.

Stripping depths for the Dewey-Burdock Uranium permit area were evaluated during mapping and sampling. Soil depths within a given mapping unit will vary based on any combination of the five primary soil forming factors, i.e., climate including effective precipitation, organisms, relief or topography, parent material, and time. Subtle differences in any one of the previously mentioned factors will impact development between series and within series designation but may not be as noticeable as when topography is a major factor. The proposed topsoil salvage depths for the Dewey-Burdock Uranium permit area are based on laboratory data of the samples found within the borders of the area, as well as field observations and knowledge of the soils in Custer and Fall River Counties, South Dakota.

Soils in the Dewey-Burdock Uranium permit area are typical for semi-arid grasslands and shrublands in the Western United States. Parent material included colluvium, residuum, and alluvium. Most soils are classified taxonomically as Aridic Argiustolls, Aridic Ustorthents, and Aridic Haplusterts.

Almost all soils have some suitable topsoil. The primary limiting factors within the Dewey-Burdock Uranium permit area are EC-electrical conductivity, SAR-sodium adsorption ratio, calcium carbonates, and texture (clay percentage).

Refer to Addendum D-7-A for the Dewey-Burdock Tables. Refer to Addendum D-7-B for the Soil Mapping Unit Descriptions. Refer to Addendum D-7-C for the Soil Series Descriptions. Refer to Addendum D-7-D for the Original Laboratory Data Sheets. Refer to Addendum D-7-E for the Prime Farmland Designation. Refer to Addendum D-7-F for the Site Photographs.

### **D-7.2 INTRODUCTION**

The proposed 10,557.03 acre permit area was investigated for baseline soils information in support of a Nuclear Regulatory Commission (NRC) Source Materials License and South Dakota Department of Environmental and Natural Resources (SD DENR) Regular Mine Permit Application. The project is located approximately seven to ten miles north of Edgemont, South Dakota.

The Dewey-Burdock Uranium permit area is located in all or parts of:

- Township 6S, Range 1E, Sections 20-21 and 27-35.
- Township 7S, Range 1E, Sections 1-5, 10-12, and 14-15.

Large scale soil surveys had been previously conducted by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) in 1982 and 1990. The major objective of the 2007 assessment was to define the existing topsoil resource within the Dewey-Burdock Uranium permit area and determine the extent, availability, and suitability of soils material for use in reclamation.

The mapping and reporting for the Dewey-Burdock Uranium permit area incorporated map unit information from the previous NRCS soil surveys. The number of necessary soil samples was determined from Guideline No. 1 (original November, 1984 and updated August, 1994) of the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD), since the state of South Dakota does not have specific requirements.

### **D-7.3 METHODOLOGY**

#### **D-7.3.1 Review of Existing Literature**

The soils in this portion of Custer and Fall River Counties were studied and mapped to an Order 2 scale by the USDA, NRCS in 1982 and 1990. Information for Custer and Fall River Counties is available electronically as well as hard copy. The NRCS has also centralized dissemination of typical soil series descriptions; general information is available on the internet at [www.nrcs.usda.gov](http://www.nrcs.usda.gov).

#### **D-7.3.2 Project Participants**

BKS performed the 2007 soil survey field work and compiled the resulting report. All soil analysis was handled by Energy Labs in Gillette, Wyoming.

#### **D-7.3.3 Soil Survey**

Construction of the project area soil map was completed according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (August, 1994 Revision) of the WDEQ-LQD was followed during all phases of the work.

A total of 10,557.03 acres were included in the final soil mapping of the Dewey-Burdock Uranium permit area, in which 3,065.74 of those acres were located in disturbance areas. Refer to Table D-7.1.1 for soil mapping unit designations and associated acreage within the Dewey-Burdock Uranium permit area. Table D-7.1.1 also describes the soil map units in terms of actual map designations and slope percentages.

#### **D-7.3.4 Field Sampling**

Soil series were sampled to reflect recommended sample numbers in WDEQ Guideline 1 (August 1994 Revision) based on mapping acreage. Most samples were taken either in or near disturbed areas. Additional sampling of soils in the permit area will occur as the operation is expanded outside the current disturbed areas.

Series were sampled and described by coring with a mechanical auger, i.e., truck-mounted Giddings. The physical and chemical nature of each horizon within the sampled profile was described and recorded in the field. Each hole augered for series and map unit verification was plotted on the soils map included with this report. Sampled soil material was placed in clean, labeled, polyethylene plastic bags and kept cool to limit chemical changes. Samples were kept out of direct sunlight and transported to Energy Labs for analysis. A total of 37 sites on the Dewey-Burdock Uranium permit area were sampled for analysis; all had corresponding soil profile descriptions written. Refer to Table D-7.1.2 Soils Series Sample Summary and Table D-7.1.3 Soil Sample Locations.

#### **D-7.3.5 Laboratory Analysis**

Samples were individually 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 Labs. Approximately 10 percent of the samples are run for duplicate analysis. Actual laboratory analysis follows the methodology outlined in WDEQ-LQD Guideline 1 (August 1994 Revision). In general, samples were analyzed within 45 days of receipt of the samples at the laboratory. All analytical data is presented in Addendum D-7-D, Original Laboratory Data Sheets.

### **D-7.4 RESULTS AND DISCUSSION**

#### **D-7.4.1 Soil Survey - General**

General topography of the area ranged from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the Dewey-Burdock Uranium permit area were generally a clayey or very fine texture throughout with patches of sandy loam on upland areas and fine, clay textured soils occurring in or near drainages. The project area contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks.

#### **D-7.4.2 Soil Mapping Unit Interpretation**

The primary purpose of the 2007 fieldwork was to characterize the soils within the permit area in terms of topsoil salvage depths and related physical and chemical properties. The total number of samples per series was established in line with WDEQ Guideline 1 (August 1994 Revision) recommendations based on estimated acreage of soil series known within the Dewey-Burdock Uranium permit area. Refer to Addendum D-7-B and D-7-C for soil mapping unit descriptions and soil series descriptions, respectively.

#### **D-7.4.3 Analytical Results**

Analyzed parameters, as defined in WDEQ Guideline 1 (August 1994 Revision), are in

Addendum D-7-D, Original Laboratory Data Sheets. Laboratory soil texture analysis did not include percent fine sands. Field observations of fine sands within individual pedestals as well as sample site topographic position were used in conjunction with laboratory analytical results to determine series designation. Where applicable, field observation of fine sands is also included in the textures found in the soil series descriptions in Addendum D-7-C. In several of the pedestal sampling locations, laboratory analysis yielded finer or coarser than expected textures (based upon field observations). Where textures are finer or coarser than typical for the series, it is noted in the Range of Characteristics (according to field observations, lab analysis) in the soil series descriptions.

#### **D-7.4.4 Evaluation of Soil Suitability as a Plant Growth Medium**

Approximate salvage depths of each map unit series is presented in Table D-7.1.6 and ranged from 0.0 to 5.0 feet. Within the Dewey-Burdock Uranium permit area, suitability of soil as a plant growth medium is generally affected by physical factors such as texture (clay percentage) and saturation percentage. Chemical limiting factors included selenium (Se), calcium carbonate content (based upon field observations of strong or violent effervescence), SAR, EC, pH, and boron (B). Marginal material, according to WDEQ Guideline 1, was found in 30 of the 37 profiles. Unsuitable material, according to WDEQ Guideline 1, was found in 15 of the 37 profiles. Marginal or unsuitable parameter information for sampled profiles is identified in Table D-7.1.4. A summary of trends in marginal or unsuitable parameters as it relates to soil series is found in Table D-7.1.5. Based on laboratory analysis and field observations, marginal material parameters primarily consisted of texture (clay percentage), calcium carbonates, EC, and SAR.

#### **D-7.4.5 Topsoil Volume Calculations**

Based on the 2007 fieldwork with associated field observations and subsequent chemical analysis, the recommended topsoil average salvage depth over the Dewey-Burdock Uranium permit area was determined to be 1.63 feet. Refer to Table D-7.1.6, Summary of Approximate Soil Salvage Depths.

#### **D-7.4.6 Soil Erosion Properties and Impacts**

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the Dewey-Burdock Uranium permit area varies from negligible to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the very fine and clayey texture of the surface horizons throughout the majority of the Dewey-Burdock Uranium permit area, the soils are more susceptible to erosion from water than wind. See Table D-7.1.7 for a summary of wind and water erosion hazards within the Dewey-Burdock Uranium permit area.

#### **D-7.4.7 Prime Farmland Assessment**

Prime farmland was assessed by Dan Shurtliff, the Acting State Soil Scientist out of Huron, South Dakota. The following sections in T6S R1E contain prime farmland if irrigated: Sections

27, 30, 31, 32, 34, and 35. The following sections in T7S R1E contain prime farmland if irrigated: Sections 1, 3, 4, 5, 10, 12, 14, and 15. The following sections in T7S R1E contain farmland of statewide importance: Sections 2, 3, 4, 5, 10, 11, 12, 14, and 15. See Addendum D-7-E for prime farmland designation. The following soil series have been listed as Prime farmland if irrigated: Alice, Ascalon, Barnum, Boneek, Haverson, Norka, Nunn, Satanta, and Tilford. The following soil series have been listed as Farmland of statewide importance: Kyle, Lohmiller, Nunn, Pierre, Satanta, and Stetter.

#### **D-7.5 REFERENCES**

U.S. Department of Agriculture 1975. Soil Taxonomy. U.S. Dept. of Agric. Handbook 436, 754 pp. Government Printing Office.

U.S. Department of Agriculture 1993. Soil Survey Manual. U.S. Dept. of Agric. Handbook 18, 437 pp. Government Printing Office.

Wyoming Department of Environmental Quality, Land Quality Division. 1994. Guideline 1, Topsoil and Overburden including selenium update.

Wyoming Department of Environmental Quality, Land Quality Division. 1994, Attachment III update 2000. Guideline 4, In Situ Mining.

Natural Resources Conservation Service, Soil Data Mart Website,  
<http://soildatamart.nrcs.usda.gov/> 2008.

**ADDENDUM D-7-A**  
**DEWEY-BURDOCK TABLES**

This page intentionally left blank

**Table D-7.1.1 Soil Mapping Unit Acreages**

<b>Map Unit Description</b>	<b>Permit Acreage</b>	<b>Disturbance Areas</b>	<b>% Total Project Area</b>
Alice, 0 to 6 percent slopes	37.32	0	0
Arvada, 0 to 6 percent slopes	345.17	121.78	3.97
Arvada variant, 0 to 6 percent slopes	8.72	0	0
Arvada-Slickspots complex	80.67	0	0
Ascalon, 0 to 6 percent slopes	27.33	41.22	1.35
Barnum, 0 to 6 percent slopes	577.51	13.01	0.42
Boneek, 0 to 6 percent slopes	66.74	0	0
Boneek (bedrock substratum), 0 to 6 percent slopes	23.40	0	0
Broadhurst, 6 to 15 percent slopes	100.35	190.74	6.22
Butche, 6 to 40 percent slopes	282.05	25.42	0.83
Canyon, 15 to 60 percent slopes	61.15	0	0
Colby, 6 to 15 percent slopes	67.89	0	0
Cushman, 6 to 15 percent slopes	110.06	12.26	0.40
Demar, 0 to 6 percent slopes	667.76	134.26	4.38
Disturbed-Ag	323.93	41.36	1.35
Grummit, 0 to 6 percent slopes	255.08	37.85	1.24
Grummit, 6 to 15 percent slopes	645.49	369.1	12.04
Grummit, 15 to 60 percent slopes	852.40	48.43	1.58
Grummit-Rock Outcrop complex	19.51	0	0
Haverson, 0 to 6 percent slopes	424.24	0	0
Hisle, 0 to 6 percent slopes	308.64	54.52	1.78
Hisle, 15 to 60 percent slopes	244.02	0	0
Kyle, 0 to 6 percent slopes	536.03	333.96	10.89
Lohmiller, 0 to 6 percent slopes	50.60	5.66	0.19
Mathias, 15 to 40 percent slopes	351.65	34.08	1.11
Mine Pit	342.91	18.31	0.60
Nihill, 15 to 50 percent slopes	9.71	25.61	0.84
Norka, 0 to 6 percent slopes	82.78	0	0
Nunn, 6 to 15 percent slopes	184.44	41.22	1.35
Paunsaugunt, 6 to 15 percent slopes	0.46	0	0
Penrose, 15 to 40 percent slopes	245.60	231.08	7.54
Pierre, 0 to 6 percent slopes	595.18	216.03	7.05
Pierre, 6 to 15 percent slopes	476.10	157.99	5.15
Rock Outcrop	126.16	17.42	0.57
Samsil, 15 to 40 percent slopes	345.91	515.29	16.81
Satanta, 2 to 6 percent slopes	32.12	0	0
Satanta-Arvada complex	86.66	0	0
Shingle, 15 to 40 percent slopes	183.24	11.66	0.38
Slickspots	792.80	148.77	4.85

POWERTECH (USA), INC.  
*Dewey-Burdock ISR Uranium Project*  
Pre-Mining Soil Assessment

---

<b>Map Unit Description</b>	<b>Permit Acreage</b>	<b>Disturbance Areas</b>	<b>% Total Project Area</b>
Snomo, 6 to 15 percent slopes	203.40	106.06	3.46
Tillford, 0 to 6 percent slopes	179.68	7.84	0.26
Water	32.75	72.5	2.37
Winetti, 0 to 6 percent slopes	47.48	6.92	0.23
Worfla, 15 to 40 percent slopes	3.04	0	0
Zigweid, 6 to 15 percent slopes	90.50	25.39	0.83
Zigweid, 15 to 40 percent slopes	19.32	0	0
<b>Total</b>	<b>10,557.03</b>	<b>3,065.74</b>	<b>100</b>

**Table D-7.1.2 Soil Series Sample Summary**

<b>Soil Series</b>	<b>Number of Profiles Sampled for Chemical Analysis<sup>1</sup></b>
Broadhurst	1
Kyle	3
Hisle	2
Nevee	1
Barnum	2
Ascalon	1
Cushman	1
Zigweid	1
Butche	1
Samsil	3
Paunsaugunt	1
Boneek	4
Arvada	1
Lohmiller	2
Pierre	2
Haverson	1
Demar	2
Penrose	1
Satanta	1
Snomo	1
Grummit	1
Shingle	1
Nunn	1
Canyon	1
Winetti	1
<b>Total</b>	<b>37</b>

<sup>1</sup>Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

**Table D-7.1.3 Soil Sample Locations**

<b>Soil Sample Number<sup>1</sup></b>	<b>Map Unit Designation</b>	<b>Soil Series</b>
17	Broadhurst silty clay, 6 to 15 percent slopes	Broadhurst
27	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
36	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
39	Hisle silt loam, 0 to 6 percent slopes	Hisle
40	Hisle noncalcareous variant, 0 to 6 percent slopes	Hisle
41	Nevee silt loam, 6 to 15 percent slopes	Nevee
42	Barnum silt loam, 0 to 6 percent slopes	Barnum
43	Ascalon clay loam, 0 to 6 percent slopes	Ascalon
50	Cushman loam, 6 to 15 percent slopes	Cushman
56	Zigweid loam, 0 to 6 percent slopes	Zigweid
57	Butche clay loam, 3 to 15 percent slopes	Butche
60	Samsil clay loam, 15 to 40 percent slopes	Samsil
63	Paunsaugunt loam, 6 to 15 percent slopes	Paunsaugunt
64	Boneek silty clay loam, 0 to 6 percent slopes	Boneek
72	Arvada silty clay loam, 0 to 6 percent slopes	Arvada
73	Lohmiller loam, 0 to 6 percent slopes	Lohmiller
74	Pierre sandy clay loam, 0 to 15 percent slopes	Pierre
75	Haverson clay loam, 0 to 6 percent slopes	Haverson
76	Demar loam, 0 to 6 percent slopes	Demar
77	Penrose clay loam, 0 to 6 percent slopes	Penrose
79	Demar silty clay loam, 0 to 6 percent slopes	Demar
82	Satanta loam, 0 to 6 percent slopes	Satanta
83	Snomo silty clay loam, 0 to 6 percent slopes	Snomo
84	Lohmiller silty clay loam, 0 to 6 percent slopes	Lohmiller
85	Kyle loam, 0 to 6 percent slopes	Kyle
88	Samsil noncalcareous variant, 15 to 40 percent slopes	Samsil
89	Pierre silty clay loam, 0 to 15 percent slopes	Pierre
90	Grummit silty clay, 0 to 6 percent slopes	Grummit
91	Boneek clay loam, 0 to 6 percent slopes	Boneek
92	Samsil silty clay loam, 15 to 40 percent slopes	Samsil
93	Shingle loam, 15 to 40 percent slopes	Shingle
94	Boneek noncalcareous variant, 0 to 6 percent slopes	Boneek
95	Boneek loam, 0 to 6 percent slopes	Boneek
103	Barnum clay, 0 to 6 percent slopes	Barnum
114	Nunn clay, 6 to 15 percent slopes	Nunn
115	Canyon sandy clay loam, 15 to 60 percent slopes	Canyon
116	Winetti sandy clay loam, 0 to 6 percent slopes	Winetti

<sup>1</sup>Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

**Table D-7.1.4 Summary of Marginal and Unsuitable Parameters within Sampled Profiles**

Series	Sample Point	Depth (in)	Marginal Parameter <sup>1</sup>	Unsuitable Parameter <sup>1</sup>
Broadhurst	17	0-3	Clay %	
		3-8	Clay %	
		8-24	Clay % Saturation %	
		24-40	Clay %	
		40-54	Clay % pH	
		54-60	Clay %	pH
Kyle	27	2-17	Clay %	
		17-24	Clay % SAR	
		24-39	Clay % Saturation % SAR	
		39-60	Clay % SAR	
Kyle	36	2-15	Clay % Saturation %	
		15-26	Clay % SAR	
		26-36	Clay % Saturation % SAR	
		36-60	Clay %	
Hisle	40	27-38	Clay %	
		38-60	Clay %	
Nevée	41	21-36	Selenium	EC SAR Boron
		36-45	Selenium	EC SAR
		45-60	Selenium	EC SAR
Barnum	42	6-17	Selenium	EC SAR
		17-39		EC SAR
		39-60	EC SAR	
Ascalon	43	2-14	Clay %	

POWERTECH (USA), INC.  
Dewey-Burdock ISR Uranium Project  
Pre-Mining Soil Assessment

Series	Sample Point	Depth (in)	Marginal Parameter <sup>1</sup>	Unsuitable Parameter <sup>1</sup>
Ascalon	43	38-60		SAR
Samsil	60	3-10	Clay % SAR	
		10-18	EC Selenium	
Samsil	60	10-18	SAR	
Boneek	64	17-33	pH	
		33-42	EC Selenium	
Arvada	72	18-28	Clay % Selenium	
		28-43	EC SAR Selenium	
		43-60	EC Selenium	SAR
Lohmiller	73	3-15	Clay %	SAR
		15-23	Clay % Saturation % EC Selenium	SAR
		23-34	Clay % Saturation % Selenium	SAR EC
		34-38	Clay % Selenium	SAR EC
		38-60	Clay % Saturation % Selenium	SAR EC
Pierre	74	15-27	pH	SAR
		27-38	pH Selenium	EC SAR
		38-51	Selenium	EC SAR
		51-60	Selenium	EC SAR
Haverson	75	15-35	SAR	
		35-46		SAR
		46-60		SAR
Demar	76	2-21	Clay % SAR	

Series	Sample Point	Depth (in)	Marginal Parameter <sup>1</sup>	Unsuitable Parameter <sup>1</sup>
Demar	76	21-29	Clay % SAR	
		29-46		SAR
		46-60	Selenium	SAR
Penrose	77	36-48		Boron
Demar	79	3-17	Clay %	pH
		17-30	Clay %	pH
		30-42	Clay %	pH
		42-60	Clay %	pH
Satanta	82	0-4	pH	
Snomo	83	0-3		pH
		3-17	Clay %	pH
		17-33	Clay %	
		33-42		Boron
		42-52	Saturation %	Boron
		52-60		Boron
Lohmiller	84	0-5	Saturation %	
		5-18	Saturation % EC SAR	
		18-37	Clay %	EC SAR
		37-47	EC SAR	
		47-60	EC	
Kyle	85	2-7	Saturation %	
Samsil	88	2-9	Clay %	
Pierre	89	0-2	pH	
		2-18	Clay % Saturation %	
		18-31	Clay % Saturation %	
		31-37	Clay % Saturation %	
Grummit	90	0-2	Clay % Saturation %	
		2-8	Clay % Saturation %	
		8-20	Clay % Saturation %	

Series	Sample Point	Depth (in)	Marginal Parameter <sup>1</sup>	Unsuitable Parameter <sup>1</sup>
Boneek	91	4-19	Saturation %	
		19-40		EC SAR
		40-48	Saturation %	EC SAR
		48-60	Saturation % Selenium	EC SAR
Samsil	92	7-19	Clay % Saturation %	
Boneek	94	0-2	Clay % Saturation %	
		2-8	Clay % Saturation %	
		8-20	Clay % Saturation %	
		20-32	Saturation %	
Boneek	94	32-44	Clay % Saturation %	
		44-60	Clay % Saturation %	
Boneek	95	24-38	Selenium	
Barnum	103	0-3	Clay %	
		3-12	Clay %	
		25-38	EC	
		38-48	EC Saturation %	
Nunn	114	0-2	Clay %	
		9-26	Clay %	
		26-38	Clay % EC	SAR
		38-48	Clay % pH	EC SAR
Canyon	115	19-27	Saturation %	
Winetti	116	18-36	pH	
		36-48	Saturation % pH	

<sup>1</sup>Marginal and Unsuitable Parameters identified in Lab Analysis

**Table D-7.1.5 Summary of Trends in Marginal and Unsuitable Parameters for Soil Series**

<b>Series</b>	<b>Unsuitable/Marginal Parameter<sup>1</sup></b>
Arvada	Sodium/Salts, Selenium/Boron
Ascalon	Sodium/Salts
Barnum	Sodium/Salts, Selenium/Boron
Boneek	Texture, Sodium/Salts, Selenium/Boron
Broadhurst	Texture, pH
Canyon	Saturation %
Demar	Sodium/Salts
Grummit	Texture
Haverson	Sodium/Salts
Hisle	Texture
Kyle	Texture
Lohmiller	Texture, Sodium/Salts
Nevee	Sodium/Salts, Selenium/Boron
Nunn	Sodium/Salts, Texture
Penrose	Selenium/Boron
Pierre	pH
Samsil	Texture
Satanta	pH
Snomo	Texture, pH, Selenium/Boron
Winetti	pH

<sup>1</sup>Marginal and Unsuitable Parameters identified in Lab Analysis

**Table D-7.1.6 Summary of Approximate Soil Salvage Depths**

<b>Map Symbol</b>	<b>Mapping Unit Description</b>	<b>Disturbance Areas<sup>1</sup> (acres)</b>	<b>Salvage Depth (feet)</b>	<b>Total Volume (Acre feet)</b>
Ar	Arvada	121.78	1.50	182.67
As	Ascalon	41.22	1.17	48.23
Bc	Barnum	13.01	2.58	33.57
Br	Broadhurst	190.74	0.67	127.80
Bw	Butche	25.42	0.67	17.03
Cy	Cushman	12.26	2.08	25.50
Dg	Demar	134.26	0.21	28.20
DA	Disturbed-Ag	41.36	-	-
GrA	Grummit, 0 to 6 percent slopes	37.85	1.67	63.21
GrB	Grummit, 6 to 15 percent slopes	369.10	1.67	616.40
GrC	Grummit, 15 to 60 percent slopes	48.43	1.67	80.88
He	Hisle	54.52	5	272.60
Ky	Kyle	333.96	1.65	551.03
Lo	Lohmiller	5.66	0.34	1.92
Mm	Mathias	34.08	0.00	0.00
MP	Mine Pit	18.31	-	-
Nf	Nihill	25.61	0.42	10.76
Nu	Nunn	41.22	2.17	89.31
Pg	Penrose	231.08	3.00	693.24
PeA	Pierre, 0 to 6 percent slopes	216.03	0.71	153.38
PeB	Pierre, 6 to 15 percent slopes	157.99	0.71	112.17
RO	Rock Outcrop	17.42	-	-
Sa	Samsil	515.29	0.96	494.68
Sn	Shingle	11.66	0.67	7.81
SS	Slickspots	148.77	-	-
Gs	Snomo	106.06	0.00	0.00
Ta	Tilford	7.84	3.33	26.11
W	Water	72.50	-	-
Wt	Winetti	6.92	3.00	20.76
Zn	Zigweid	25.39	5.00	126.95
<b>Average Salvage Depth of Study Area</b>			<b>1.63</b>	
<b>Total</b>		<b>3,065.74</b>		<b>3,784.21</b>

<sup>1</sup>Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

**Table D-7.1.7 Summary of Wind and Water Erosion Hazards**

<b>Soil Sample Number</b>	<b>Map Unit Description</b>	<b>Water Erosion Hazard<sup>1</sup></b>	<b>Wind Erosion Hazard<sup>1</sup></b>
17	Broadhurst silty clay, 6 to 15 percent slopes	slight	very slight
27	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
36	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
39	Hisle silt loam, 0 to 6 percent slopes	moderate	slight
40	Hisle noncalcareous variant, 0 to 6 percent slopes	slight	very slight
41	Nevee silt loam, 6 to 15 percent slopes	moderate	slight
42	Barnum silt loam, 0 to 6 percent slopes	moderate	slight
43	Ascalon clay loam, 0 to 6 percent slopes	slight	slight
50	Cushman loam, 6 to 15 percent slopes	slight	moderate
56	Zigweid silty clay loam, 0 to 6 percent slopes	moderate	very slight
57	Butche clay loam, 3 to 15 percent slopes	slight	slight
60	Samsil clay loam, 15 to 40 percent slopes	slight	slight
63	Paunsaugunt loam, 6 to 15 percent slopes	slight	moderate
64	Boneek silty clay loam, 0 to 6 percent slopes	moderate	very slight
72	Arvada silty clay loam, 0 to 6 percent slopes	moderate	slight
73	Lohmiller loam, 0 to 6 percent slopes	very slight	slight
74	Pierre sandy clay loam, 0 to 15 percent slopes	negligible	severe
75	Haverson clay loam, 0 to 6 percent slopes	slight	slight
76	Demar loam, 0 to 6 percent slopes	slight	moderate
77	Penrose clay loam, 0 to 6 percent slopes	slight	slight
79	Demar silty clay loam, 0 to 6 percent slopes	slight	slight
82	Satanta loam, 0 to 6 percent slopes	very slight	severe
83	Snomo silty clay loam, 0 to 6 percent slopes	moderate	very slight
84	Lohmiller silty clay loam, 0 to 6 percent slopes	moderate	very slight
85	Kyle loam, 0 to 6 percent slopes	slight	slight
88	Samsil noncalcareous variant, 15 to 40 percent slopes	slight	slight
89	Pierre silty clay loam, 0 to 15 percent slopes	moderate	very slight
90	Grummit silty clay, 0 to 6 percent slopes	slight	negligible
91	Boneek clay loam, 0 to 6 percent slopes	slight	slight
92	Samsil silty clay loam, 15 to 40 percent slopes	slight	slight
93	Shingle loam, 15 to 40 percent slopes	slight	severe
94	Boneek noncalcareous variant, 0 to 6 percent slopes	slight	very slight
95	Boneek loam, 0 to 6 percent slopes	slight	moderate
103	Barnum clay, 0 to 6 percent slopes	very slight	very slight
114	Nunn clay, 6 to 15 percent slopes	slight	very slight
115	Canyon sandy clay loam, 15 to 60 percent slopes	very slight	slight
116	Winetti sandy clay loam, 0 to 6 percent slopes	very slight	slight

<sup>1</sup>Based on lab analysis.

This page intentionally left blank

**ADDENDUM D-7-B**  
**SOIL MAPPING UNIT DESCRIPTIONS**

This page intentionally left blank

### **“Aa” – Alice clay, 0 to 6 percent slope**

The Alice clay mapping unit consists of very deep, well drained soils on upland hillslopes and river valley terraces. It occurs on moderately coarse textured alluvium and windblown material at elevations from 3000 to 5500 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 49 degrees Fahrenheit. The frost-free season ranges from 120 to 150 days.

Slopes range from 0 to 15 percent. Parent material consists of moderately coarse textured material that is mainly alluvium but may include some eolian sands and loess.

A typical profile contains a 9 inch grayish brown fine sandy loam surface layer. The transition subsoil is a grayish brown fine sandy loam that is approximately 4 inches thick. The substratum is a light brownish gray fine sandy loam that extends to approximately to 26 inches in depth.

Permeability within the Alice soil is moderately rapid. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is severe and the wind erosion hazard is severe.

### **Productivity and Reclamation Potential**

There are twenty seven plant species that are common to this map unit:

Needle and thread, Little bluestem, Prairie sandreed, Blue grama, Western wheatgrass, Big bluestem, Hairy grama, Sand bluestem, Sedge, Sideoats grama, Switchgrass, Blacksamson Echinacea, Breadroot scurfpea, Fringed sagewort, Louisiana sagewort, Prairie coneflower, Stiff sunflower, Heath aster, Leadplant, Plains pricklypear, Rose, Sand sagebrush, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, Wormwood, and Yucca .

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

### **“Ar” - Arvada fine sandy loam, 0 to 6 percent slope**

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty two plant species that are common to this map unit:

Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, *Ericameria nauseosa* ssp. *nauseosa* var *nauseosa*, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

### **“ArV” - Arvada variant, 0 to 6 percent slope**

The Arvada variant mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty two plant species that are common to this map unit:

Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, *Ericameria nauseosa* ssp. *nauseosa* var *nauseosa*, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

## **“Ar-SS” – Arvada-Slickspots complex**

### **Arvada fine sandy loam**

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty two plant species that are common to this map unit:

Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, *Ericameria nauseosa* ssp. *nauseosa* var *nauseosa*, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

**“As” - Ascalon fine sandy loam, 0 to 6 percent slope**

The Ascalon fine sandy loam mapping unit consists of very deep, well drained soils that formed in moderate coarse textured calcareous material. It occurs on upland hillslopes and tableland plains at elevation ranges from 4,000 feet to 6,000 feet.

The mean annual precipitation is estimated to be 13 to 17 inches. The mean annual air temperature is approximately 49 degrees Fahrenheit. The frost-free season ranges from 130 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of thick, moderately coarse textured, calcareous material.

A typical profile contains a 4 inch grayish brown fine sandy loam surface layer. The transition subsoil is a grayish brown fine sandy loam that is approximately 3 inches thick. The substratum is a brown sandy clay loam that extends to approximately to 14 inches in depth.

Saturated hydraulic conductivity within the Ascalon soil is high. Runoff is low on the gentler slopes and high on the steeper slopes. The water erosion hazard is severe and the wind erosion hazard is severe.

**Productivity and Reclamation Potential**

There are twenty seven plant species that are common to this map unit:

Needle and thread, Little bluestem, Prairie sandreed, Blue grama, Western wheatgrass, Big bluestem, Hairy grama, Sand bluestem, Sedge, Sideoats grama, Switchgrass, Blacksamson Echinacea, Breadroot scurfpea, Fringed sagewort, Louisiana sagewort, Prairie coneflower, Stiff sunflower, Heath aster, Leadplant, Plains pricklypear, Rose, Sand sagebrush, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, Wormwood, and Yucca.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

### **“Bc” - Barnum very fine sandy loam, 0 to 6 percent slope**

The Barnum very fine sandy loam mapping unit consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. It occurs on flood plains and alluvial terraces with an elevation range from 4,000 feet to 6,600 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 110 to 135 days.

Slopes range from 0 to 8 percent. Parent material consists of calcareous alluvium from red bed sediments.

A typical profile contains a 4 inch reddish brown very fine sandy loam surface layer. The transition subsoil and substratum is a reddish brown loam stratified with thin lenses of fine sandy loam and light clay loam that extends to approximately to 60 inches in depth.

Permeability within the Barnum soil is moderate or moderately slow because of stratification. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight to moderate and the wind erosion hazard is very slight to moderate.

### **Productivity and Reclamation Potential**

There are twenty three plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Bluegrass, Big bluestem, Fringed sagewort, Wormwood, Sedge, Switchgrass, Yellow Indiangrass, Blue grama, Breadroot scurfpea, Broom snakeweed, Hairy grama, Heath aster, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Leadplant, Skunkbush sumac, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a fair source for roadfill; limitations include low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include salinity.

### **“Bo” - Boneek silt loam, 0 to 6 percent slope**

The Boneek silt loam mapping unit consists of deep and very deep, well drained soils formed in silty sediments underlain by sandstone or siltstone. It occurs on nearly level to moderately sloping high terraces and uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 15 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 15 percent. Parent material consists of silty mantle overlying sandstone or siltstones, or in loess or silty alluvium.

A typical profile contains a 3 inch brown silt loam surface layer. The transition subsoil is a brown silt loam that is approximately 3 inches thick. The substratum is a brown silty clay that extends to approximately to 10 inches in depth.

Permeability within the Boneek soil is moderately slow in the solum and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty three plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Bluegrass, Big bluestem, Fringed sagewort, Wormwood, Sedge, Switchgrass, Yellow Indiangrass, Blue grama, Breadroot scurfpea, Broom snakeweed, Hairy grama, Heath aster, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Leadplant, Skunkbush sumac, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a fair source for roadfill; limitations include low strength. This map unit is a good source for topsoil.

**“Bp” - Boneek silt loam (bedrock substratum), 0 to 6 percent slope**

The Boneek silt loam (bedrock substratum) mapping unit consists of deep and very deep, well drained soils formed in silty eolian deposits over residuum weathered from sandstone and siltstone. It occurs on plains on uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 15 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 2 to 6 percent. Parent material consists of silty eolian deposits over residuum weathered from sandstone and siltstone.

A typical profile contains a 3 inch brown silt loam surface layer. The transition subsoil is a brown silt loam that is approximately 3 inches thick. The substratum is a brown silty clay that extends to approximately to 10 inches in depth.

Permeability within the Boneek soil is moderately slow in the solum and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

**Productivity and Reclamation Potential**

There are twenty three plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Bluegrass, Big bluestem, Fringed sagewort, Wormwood, Sedge, Switchgrass, Yellow Indiangrass, Blue grama, Breadroot scurfpea, Broom snakeweed, Hairy grama, Heath aster, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Leadplant, Skunkbush sumac, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a poor source for roadfill; limitations include low strength and depth to bedrock. This map unit is a good source for topsoil.

### **“Br” - Broadhurst clay, 6 to 15 percent slope**

The Broadhurst clay mapping unit consists of very deep, well drained soils formed in clayey material derived from acid shales. It occurs on fans and terraces at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 15 to 18 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 15 percent. Parent material consists of clayey material derived from acid shales.

A typical profile contains a 3 inch light brownish gray clay surface layer. The transition subsoil is a grayish brown clay that is approximately 13 inches thick. The substratum is a grayish brown and light brownish gray clay that extends to approximately to 41 inches in depth.

Permeability within the Broadhurst soil is very slow except after dry periods when the initial intake in cracks is rapid. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are nine plant species that are common to this map unit:

Western wheatgrass, Thickspick wheatgrass, Green needlegrass, American vetch, Onion, Plains springparsley, Big sagebrush, Nuttall's saltbush, and Plains pricklypear.

In a favorable year (above average moisture), the production is approximately 1,700 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, water erosion, too clayey, too acid and salinity. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey, salinity, too acid and slope.

**“Bw” – Butche cobbly loam, 6 to 40 percent slope**

The Butche cobbly loam mapping unit consists of shallow, well drained to excessively drained soils formed in loamy materials weathered from sandstone. It occurs on sloping to very steep uplands at elevations from 3000 to 5500 feet.

The mean annual precipitation is estimated to be 13 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 1 to 60 percent. Parent material consists of loamy materials weathered from noncalcareous sandstone.

A typical profile contains a 4 inch dark grayish brown cobbly loam surface layer. The transition subsoil is a pale brown cobbly loam that is approximately 6 inches thick. The substratum is very pale brown indurated sandstone that extends to approximately to 60 inches in depth.

Permeability within the Butche soil is moderate or moderately rapid. Runoff is low on the gentler slopes and high on the steeper slopes. The water erosion hazard is negligible and the wind erosion hazard is negligible.

**Productivity and Reclamation Potential**

There are twenty seven plant species that are common to this map unit:

Little bluestem, Sideoats grama, Big bluestem, Needle and thread, Switchgrass, Yellow Indiangrass, Bluegrass, Prairie dropseed, Prairie sandreed, Sedge, Western wheatgrass, Dropseed, Blacksamson Echinacea, Breadroot scurfpea, Broom snakeweed, Dotted gayfeather, Louisiana sagewort, Blue grama, Fringed sagewort, Hairy grama, Leadplant, Ponderosa pine, Silverleaf scurfpea, Skunkbush sumac, Slimflower scurfpea, True mountain mahogany, and Wormwood.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,000 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock and cobble content. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and rock fragments.

### **“Cd” – Canyon loam, 15 to 60 percent slope**

The Canyon loam mapping unit consists of shallow, well drained soils formed in loamy, calcareous residuum on uplands. It occurs on sideslopes and ridgetops of hills, plains, tablelands, and uplands.

The mean annual precipitation is estimated to be 14 to 19 inches. The mean annual air temperature is approximately 48 to 55 degrees Fahrenheit.

Slopes range from 0 to 60 percent. Parent material consists of weakly cemented limestone or very fine grain sandstone which is Tertiary in age.

A typical profile contains a 4 inch grayish brown loam surface layer. The transition subsoil is a light brownish gray loam that is approximately 5 inches thick. The substratum is a very pale brown very fine sandy loam that extends to approximately 7 inches in depth.

Permeability within the Canyon soil is moderate. Runoff is moderately slow on the gentler slopes and rapid on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is slight.

### **Productivity and Reclamation Potential**

There are twenty seven plant species that are common to this map unit:

Little bluestem, Sideoats grama, Big bluestem, Needleandthread, Switchgrass, Yellow Indiangrass, Bluegrass, Prairie dropseed, Prairie sandreed, Sedge, Western wheatgrass, Dropseed, Blacksamson echinacea, Breadroot scurfpea, Broom snakeweed, Dotted gayfeather, Louisiana sagewort, Blue grama, Fringed sagewort, Hairy grama, Leadplant, Ponderosa pine, Silverleaf scurfpea, Skunkbush sumac, Slimflower scurfpea, True mountain mahogany, and Wormwood.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 900 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include droughtiness, depth to bedrock, and low organic matter content. This map unit is a poor source for roadfill; limitations include depth to bedrock and slope. This map unit is a poor source for topsoil; limitations include slope, depth to bedrock, and rock fragments.

### **“Cn” – Colby silt loam, 6 to 15 percent slope**

The Colby silt loam mapping unit consists of very deep, well drained and somewhat excessively drained soils formed in calcareous loess. It occurs on nearly level to steep hills and plains at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 13 to 20 inches. The mean annual air temperature is approximately 45 to 55 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 60 percent. Parent material consists of calcareous silty loess.

A typical profile contains a 4 inch grayish brown silt loam surface layer. The transition subsoil is a light brownish gray silt loam that is approximately 4 inches thick. The substratum is a pale brown silt loam that extends to approximately to 20 inches in depth.

Permeability within the Colby soil is moderate. Runoff is low on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty three plant species that are common to this map unit:

Needle and thread, Little bluestem, Western wheatgrass, Sedge, Prairie sandreed, Sideoats grama, Blue grama, Green needlegrass, Hairy grama, Inland saltgrass, Plains muhly, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Plains pricklypear, Prairie coneflower, Violet prairieclover, Wormwood, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, water erosion and carbonate content. This map unit is a poor source for roadfill; limitations include low strength and slope. This map unit is a poor source for topsoil; limitations include slope and carbonate content.

### **“Cy” - Cushman very fine sandy loam, 6 to 15 percent slope**

The Cushman very fine sandy loam mapping unit consists of well drained soils that are moderately deep to bedrock and formed in slopewash alluvium and residuum from interbedded shales and siltstone and fine-grained argillaceous sandstone. It occurs on buttes, fan remnants, hills, piedmonts, ridges and terraces at elevations from 3,500 to 6,000 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 20 percent. Parent material consists of moderately fine textured slopewash alluvium and residuum.

A typical profile contains a 2 inch light brownish gray very fine sandy loam surface layer. The transition subsoil is a brown clay loam that is approximately 6 inches thick. The substratum is a yellowish brown clay loam that extends to approximately to 14 inches in depth.

Permeability within the Cushman soil is moderate. Runoff is medium. The water erosion hazard is slight and the wind erosion hazard is slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include depth to bedrock.

### **“Dg” – Demar loam, 0 to 6 percent slope**

The Demar loam mapping unit consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. It occurs on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 6 percent. Parent material consists of clayey alluvium derived from acid clay shales.

A typical profile contains a 5 inch pale brown loam surface layer. The transition subsoil is a brown silty clay loam that is approximately 7 inches thick. The substratum is a grayish brown silty clay that extends to approximately to 24 inches in depth.

Permeability within the Demar soil is very slow. Runoff is medium. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are fifteen plant species that are common to this map unit:

Western wheatgrass, Blue grama, Needle and thread, Buffalograss, Green needlegrass, Prairie sandreed, Sedge, American vetch, Broom snakeweed, Fringed sagewort, Louisiana sagewort, Scarlet globemallow, Big sagebrush, *Ericameria nauseosa* ssp. *nauseosa* var. *nauseosa*, and Plains pricklypear.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 900 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, water erosion, too clayey, too acid and salinity. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include too clayey and sodium content.

### **“Gr” – Grummit clay, 0 to 6, 6 to 15 and 15 to 60 percent slope**

The Grummit clay mapping unit consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. It occurs on gently sloping to very steep uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 2 to 60 percent. Parent material consists of clayey residuum weathered from acid shales.

A typical profile contains a 3 inch light brownish gray clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown and gray clay that extends to approximately 17 inches in depth.

Permeability within the Grummit soil is moderate or moderately slow in the upper part and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and too acid. This map unit is a poor source for roadfill; limitations include depth to bedrock and slope. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope, too clayey and too acid.

## **“GrE” – Grummit-Rock Outcrop complex**

### **Grummit clay**

The Grummit clay mapping unit consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. It occurs on gently sloping to very steep uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 2 to 60 percent. Parent material consists of clayey residuum weathered from acid shales.

A typical profile contains a 3 inch light brownish gray clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown and gray clay that extends to approximately 17 inches in depth.

Permeability within the Grummit soil is moderate or moderately slow in the upper part and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and too acid. This map unit is a poor source for roadfill; limitations include depth to bedrock and slope. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope, too clayey and too acid.

### **“Ha” - Haverson loam, 0 to 6 percent slope**

The Haverson loam mapping unit consists of very deep, well drained soils that formed in alluvium from mixed sources. It occurs on floodplains and low terraces at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 49 degrees Fahrenheit. The frost-free season ranges from 125 to 180 days.

Slopes range from 0 to 9 percent. Parent material consists of highly stratified, calcareous, recent alluvium derived from mixed sources.

A typical profile contains a 3 inch pale brown loam surface layer. The transition subsoil is a pale brown loam that is approximately 3 inches thick. The substratum is a light brownish gray loam that extends to approximately to 12 inches in depth.

Permeability within the Haverson soil is moderate. Runoff is negligible on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty four plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Prairie sandreed, Needle and thread, Blue grama, Buffalograss, Bluegrass, Fringed sagewort, Sedge, Heath aster, Western yarrow, Wormwood, Big bluestem, Big sagebrush, Boxelder, Common chokecherry, Green ash, Leadplant, Little bluestem, Louisiana sagewort, Plains cottonwood, Silver buffaloberry, Skunkbush sumac, and Western snowberry.

In a favorable year (above average moisture), the production is approximately 2,800 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,600 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a fair source for roadfill; limitations include shrink-swell. This map unit is a good source for topsoil.

### **“He” - Hisle silt loam, 0 to 6 percent slope**

The Hisle silt loam mapping unit consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. It occurs on nearly level to moderately sloping on uplands at elevations around 3,020 feet.

The mean annual precipitation is estimated to be 12 to 16 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 15 percent. Parent material consists of clays transported locally or weathered in place from clay shales.

A typical profile contains a 1 inch light gray silt loam surface layer. The transition subsoil is a light brownish gray clay that is approximately 1 inch thick. The substratum is a light brownish gray clay that extends to approximately to 9 inches in depth.

Permeability within the Hisle soil is very slow, but after dry periods initial intake commonly is rapid because of cracks. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty two plant species that are common to this map unit:

Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, *Ericameria nauseosa* ssp. *nauseosa* var. *nauseosa*, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 1,100 lbs/acres. In an unfavorable (drought) year, the production is approximately 500 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include sodium content, droughty, too clayey, depth to bedrock and salinity. This map unit is a poor source for roadfill; limitations include low strength, depth to bedrock and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey, salinity, depth to bedrock and sodium content.

### **“Ky” – Kyle clay, 0 to 6 percent slope**

The Kyle clay mapping unit consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. It occurs on nearly level to strongly sloping on uplands and colluvial fans at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 12 to 19 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 15 percent. Parent material consists of clayey sediments weathered from calcareous clay shale.

A typical profile contains a 4 inch grayish brown clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown clay that extends to approximately to 16 inches in depth.

Permeability within the Kyle soil is very slow, except after dry periods when the initial intake into cracks is rapid. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are nineteen plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Sideoats grama, Needle and thread, Blue grama, Bluegrass, Buffalograss, Sedge, Big sagebrush, Fringed sagewort, Heath aster, Louisiana sagewort, Plains pricklypear, Silverleaf scurfpea, Western yarrow, American vetch, Breadroot scurfpea, Scarlet globemallow, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, water erosion, too clayey and sodium content. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey and sodium content.

### **“Lo” – Lohmiller silty clay loam, 0 to 6 percent slope**

The Lohmiller silty clay loam mapping unit consists of very deep, well drained soils formed in alluvium on bottom lands. It occurs on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 10 to 19 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 8 percent. Parent material consists of calcareous alluvium from sedimentary rock.

A typical profile contains a 4 inch grayish brown silty clay loam surface layer. The transition subsoil is a grayish brown clay loam that is approximately 4 inches thick. The substratum is a grayish brown clay loam that extends to approximately to 60 inches in depth.

Permeability within the Lohmiller soil is slow or moderately slow. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty four plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Prairie sandreed, Needle and thread, Blue grama, Buffalograss, Bluegrass, Fringed sagewort, Sedge, Heath aster, Western yarrow, Wormwood, Big bluestem, Big sagebrush, Boxelder, Common chokecherry, Green ash, Leadplant, Little bluestem, Louisiana sagewort, Plains cottonwood, Silver buffaloberry, Skunkbush sumac, and Western snowberry.

In a favorable year (above average moisture), the production is approximately 2,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,500 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, water erosion and too clayey. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey.

**“Mm” – Mathias extremely stony very fine sandy loam, 15 to 40 percent slope**

The Mathias extremely stony very fine sandy loam mapping unit consists of very deep, well drained soils formed in colluvial sediments weathered from interbedded sandstone and shale on uplands. It occurs below sandstone outcrops on mountain side slopes at elevations from 2,950 to 5,600 feet.

The mean annual precipitation is estimated to be 15 to 18 inches. The mean annual air temperature is approximately 45degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 15 to 70 percent. Parent material consists of material weathered from interbedded fine grain sandstone and shale.

A typical profile contains a 2 inch dark grayish brown extremely stony very fine sandy loam surface layer. The transition subsoil is a light brownish gray very fine sandy loam that is approximately 7 inches thick. The substratum is a brown very fine sandy loam that extends to approximately to 13 inches in depth.

Permeability within the Mathias soil is moderate. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is negligible and the wind erosion hazard negligible.

**Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:  
Sedge, Little bluestem, Sideoats grama, Achnatherum richardsonii, Big bluestem, Dropseed, Green needlegrass, Leadplant, Prairie dropseed, Prairie junegrass, Rose, Switchgrass, Yellow Indiangrass, Bearded wheatgrass, Ponderosa pine, Slender wheatgrass, Western wheatgrass, Rocky Mountain juniper, Breadroot scurfpea, Dotted gayfeather, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, and Columbia needlegrass.

In a favorable year (above average moisture), the production is approximately 2,900 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,700 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, cobble content and stone content. This map unit is a poor source for roadfill; limitations include slope, cobble content and stone content. This map unit is a poor source for topsoil; limitations include slope, rock fragments and hard to reclaim (rock fragments).

### **“Ne” – Nevee silt loam, 6 to 15 percent slope**

The Nevee silt loam mapping unit consists of deep and very deep, well drained soils formed in reddish silty alluvial-colluvial sediments on terraces and uplands. It occurs on nearly level to steep on terraces, uplands, and alluvial fans at elevations from 2950 to 3510 feet.

The mean annual precipitation is estimated to be 15 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 1 to 30 percent. Parent material consists of silty alluvium weathered from reddish colored silty shale, siltstone, or sandstone.

A typical profile contains a 4 inch reddish brown silt loam surface layer. The transition subsoil is a yellowish red silt loam that is approximately 4 inches thick. The substratum is a reddish yellow silt loam that extends to approximately to 24 inches in depth.

Permeability within the Nevee soil is moderate. Runoff is very low on the gentler slopes and high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are nineteen plant species that are common to this map unit:

Little bluestem, Sideoats grama, Needle and thread, Sedge, Blue grama, Hairy grama, Western wheatgrass, Buffalograss, Green needlegrass, Blacksamson Echinacea, Breadroot scurfpea, Fringed sagewort, Heath aster, Louisiana sagewort, Plains pricklypear, Rose, Silverleaf scurfpea, Slimflower scurfpea, and Wormwood.

In a favorable year (above average moisture), the production is approximately 2,000 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,200 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; water erosion and carbonate content. This map unit is a poor source for roadfill; limitations include depth to bedrock and low strength. This map unit is a poor source for topsoil; limitations include slope and carbonate content.

### **“Nf” – Nihill gravelly loam, 15 to 50 percent slope**

The Nihill gravelly loam mapping unit consists of very deep, well drained soils formed in gravelly alluvium from mixed sources. It occurs on Pleistocene terraces and terrace remnants at elevations from 2,600 to 6,800 feet.

The mean annual precipitation is estimated to be 10 to 19 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 80 percent. Parent material consists of calcareous gravelly alluvium from mixed sources.

A typical profile contains a 5 inch dark brown gravelly loam surface layer. The transition subsoil is a light yellowish brown very gravelly clay loam that is approximately 25 inches thick. The substratum is a very pale brown very gravelly sandy clay loam that extends to approximately 60 inches in depth.

Permeability within the Nihill soil is moderate. Runoff is medium on the gentler slopes and high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are eighteen plant species that are common to this map unit:

Sedge, Needle and thread, Sideoats grama, Blue grama, Hairy grama, Bluegrass, Little bluestem, Sand dropseed, Western wheatgrass, Blacksamson Echinacea, Broom snakeweed, Fringed sagewort, Hairy goldenaster, Louisiana sagewort, Plains pricklypear, Skunkbush sumac, Violet prairieclover, and Wormwood.

In a favorable year (above average moisture), the production is approximately 1,100 lbs/acres. In an unfavorable (drought) year, the production is approximately 600 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and droughty. This map unit is a fair source for roadfill; limitations include slope. This map unit is a poor source for topsoil; limitations include slope, hard to reclaim (rock fragments) and rock fragments.

### **“No” – Norka loam, 0 to 6 percent slope**

The Norka loam mapping unit consists of very deep well drained soils that formed in thick, calcareous, eolian or alluvial materials high in very fine sand. It occurs on hills, ridges, slope breaks and valley sideslopes at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 13 to 18 inches. The mean annual air temperature is approximately 48 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 12 percent. Parent material consists of thick, calcareous, eolian or alluvial materials often containing a large proportion of very fine sand.

A typical profile contains a 4 inch grayish brown loam surface layer. The transition subsoil is a grayish brown silt loam that is approximately 3 inches thick. The substratum is a grayish brown light silty clay loam that extends to approximately to 13 inches in depth.

Permeability within the Norka soil is moderate. Runoff is low on the gentler slopes and high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

### **“Nu” – Nunn clay loam, 0 to 6 and 6 to 15 percent slope**

The Nunn clay loam mapping unit consists of very deep, well drained soils that formed in loess and mixed alluvium. It occurs on terraces or alluvial fans, and in drainageways at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 14 inches. The mean annual air temperature is approximately 48 degrees Fahrenheit. The frost-free season ranges from 120 to 210 days.

Slopes range from 0 to 25 percent. Parent material consists mixed alluvium.

A typical profile contains a 6 inch grayish brown clay loam surface layer. The transition subsoil is a grayish brown clay loam that is approximately 4 inches thick. The substratum is a pale brown clay loam that extends to approximately to 24 inches in depth.

Permeability within the Nunn soil is moderately slow to slow. Runoff is negligible on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight to slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 1,900 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,100 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, too clayey and water erosion. This map unit is a fair source for roadfill; limitations include shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey.

### **“Pa” – Paunsaugunt gravelly loam, 6 to 15 percent slope**

The Paunsaugunt gravelly loam mapping unit consists of well drained soils that are shallow to limestone and formed in residuum from limestone and calcareous sandstone. It occurs on mesas and hillsides at elevations from 6,000 to 8,400 feet.

The mean annual precipitation is estimated to be 16 to 22 inches. The mean annual air temperature is approximately 43 degrees Fahrenheit. The frost-free season ranges from 70 to 100 days.

Slopes range from 2 to 70 percent. Parent material consists of residuum on limestone and calcareous sandstone.

A typical profile contains a 3 inch brown gravelly loam surface layer. The transition subsoil is a grayish brown cobbly sandy loam that is approximately 5 inches thick. The substratum is a light brownish gray very cobbly sandy loam that extends to approximately to 15 inches in depth.

Permeability within the Paunsaugunt soil is moderate. Runoff is medium on the gentler slopes and rapid on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty nine plant species that are common to this map unit:

Little bluestem, Sideoats grama, Needle and thread, Blue grama, Bluegrass, Dropseed, Hairy grama, Idaho fescue, Prairie dropseed, Sedge, Prairie junegrass, Bearded wheatgrass, Skunkbush sumac, Achnatherum richardsonii, Blacksamson Echinacea, Breadroot scurfpea, Broom snakeweed, Columbia needlegrass, Dotted gayfeather, Fringed sagewort, Green needlegrass, Heath aster, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slender wheatgrass, Slimflower scurfpea, True mountain mahogany, and Western wheatgrass.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,000 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and rock fragments.

### **“Pg” – Penrose channery loam, 15 to 40 percent slope**

The Penrose channery loam mapping unit consists of shallow, well and somewhat excessively drained soils formed in thin, calcareous, loamy materials weathered in place from limestone and interbedded limy materials. It occurs on hills, plains, ridges, hogbacks, cuerdas, and mesa tops at elevations from 3,000 to 6,500 feet.

The mean annual precipitation is estimated to be 11 to 15 inches. The mean annual air temperature is approximately 51 degrees Fahrenheit. The frost-free season ranges from 125 to 165 days.

Slopes range from 1 to 65 percent. Parent material consists of residuum and slope alluvium derived from limestone and interbedded limy materials.

A typical profile contains a 4 inch light brownish gray channery loam surface layer. The transition subsoil is a light gray channery loam that is approximately 11 inches thick. The substratum is limestone bedrock that extends to approximately to 15 inches in depth.

Permeability within the Penrose soil is moderate to moderately slow. Runoff is low on the gentler slopes and very rapid on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are six plant species that are common to this map unit:  
Sideoats grama, Blue grama, Achnatherum scribneri, Indian ricegrass, Juniper, and Little bluestem.

In a favorable year (above average moisture), the production is approximately 800 lbs/acres. In an unfavorable (drought) year, the production is approximately 300 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and rock fragments.

### **“Pe” – Pierre clay, 0 to 6 and 6 to 15 percent slope**

The Pierre clay mapping unit consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. It occurs on nearly level to steep uplands at elevations from 1300 to 3600 feet.

The mean annual precipitation is estimated to be 10 to 13 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 30 percent. Parent material consists of residuum weathered from clay shale.

A typical profile contains a 2 inch grayish brown clay surface layer. The transition subsoil is a light brownish gray clay that is approximately 5 inches thick. The substratum is a light brownish gray clay that extends to approximately 20 inches in depth.

Permeability within the Pierre soil is very slow, except after dry periods when the initial intake may be rapid due to cracks. Runoff is low on the gentler slopes and medium to very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are nineteen plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Sideoats grama, Needle and thread, Blue grama, Bluegrass, Buffalograss, Sedge, Big sagebrush, Fringed sagewort, Heath aster, Louisiana sagewort, Plains pricklypear, Silverleaf scurfpea, Western yarrow, American vetch, Breadroot scurfpea, Scarlet globemallow, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,200 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, depth to bedrock, droughty, too clayey and sodium content. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, too clayey and sodium content.

### **“Sa” – Samsil clay, 15 to 40 percent slope**

The Samsil clay mapping unit consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. It occurs on gently sloping to very steep hills, ridges and breaks of dissected shale plains at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 14 to 19 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 2 to 60 percent. Parent material consists of alluvium or residuum weathered from shale.

A typical profile contains a 2 inch light brownish gray clay surface layer. The transition subsoil is a light grayish brown clay that is approximately 5 inches thick. The substratum is a light grayish brown clay that extends to approximately to 11 inches in depth.

Permeability within the Samsil soil is slow. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and water erosion. This map unit is a poor source for roadfill; limitations include depth to bedrock, slope, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and too clayey.

### **“Sc” – Satanta loam, 0 to 6 percent slope**

The Satanta loam mapping unit consists of very deep well drained soils that formed in eolian deposits. It occurs on plains or high stream terraces in the Central High Tablelands at elevations from 2000 to 4500 feet.

The mean annual precipitation is estimated to be 14 to 22 inches. The mean annual air temperature is approximately 56 degrees Fahrenheit. The frost-free season ranges from 140 to 200 days.

Slopes range from 0 to 15 percent. Parent material consists of eolian deposits.

A typical profile contains a 4 inch dark grayish brown loam surface layer. The transition subsoil is a dark grayish brown loam that is approximately 4 inches thick. The substratum is a very dark grayish brown loam that extends to approximately to 19 inches in depth.

Saturated hydraulic conductivity within the Satanta soil is moderately high. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

## **“Sc-Ar” – Satanta-Arvada complex**

### **Satanta loam**

The Satanta loam mapping unit consists of very deep well drained soils that formed in eolian deposits. It occurs on plains or high stream terraces in the Central High Tablelands at elevations from 2000 to 4500 feet.

The mean annual precipitation is estimated to be 14 to 22 inches. The mean annual air temperature is approximately 56 degrees Fahrenheit. The frost-free season ranges from 140 to 200 days.

Slopes range from 0 to 15 percent. Parent material consists of eolian deposits.

A typical profile contains a 4 inch dark grayish brown loam surface layer. The transition subsoil is a dark grayish brown loam that is approximately 4 inches thick. The substratum is a very dark grayish brown loam that extends to approximately to 19 inches in depth.

Saturated hydraulic conductivity within the Satanta soil is moderately high. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

### **Arvada fine sandy loam**

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature

is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty two plant species that are common to this map unit:

Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, *Ericameria nauseosa* ssp. *nauseosa* var *nauseosa*, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

### **“Sn” – Shingle clay loam, 15 to 40 percent slope**

The Shingle clay loam mapping unit consists of well drained soils that are very shallow or shallow to bedrock and formed in residuum and colluvium derived from interbedded shale and sandstone or in alluvium from mudstone. It occurs on bedrock controlled hillslopes and ridges at elevations from 3,200 to 6,500 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 80 percent. Parent material consists of colluvium and residuum weathered from soft, interbedded sandstone and shale or in alluvium from mudstone.

A typical profile contains a 4 inch light brownish gray clay surface layer. The transition subsoil is a light yellowish brown clay loam that is approximately 4 inches thick. The substratum is a light yellowish brown clay loam that extends to approximately to 15 inches in depth.

Permeability within the Shingle soil is moderate. Runoff is medium on the gentler slopes and high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are twenty nine plant species that are common to this map unit:

Little bluestem, Sideoats grama, Needle and thread, Western wheatgrass, Big bluestem, Blue grama, Green needlegrass, Hairy grama, Prairie sandreed, Sedge, Plains muhly, Rocky Mountain juniper, American vetch, Blacksamson echinacea, Breadroot scurfpea, Broom snakeweed, Fringed sagewort, Leadplant, Louisiana sagewort, Missouri goldenrod, Nineanther prairieclover, Oligoneuron rigidum var. rigidum, Prairie coneflower, Rose, Silver buffaloberry, Silverleaf scurfpea, Skunkbush sumac, Slimflower scurfpea, and Violet prairieclover.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock, slope, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and rock fragments.

### **“Gs” – Snomo clay, 6 to 15 percent slope**

The Snomo clay mapping unit consists of deep or very deep, well drained soils formed in clayey materials weathered from acid shale on the uplands. It occurs on gently sloping to moderately steep uplands at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 2 to 20 percent. Parent material consists of clayey materials weathered from acid shale.

A typical profile contains a 2 inch light gray silty clay surface layer. The transition subsoil is a light gray clay that is approximately 3 inches thick. The substratum is a light brownish gray clay that extends to approximately to 14 inches in depth.

Permeability within the Snomo soil is moderate. Runoff is very low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

### **Productivity and Reclamation Potential**

There are nineteen plant species that are common to this map unit:

Little bluestem, Sedge, Western wheatgrass, Sideoats grama, Blue grama, Bur oak, Ponderosa pine, Prairie sandreed, Big bluestem, Switchgrass, Yellow Indiangrass, Fringed sagewort, Louisiana sagewort, Blacksamson Echinacea, Breadroot scurfpea, Heath aster, Silverleaf scurfpea, Slimflower scurfpea, and Wormwood.

In a favorable year (above average moisture), the production is approximately 1,700 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, too acid and water erosion. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include slope, too clayey and too acid.

### **“Ta” – Tilford silt loam, 0 to 6 percent slope**

The Tilford silt loam mapping unit consists of very deep or deep, well drained soils formed in local alluvium and residuum from weathered reddish shales on uplands and terraces. It occurs on nearly level to rolling on uplands, stream terraces and fans at elevations from 2950 to 3510 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 15 percent. Parent material consists of silty local alluvium and residuum derived from reddish colored silty shales.

A typical profile contains a 5 inch dark brown silt loam surface layer. The transition subsoil is a dark reddish gray silt loam that is approximately 4 inches thick. The substratum is a reddish brown silt loam that extends to approximately to 16 inches in depth.

Permeability within the Tilford soil is moderate. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty six plant species that are common to this map unit:

Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,500 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a fair source for roadfill; limitations include low strength. This map unit is a good source for topsoil.

**“Wt” – Winetti gravelly sandy loam, 0 to 6 percent slope**

The Winetti gravelly sandy loam mapping unit consists of very deep, somewhat excessively drained, moderately rapidly permeable soils that formed in mixed alluvium from sedimentary rocks. It occurs on long, narrow, gently sloping bottoms or valleys and strongly sloping toeslopes at elevations from 7,100 to 8,000 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 44 degrees Fahrenheit. The frost-free season ranges from 80 to 100 days.

Slopes range from 0 to 8 percent. Parent material consists of mixed alluvium from sandstone, limestone and shale.

A typical profile contains a 4 inch brown gravelly sandy loam surface layer. The transition subsoil is a light yellowish brown gravelly loamy sand that is approximately 3 inches thick. The substratum is a light yellowish brown very gravelly sandy loam that extends to approximately 17 inches in depth.

Permeability within the Winetti soil is moderately rapid. Runoff is medium. The water erosion hazard is negligible to very slight and the wind erosion hazard is negligible to slight.

**Productivity and Reclamation Potential**

There are twenty eight plant species that are common to this map unit:  
Western wheatgrass, Big bluestem, Switchgrass, Yellow Indiangrass, Green needlegrass, Little bluestem, Prairie sandreed, Sideoats grama, Bluegrass, Sedge, Blue grama, American elm, Common chokecherry, Eastern cottonwood, Fringed sagewort, Green ash, Hairy grama, Heath aster, Leadplant, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silver buffaloberry, Violet prairieclover, Western snowberry, Western yarrow, Woods' rose, and Wormwood.

In a favorable year (above average moisture), the production is approximately 3,800 lbs/acres. In an unfavorable (drought) year, the production is approximately 2,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and droughty. This map unit is a good source for roadfill. This map unit is a poor source for topsoil; limitations include hard to reclaim (rock fragments), rock fragments.

### **“202” – Worfka clay loam, 15 to 40 percent slope**

The Worfka clay loam mapping unit consists of well drained soils that are very shallow or shallow to bedrock and formed in slopewash alluvium and residuum derived from interbedded calcareous shale and argillaceous sandstone. It occurs on ridge crests, shoulders, footslopes and toeslopes as well as uplands, ridges and hills at elevations from 3,500 to 6,500 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 30 percent. Parent material consists of alluvium and residuum weathered from calcareous shales and argillaceous sandstone.

A typical profile contains a 2 inch light brownish gray light clay loam surface layer. The transition subsoil is a grayish brown clay loam that is approximately 5 inches thick. The substratum is a pale brown clay loam that extends to approximately to 13 inches in depth.

Permeability within the Worfka soil is slow. Runoff is medium on the gentler slopes and rapid on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are five plant species that are common to this map unit:  
Green needlegrass, Western wheatgrass, Bluebunch wheatgrass, Big sagebrush, and Blue grama.

In a favorable year (above average moisture), the production is approximately 1,000 lbs/acres. In an unfavorable (drought) year, the production is approximately 450 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and water erosion. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and too clayey.

### **“Zn” – Zigweid loam, 6 to 15 and 6 to 40 percent slope**

The Zigweid loam mapping unit consists of very deep, well drained soils formed in alluvium from mixed sedimentary sources. It occurs on fan aprons, alluvial fans, fan piedmonts, fan remnants, terraces, ridges and hills at elevations from 3,500 to 6,600 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 20 percent. Parent material consists of calcareous, moderately fine textured sediments derived from interbedded shale and soft sandstone.

A typical profile contains a 4 inch light brownish gray loam surface layer. The transition subsoil is a brown clay loam that is approximately 13 inches thick. The substratum is a brown clay loam that extends to approximately to 34 inches in depth.

Permeability within the Zigweid soil is moderate. Runoff is medium on the gentler slopes and rapid on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

### **Productivity and Reclamation Potential**

There are twenty three plant species that are common to this map unit:

Needle and thread, Little bluestem, Western wheatgrass, Sedge, Prairie sandreed, Sideoats grama, Blue grama, Green needlegrass, Hairy grama, Inland saltgrass, Plains muhly, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, *Oligoneuron rigidum* var. *rigidum*, Plains pricklypear, Prairie coneflower, Violet prairieclover, Wormwood, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,800 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,000 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include slope.

**ADDENDUM D-7-C**  
**SAMPLED SOIL SERIES DESCRIPTIONS**

This page intentionally left blank

BROADHURST  
SILTY CLAY

Soil Mapping Unit "Br"

Lab/BKS Sample ID: G08020803-001\_006

Typical Pedon: Broadhurst silty clay- native grass. When described the soil was dry below 20 inches. (Colors are for dry soil unless otherwise stated.)

The Broadhurst series consists of very deep, well drained soils formed in clayey material derived from acid shales on colluvial fans and terraces. These soils have very slow permeability. Slopes range from 0 to 15 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-3 inches. Light brownish gray (10YR 6/2) silty clay, moist; weak thick platy structure; very hard, very firm, sticky and plastic; few roots; moderately acid (pH 5.8); abrupt smooth boundary, noneffervescent.

**C1** – 3-8 inches. Dark gray (10YR 4/1D, 10YR 3/1W) silty clay, moist; weak coarse blocky and subangular blocky structure; very hard, very firm, sticky and plastic; few roots; moderately acid (pH 5.7); gradual smooth boundary, noneffervescent.

**C2** – 8-24 inches. Dark gray (10YR 4/1D, 10YR 3/1W) silty clay, moist; massive; extremely hard, very firm, sticky and plastic; moderately acid (pH 5.7); clear smooth boundary, noneffervescent.

**C4** – 24-40 inches. Dark gray (10YR 4/1D, 10YR 3/1W) silty clay, moist; massive; extremely hard, very firm, sticky and plastic; moderately acid (pH 5.8); clear smooth boundary, noneffervescent.

**C5n** – 40-54 inches. Very dark grayish brown (2.5Y 3/2 DW) silty clay, moist; massive; hard, very firm, sticky and plastic; common fine fragments of shale; common fine nests of gypsum and other salts; very strongly acid (pH 5.0). noneffervescent.

**C6n** – 54-60 inches. Dark gray (10YR 4/1D, 10YR 3/1W) silty clay, moist; massive; hard, very firm, sticky and plastic; common fine fragments of shale; common fine nests of gypsum and other salts; very strongly acid (pH 4.5). noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 17 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Colors throughout the soil are largely inherited from the parent rock. The control section averages between 60 and 70 percent clay. The soil has an Ustic moisture regime that borders on Aridic. Consistence is hard to extremely hard when dry and very firm when moist. When the soil is dry, cracks 1/2 to 1 inch

wide and several feet long extend downward for 20 inches or more. The soil typically is very strongly acid but ranges from extremely acid to moderately acid.

A and AC horizons have hue of 10YR or 2.5Y, value of 5 or 6 and 3 or 4 moist, and chroma of 1 or 2.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6 and 3 or 4 moist; and chroma of 1 or 2. Few or common partially weathered very fine fragments of shale are in the C horizon in most pedons. Nests of gypsum and other salts are few or common in the lower part of the C horizon.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Very-fine, smectitic, acid, mesic Torrertic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 0-60 inches. Saturation percentage was marginal at 8-24 inches. pH was unsuitable (acidic) at 54-60 inches. Estimated stripping depth is 8 inches.

Geographic Setting (According to Official Series Description) - Broadhurst soils are on colluvial fans and terraces. Slope gradients range from 0 to 15 percent. These soils formed in clayey material derived from acid shales. Mean annual air temperature ranges from 43 to 48 degrees F, and mean annual precipitation ranges from 15 to 18 inches.

KYLE  
NONCALCAREOUS VARIANT

Soil Mapping Unit "Ky"  
Lab/BKS Sample ID: G08020803-007\_011

Typical Pedon: Kyle silty clay loam - on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-2 inches. Grayish brown (2.5YR 5/2) silty clay loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary, slightly alkaline (pH 7.4); noneffervescent.

**Bt** - 2-17 inches. Olive brown (2.5Y 4/3DW) silty clay, moist; weak coarse blocky structure parting to weak medium blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; gradual wavy boundary; moderately alkaline (pH 7.9); very slightly effervescent.

**C1n** - 17-24 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 3/2W) silty clay, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); noneffervescent.

**C2** - 24-39 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 3/2W) silty clay, moist; weak medium subangular blocky structure in upper part becoming massive in lower part; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; common fine and medium nests of gypsum; strong effervescence; slightly alkaline; gradual wavy boundary. moderately alkaline (pH 7.9); noneffervescent.

**C3n** - 39-60 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; massive; very hard, firm, sticky and plastic; few fine accumulations of carbonate and gypsum; moderately alkaline (pH 7.9). noneffervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 27 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The control section averages 60 to 65 percent clay. The soil does

not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-60 inches. Saturation percentage was marginal at 24-39 inches. Sodium absorption ratio was marginal at 17-60 inches. Estimated stripping depth is 17 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

KYLE  
NONCALCAREOUS VARIANT

Soil Mapping Unit "Ky"  
Lab/BKS Sample ID: G08020803-012\_016

Typical Pedon: Kyle silty clay loam- on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-2 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary, moderately alkaline (pH 8.0); noneffervescent.

**Bt1** - 2-15 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay, moist; weak coarse blocky structure parting to weak medium blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; gradual wavy boundary; moderately alkaline (pH 8.0); very slightly effervescent.

**Bt2n** - 15-26 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); very slightly effervescent.

**C1** - 26-36 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; weak medium subangular blocky structure in upper part becoming massive in lower part; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; common fine and medium nests of gypsum; strong effervescence; slightly alkaline; gradual wavy boundary. moderately alkaline (pH 8.0); very slightly effervescent.

**C2** - 36-60 inches. Olive brown (2.5Y 4/3DW) clay, moist; massive; very hard, firm, sticky and plastic; few fine accumulations of carbonate and gypsum; moderately alkaline (pH 8.0); slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 36 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The control section averages 60 to 65 percent clay. The soil does

not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-60 inches. Saturation percentage was marginal at 2-16 and 26-36 inches. Sodium absorption ratio was marginal at 15-36 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

HISLE  
SILT LOAM

Soil Mapping Unit "He"

Lab/BKS Sample ID: G08020803-017\_021

Typical Pedon: Hisle silt loam - on an east-facing plane slope of 3 percent in native grass at 3,020 feet elevation. When described the soil was moist below a depth of 2 inches. (Colors are for dry soil unless otherwise stated.)

The Hisle series consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 45 degrees F.

**A** - 0-2 inches. Light gray (10YR 7/2) silt loam, moist; weak very thin platy structure parting to weak fine granular; soft, very friable; surface crust about 1/8 inch thick; abrupt smooth boundary; neutral (pH 6.8); noneffervescent.

**Bt** - 2-15 inches. Grayish brown (10YR 5/2D, 10YR 4/2W) silty clay loam, moist; weak medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; gradual wavy boundary; neutral (pH 7.3); noneffervescent.

**C1k** - 15-32 inches. Light yellowish brown (2.5Y 6/3D, 2.5Y 4/3W) clay loam, moist; common medium distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; fine earth is massive; hard, firm, sticky; 50 to 70 percent by volume of fragments of shale; few fine accumulations of carbonate and salt; clear wavy boundary; moderately alkaline (pH 8.0); strongly effervescent.

**C2k** - 32-52 inches. Brown (10YR 5/3D, 10YR 4/3W) clay loam, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.0); strongly effervescent.

**C3** - 52-60 inches. Light brownish gray (10YR 6/2D, 10YR 4/2W) silt loam, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.1). slightly effervescent.

Type Location - Shannon County, South Dakota; refer to waypoint 39 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale typically is about 20 to 26 inches and ranges from 20 to 40 inches. Colors of the soil commonly are inherited from the underlying shale. A few small pebbles are on the surface and mixed throughout the solum in some pedons.

The E horizon has hue of 10YR or 2.5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 3. It is silt loam or loam and ranges from slightly acid to slightly alkaline. When dry, the surface is crusted up to 1/8 inch thick.

The Btn horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is clay or silty clay averaging between 50 and 60 percent clay. It ranges from slightly to strongly alkaline. The Btn horizon has weak or moderate, fine to coarse columnar structure parting to moderate or strong, fine to coarse blocky structure in the upper part. Accumulations of salts and carbonates are in the lower Btn horizon of some pedons.

The Bkz horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is silty clay or clay. It has few to many accumulations of carbonate and typically has accumulations of gypsum and salts. It ranges from slightly to strongly alkaline. It contains up to 15 percent fragments of shale by volume.

The C horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is clay, or silty clay. Fragments of shale increase with depth and range up to 80 percent by volume. It ranges from slightly to strongly alkaline. Most pedons contain accumulations of carbonate and salts.

The Cr horizon is shale and hue of 10R to 5Y. It ranges from slightly acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer or have slightly less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Leptic Torrertic Natrustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - No unsuitable or marginal values were present. Strongly calcareous at 15 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - Hisle soils are nearly level to moderately sloping on uplands. Slope gradients range from 0 to 15 percent. Hisle soils formed in clays transported locally or weathered in place from clay shales. The mean annual soil temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches.

HISLE  
NONCALCAREOUS VARIANT

Soil Mapping Unit "He"

Lab/BKS Sample ID: G08020803-022\_026

Typical Pedon: Hisle silty clay loam - on an east-facing plane slope of 3 percent in native grass at 3,020 feet elevation. When described the soil was moist below a depth of 2 inches. (Colors are for dry soil unless otherwise stated.)

The Hisle series consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 45 degrees F.

**A** - 0-4 inches. Light gray (10YR 7/2) silty clay loam, moist; weak very thin platy structure parting to weak fine granular; soft, very friable; surface crust about 1/8 inch thick; abrupt smooth boundary; neutral (pH 6.6); noneffervescent.

**Bt1** - 4-14 inches. Light olive brown (2.5Y 5/3D, 2.5Y 4/3W) silty clay loam, moist; weak medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; gradual wavy boundary; neutral (pH 7.1); noneffervescent.

**Bt2** - 14-27 inches. Light olive brown (2.5Y 5/3D, 2.5Y 4/3W) silty clay loam, moist; few faint yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; very hard, firm, sticky and plastic; many small pebbles and fragments of shale; few fine dark concretions (Fe and Mn oxides); common fine threads and accumulations of carbonate and salt; clear wavy boundary; slightly alkaline (pH 7.8); noneffervescent.

**Bt3n** - 27-38 inches. Olive brown (2.5Y 4/3D, 2.5Y 4/2W) silty clay, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.1); noneffervescent.

**Cn** - 38-60 inches. Olive brown (2.5Y 4/3D, 2.5Y 4/2W) silty clay, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 7.9); noneffervescent.

Type Location - Shannon County, South Dakota; refer to waypoint 40 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale typically is about 20 to 26 inches and ranges from 20 to 40 inches. Colors of the soil commonly are inherited from the underlying shale. A few small pebbles are on the surface and mixed throughout the solum in some pedons.

The E horizon has hue of 10YR or 2.5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 3. It is silt loam or loam and ranges from slightly acid to slightly alkaline. When dry, the surface is crusted up to 1/8 inch thick.

The Btn horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is clay or silty clay averaging between 50 and 60 percent clay. It ranges from slightly to strongly alkaline. The Btn horizon has weak or moderate, fine to coarse columnar structure parting to moderate or strong, fine to coarse blocky structure in the upper part. Accumulations of salts and carbonates are in the lower Btn horizon of some pedons.

The Bkz horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is silty clay or clay. It has few to many accumulations of carbonate and typically has accumulations of gypsum and salts. It ranges from slightly to strongly alkaline. It contains up to 15 percent fragments of shale by volume.

The C horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is clay, or silty clay. Fragments of shale increase with depth and range up to 80 percent by volume. It ranges from slightly to strongly alkaline. Most pedons contain accumulations of carbonate and salts.

The Cr horizon is shale and hue of 10R to 5Y. It ranges from slightly acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Leptic Torrertic Natrustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 27-60 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - Hisle soils are nearly level to moderately sloping on uplands. Slope gradients range from 0 to 15 percent. Hisle soils formed in clays transported locally or weathered in place from clay shales. The mean annual soil temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches.

NEVEE  
SILT LOAM

Soil Mapping Unit "Ne"  
Lab/BKS Sample ID: G08020803-027\_031

Typical Pedon: Nevee silt loam- on a southwest-facing slope of 8 percent in native grass. When described, the soil was dry throughout. (Colors are for dry soil unless otherwise stated.)

The Nevee series consists of deep and very deep, well drained soils formed in reddish silty alluvial-colluvial sediments on terraces and uplands. Permeability is moderate. Slopes range from 1 to 30 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 46 degrees F.

**A** - 0-4 inches. Reddish brown (5YR 4/4) silt loam, moist; weak fine granular structure; soft, very friable; many fine roots; clear smooth boundary; slightly alkaline (pH 7.7); noneffervescent.

**AC** - 4-21 inches. Brown (7.5YR 5/4D, 7.5YR 4/4W) silty clay loam, moist; massive; slightly hard, very friable; common fine roots; few fine accumulations of carbonate; gradual wavy boundary; slightly alkaline (pH 7.7); strongly effervescent.

**C1k** – 21-36 inches. Reddish brown (5YR 5/4D, 5YR 4/4W) silt, moist; massive; hard, very friable; few fine roots; gradual wavy boundary; strongly alkaline (pH 8.6); strongly effervescent.

**C2k** – 36-45 inches. Yellowish red (5YR 5/6D, 5YR 4/4W) silt loam, moist; massive; hard, very friable; many coarse fragments of siltstone; gradual wavy boundary; strongly alkaline (pH 8.7); strongly effervescent.

**C3k** – 45-60 inches. Yellowish red (5YR 5/6D, 5YR 4/4W) loam, moist; extremely hard, friable; strongly alkaline (pH 8.7); strongly effervescent.

Type Location - Butte County, South Dakota; refer to waypoint 41 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock typically ranges from 40 to 60 inches or more. Depth to free carbonates is less than 10 inches. The control section is silt loam, loam, or very fine sandy loam averaging between 10 and 18 percent clay. Some pedons have up to 35 percent coarse fragments greater than 3 inches in the surface.

The A horizon has hue of 5YR to 10YR, value of 4 to 6 and 3 or 4 moist, and chroma of 2 to 6. Where the color value is as dark or darker than 5.5 and 3.5 moist, the horizon has chroma of 4 or more or is too thin for a mollic epipedon. It is typically silt loam, but some pedons are loam or very fine sandy loam. It ranges from neutral to moderately alkaline. Some pedons have an AC horizon. It has colors and textures of the A horizon.

The C horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 and 4 to 6 moist, and chroma of 3 to 6. It is loam, silt loam, or very fine sandy loam, but some pedons are silty clay loam in the lower part. It typically has few to many, fine or medium accumulations of carbonate in the upper part. It ranges from slightly to strongly alkaline.

The Cr horizon is reddish colored silty shale, siltstone, or sandstone and is below depths of 40 inches. It ranges from slightly to strongly alkaline.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Coarse-silty, mixed, superactive, calcareous, mesic Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) – Electrical conductivity was unsuitable at 21-60 inches. Sodium absorption ratio was unsuitable at 21-60 inches. Boron was unsuitable at 21-36 inches. Selenium was marginal at 21-60 inches. Strongly effervescent at 4 inches. Estimated stripping depth is 21 inches.

Geographic Setting (According to Official Series Description) - Nevee soils are nearly level to steep on terraces, uplands, and alluvial fans. Surfaces are dominantly smooth plane, and slope gradients range from 1 to 30 percent. The Nevee soils formed in silty alluvium weathered from reddish colored silty shale, siltstone, or sandstone. Mean annual air temperature is 43 to 48 degrees F, and mean annual precipitation ranges from 15 to 18 inches.

BARNUM  
SILT LOAM

Soil Mapping Unit "Bc"

Lab/BKS Sample ID: G08020803-032\_035

Typical Pedon: Barnum silt loam-rangeland. (Colors are for dry soil unless otherwise stated.)

The Barnum series consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. Barnum soils are on flood plains and alluvial terraces. Slopes are simple and range from 0 to 8 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 47 degrees F.

**A** - 0-6 inches. Reddish brown (5YR 4/4) silt loam, moist; moderate very fine granular structure; soft, very friable; calcium carbonate disseminated; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

**C1k** - 6-17 inches. Reddish brown (5YR 5/4D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.3); strongly effervescent.

**C2k** - 17-39 inches. Reddish brown (5YR 5/4D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; strongly alkaline (pH 8.6); strongly effervescent.

**C3kn** - 39-60 inches. Yellowish red (5YR 4/6D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; strongly alkaline (pH 8.5); strongly effervescent.

Type Location - Johnson County, Wyoming; refer to waypoint 42 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - These soils typically contain free carbonates throughout but may be leached a few inches in some pedons. Organic carbon ranges from .6 to 3 percent in the upper 10 inches and decreases irregularly with depth. The mean annual soil temperature is about 47 to 53 degrees F. The particle size control section is highly stratified and typically averages loam or light clay loam with 18 to 35 percent clay and more than 15 percent fine or coarser sand. Strata of sandy loam, silt loam, silty clay loam, and fine sandy loam are common. Rock fragments are variable between strata but average from 0 to 10 percent pebbles. Exchangeable sodium ranges from 4 to 15 percent throughout the soil. EC typically ranges from 2 to 8 mmhos throughout under natural conditions but may range to 16 mmhos where poorly irrigated.

The A horizon has hue of 7.5YR through 2.5YR, value of 4 through 6 dry, 3 through 5 moist, and chroma of 2 through 6. Reaction is slightly through strongly alkaline.

The C horizon has hue of 5YR through 10R, value of 4 through 7 dry, 3 through 5 moist, and chroma of 2 through 6. Some strata have visual accumulations of salts and carbonates which are typically discontinuous throughout the extent of the pedon. Reaction is slightly through strongly alkaline. Some pedons may have buried horizons below 40 inches.

Range in Characteristics (according to field observations, lab analysis): Textures are finer than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifuvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Electrical conductivity was unsuitable at 6-39 inches. Sodium absorption ratio was unsuitable at 6-39 inches. Selenium was unsuitable at 6-17 inches. Strongly effervescent at 6 inches. Estimated stripping depth is 6 inches.

Geographic Setting (According to Official Series Description) - Barnum soils are on flood plains and alluvial terraces. These soils formed in calcareous alluvium derived from red beds containing siltstone, shale, and sandstone. Slopes are 0 to 8 percent. Elevations are 4,000 to 6,600 feet. The mean annual precipitation is about 12 inches and ranges from 10 to 14 inches with about half falling as snow or rain in April, May, and early June. The mean annual temperature is about 43 to 49 degrees F. The frost-free season is estimated to range from 110 to 135 days depending upon elevation, aspect, and air drainage.

ASCALON  
CLAY LOAM

Soil Mapping Unit "As"

Lab/BKS Sample ID: G08020803-036\_039

Typical Pedon: Ascalon clay loam- grassland. (Colors are for dry soil unless otherwise stated.)

The Ascalon series consists of very deep, well drained soils that formed in moderate coarse textured calcareous material. Ascalon soils are on upland hillslopes and tableland plains. Slopes range from 0 to 25 percent. The mean annual precipitation is about 41 centimeters (16 inches) and the mean annual air temperature is about 10 degrees C (49 degrees F) at the type location.

**A** - 0-2 inches. Grayish brown (10YR 5/2) clay loam, moist; moderate very fine granular structure; soft, very friable; 3 percent pebbles; clear smooth boundary; slightly acid (pH 6.2); noneffervescent.

**Bt** - 2-14 inches. Dark grayish brown (10YR 4/2DW) clay, moist; moderate medium prismatic structure parting to moderate medium subangular blocks; very hard, very friable; many distinct clay films on faces of peds; 3 percent pebbles; gradual smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

**C1k** – 14-38 inches. Light yellowish brown (2.5Y 6/3D. 2.5Y 5/2W) clay loam, moist; weak medium subangular blocky structure; hard, very friable; concretions, thin seams and streaks of calcium carbonate; few faint clay films on faces of some peds; 5 percent pebbles, gradual smooth boundary; strongly alkaline (pH 8.5); violently effervescent.

**C2k** – 38-60 inches. Pale yellow (2.5Y 7/3) loam, moist; massive; slightly hard, very friable; 5 percent pebbles; concretions, thin seams and streaks of calcium carbonate; strongly alkaline (pH 8.8); strongly effervescent.

Type Location - Washington County, Colorado; refer to waypoint 43 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock typically ranges from 40 to 60 inches or more. Depth to free carbonates is less than 10 inches. The control section is silt loam, loam, or very fine sandy loam averaging between 10 and 18 percent clay. Some pedons have up to 35 percent coarse fragments greater than 3 inches in the surface.

The A horizon has hue of 5YR to 10YR, value of 4 to 6 and 3 or 4 moist, and chroma of 2 to 6. Where the color value is as dark or darker than 5.5 and 3.5 moist, the horizon has chroma of 4 or more or is too thin for a mollic epipedon. It is typically silt loam, but some pedons are loam or very fine sandy loam. It ranges from neutral to moderately alkaline. Some pedons have an AC horizon. It has colors and textures of the A horizon.

The C horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 and 4 to 6 moist, and chroma of 3 to 6. It is loam, silt loam, or very fine sandy loam, but some pedons are silty clay loam in the lower part. It typically has few to many, fine or medium accumulations of carbonate in the upper part. It ranges from slightly to strongly alkaline.

The Cr horizon is reddish colored silty shale, siltstone, or sandstone and is below depths of 40 inches. It ranges from slightly to strongly alkaline.

Mean annual soil temperature: 8 to 15 degrees C (47 to 58 degrees F).

Mean summer soil temperature: 15 to 26 degrees C (59 to 78 degrees F).

Mollic epipedon: thickness ranges from 18 to 51 centimeters (7 to 20 inches)

Depth to secondary calcium carbonate: 20 to 76 centimeters (8 to 30 inches)

Depth to the base of the Bt horizon: 38 to 76 centimeters (15 to 30 inches)

Organic carbon: ranges from .6 to 2 percent in the mollic epipedon and decreases uniformly with depth.

Rock fragments: range from 0 to 15 percent but are usually less than 5 percent.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-14 inches. Sodium absorption ratio was unsuitable at 38-60 inches. Violently effervescent at 14 inches. Estimated stripping depth is 14 inches.

Geographic Setting (According to Official Series Description) –

Parent material: thick, moderately coarse textured, calcareous material.

Landform: hills and plains

Slope: 0 to 25 percent

Elevation: 1219 to 1829 meters (4000 to 6000 feet).

Mean annual precipitation: 33 to 43 centimeters (13 to 17 inches), with peak periods of precipitation occurring during the spring and summer.

Mean annual temperature: 10 to 12 degrees C (49 to 53 degrees F).

Average summer temperature: 20 to 23 Degree C (68 to 73 degrees F).

Frost-free season: about 130 to 160 days.

CUSHMAN  
LOAM

Soil Mapping Unit "Cy"  
Lab/BKS Sample ID: G08020803-040\_043

Typical Pedon: Cushman loam - on south facing slope of about 3 percent under native grass vegetation. (Colors are for dry soil unless otherwise stated.)

The Cushman series consists of well drained soils that are moderately deep to bedrock. These soils formed in slopewash alluvium and residuum from interbedded shales and siltstone and fine-grained argillaceous sandstone. Cushman soils are on buttes, fan remnants, hills, piedmonts, ridges and terraces. Slopes are 0 to 20 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 45 degrees F

**A** - 0-2 inches. Light brownish gray (10YR 6/2) loam, moist; moderate medium granular structure; soft, friable, slightly sticky and slightly plastic; common very fine, fine, and few medium roots; clear smooth boundary; neutral (pH 6.6); noneffervescent.

**Bt** - 2-7 inches. Brown (10YR 5/3) clay loam, moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; common very fine, fine and few medium roots; few faint clay films on faces of peds and lining pores; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

**Btk** - 7-13 inches. Brown (10YR 4/3DW) clay loam, moist; moderate coarse prismatic structure parting to strong medium angular blocky; hard, firm, moderately sticky and moderately plastic; few fine, medium and coarse roots; common distinct clay films on faces of peds, lining pores and root channels; clear wavy boundary; moderately alkaline (pH 8.1); strongly effervescent.

**Ck** - 13-25 inches. Dark grayish brown (10YR 4/2D, 10YR 3/2W) clay loam, moist; moderate coarse prismatic structure parting to moderate fine and very fine subangular blocky; hard, firm, moderately sticky and moderately plastic; few fine roots; few faint clay films on faces of peds; calcium carbonate on faces of peds and in pores as common distinct irregularly shaped filaments and masses; clear smooth boundary; moderately alkaline (pH 8.3); strongly effervescent.

Type Location - Sheridan County, Wyoming; refer to waypoint 50 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to a paralithic contact and bedrock is typically about 28 to 32 inches but ranges from 20 to 40 inches. Depth to continuous horizons of carbonate accumulation is 7 to 26 inches. Depth to the base of the argillic horizon ranges from 10 to 26 inches. Rock fragments range from 0 to 15 percent and are soft shale channers or semirounded sandstone pebbles. The soil is dry in the moisture control section more than half the time cumulative that the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, and is dry in all parts of the moisture control section for at

least 60 consecutive days from July 15 to October 25 and for at least 90 cumulative days during this period. The mean annual soil temperature is 47 to 53 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days. EC ranges from 0 to 2 mmhos throughout.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Reaction is neutral or slightly alkaline.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Texture of the Bt is clay loam or loam with 20 to 35 percent clay and more than 15 percent but less than 35 percent fine sand or coarser. Reaction is neutral to moderately alkaline.

The Btk horizon has hue of 10YR or 2.5Y, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. Texture is loam or clay loam with 20 to 35 percent clay. Reaction is moderately alkaline or strongly alkaline. Calcium carbonate ranges from 3 to 12 percent.

The Bk horizon has hue of 10YR and 2.5Y, value of 6 to 8 dry, 4 to 6 moist, and chroma of 2 to 4. Texture is loam or clay loam with 20 to 30 percent total clay of which about 2 to 4 percent is carbonate clay. Reaction is typically moderately alkaline but may be strongly alkaline when sodic shales are present. Calcium carbonate equivalent is 5 to 15 percent, but some horizons may exceed 15 percent but are discontinuous or too thin to be considered as a calcic.

The Cr is weakly consolidated sedimentary rock. It is primarily calcareous shale; but siltstone or thinly interbedded fine grained argillaceous sandstone is common. The rock is typically moderately alkaline or strongly alkaline when crushed, but slightly alkaline or neutral shales are not uncommon.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Ustic Haplargids

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 7 inches. Estimated stripping depth is 25 inches.

Geographic Setting (According to Official Series Description) - Cushman soils are on buttes, fan remnants fan piedmonts, hills and ridges. Slopes range from 0 to 20 percent. The soils formed in moderately fine textured slopewash alluvium and residuum. Surface erosion is common in overgrazed areas, and some thin eolian deposits overlie these soils in some areas. Elevations are 3,500 to 6,000 feet. The mean annual precipitation is 13 inches and ranges from 10 to 14 inches with over half of the annual precipitation falling in April, May, and June and less than one inch falling in each month of July, August, September and October. The mean annual temperature is 43 to 51 degrees F. The frost-free season is about 105 to 130 days depending upon elevation, aspect, and air drainage.

ZIGWEID  
SILTY CLAY LOAM

Soil Mapping Unit "Zn"  
Lab/BKS Sample ID: G08020803-044\_048

Typical Pedon: Zigweid silty clay loam - on a 3 percent southwest facing slope utilized as rangeland. (Colors are for dry soil unless otherwise stated.)

The Zigweid series consists of very deep, well drained soils formed in alluvium from mixed sedimentary sources on fan aprons, alluvial fans, fan piedmonts, fan remnants, terraces, ridges and hills. Slopes range from 0 to 20 percent. Permeability is moderate. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 46 degrees F.

**A** - 0-3 inches. Light brownish gray (10YR 6/2) silty clay loam, moist; moderate fine and medium granular structure; slight hard, friable, nonsticky and nonplastic; many very fine and fine roots throughout; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

**B1** - 3-14 inches. Brown (10YR 5/3D, 10YR 4/2W) silty clay loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout and few medium throughout; carbonates are disseminated throughout; gradual wavy boundary; slightly alkaline (pH 7.7); very slightly effervescent.

**B2** - 14-26 inches. Dark grayish brown (10YR 4/2DW) silty clay loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; gradual wavy boundary; slightly alkaline (pH 7.6); very slightly effervescent.

**C1** - 26-36 inches. Yellowish brown (10YR 5/4D, 10YR 4/3W) silt loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; gradual wavy boundary; slightly alkaline (pH 7.5); very slightly effervescent.

**C2** - 36-60 inches. Brown (10YR 5/3D, 10YR 4/2W) loam, moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; slightly alkaline (pH 7.7); strongly effervescent.

Type Location - Campbell County, Wyoming; refer to waypoint 56 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to carbonates ranges from 0 to 8 inches. Depth to the Bk horizon and the base of the cambic horizon ranges from 10 to 22 inches. The particle-size control section and soil profile are clay loam or loam. Clay ranges from 18 to 35 percent, silt from 20 to 55 percent, and sand from 15 to 50 percent with more than 15 percent but less than 35 percent fine sand or coarser. Rock fragments range from 0 to 15 but are typically less than 5 percent and are mostly soft shale chips. The moisture control section is usually dry in all parts for 90 cumulative days following the summer solstice and for 60 consecutive days during this period. The mean annual soil temperature is 47 to 53 degrees F. The soil temperature at a depth of 20 inches is 41 degrees F. or warmer for 175 to 192 days.

The A horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 or 3. It is loam or clay loam. Reaction is neutral to moderately alkaline.

The Bw horizon has hue of 5Y, 2.5Y or 10YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 to 4. It is loam or clay loam. Reaction is slightly alkaline or moderately alkaline.

The Bk horizon has hue of 5Y, 2.5Y or 10YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. It is loam or clay loam. It has 5 to 14 percent calcium carbonate equivalent and may have a few scattered crystals of calcium sulfate. Reaction is moderately alkaline or strongly alkaline.

Some pedons have a C horizon with similar properties as the Bk horizon. Some pedons may have sandy clay loam textures below 40 inches. It typically has 3 to 5 percent less calcium carbonate than the overlying Bk horizon.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Ustic Haplocambids

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 36 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - These soils are on fan aprons, alluvial fans, terraces, fan piedmonts, fan remnants, ridges and hills. In many areas they are dissected. Slopes range from 0 to 20 percent. These soils formed in calcareous, moderately fine textured sediments derived from interbedded shale and soft sandstone. Elevations are 3,500 to 6,600 feet. The mean annual precipitation is 13 inches with over half of the annual precipitation falling in April, May, and June and less than one inch falling in each month of July, August, September, and October. Precipitation ranges from 10 to 14 inches. The mean annual temperature is about 46 degrees F., and ranges from 43 to 51 degrees F. The frost-free season is about 105 to 130 days.

BUTCHE  
CLAY LOAM

Soil Mapping Unit "Bw"  
Lab/BKS Sample ID: G08020803-049\_050

Typical Pedon: Butche clay loam - on a west-facing convex slope of 25 percent under native grass. When described the soil was moist to 10 inches. (Colors are for dry soil unless otherwise stated.)

The Butche series consists of shallow, well drained to excessively drained soils formed in loamy materials weathered from sandstone. Permeability is moderate or moderately rapid. Slopes range from 1 to 60 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 46 degrees F.

**A** - 0-2 inches. Dark grayish brown (2.5Y 4/2DW) loam, moist; weak fine granular structure; soft, very friable; coarse fragments make up about 20 percent by volume; clear wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

**C** - 2-8 inches. Grayish brown (2.5Y 5/2DW) sandy loam, moist; weak medium and coarse subangular blocky structure; slightly hard, very friable; coarse fragments make up about 30 percent by volume; abrupt wavy boundary; slightly alkaline (pH 7.6); very slightly effervescent.

Type Location - Custer County, South Dakota; refer to waypoint 57 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil has an Ustic moisture regime that borders on Aridic. Depth to sandstone ranges from 7 to 20 inches. Coarse fragments ranging in size from channery sandstone fragments up to massive slabs of sandstone about 3 feet in diameter are on the surface and mixed throughout the A and C horizons. Some pedons also have rounded cobble and stones of igneous and metamorphic rocks unrelated to the underlying sedimentary sandstone. The coarse fragments and flagstones make up 10 to 35 percent by volume of the soil mass. The control section typically is loam averaging between 15 and 25 percent clay and more than 15 percent fine sand or coarser.

The A horizon has hue of 10YR or 7.5YR, value of 4 to 6 and 2 to 4 moist, and chroma of 1.5 to 3 dry or moist. Where the color value is as dark or darker than 5.5 and 3.5 moist, the A horizon is too thin for a mollic epipedon. The A horizon is cobbly loam, cobbly fine sandy loam, stony loam, stony fine sandy loam, channery loam, loam, sandy loam, or fine sandy loam. It is slightly acid or neutral.

The C horizon typically has 10YR hue, but some pedons have hue of 7.5YR or 5YR due to variations in color of the underlying sandstone, value of 5 to 7 and 4 to 6 moist, and chroma of 2 to 6. The C horizon is cobbly loam, channery loam, stony loam, stony fine sandy loam, channery fine sandy loam, loam, sandy loam and fine sandy loam. It ranges from slightly acid to slightly

alkaline. In some pedons there is an incipient cambic horizon 1 to 2 inches thick that is intermediate in color between the A and C horizon and has more pronounced structure than the C horizon. It is not continuous and is irregular in its shape and occurrence.

The R horizon is very hard sandstone and is hard and difficult to penetrate. It lacks free carbonates.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Loamy, mixed, superactive, nonacid, mesic Aridic Lithic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Estimated stripping depth is 8 inches.

Geographic Setting (According to Official Series Description) - Butche soils are sloping to very steep on uplands with gradients ranging from 1 to 60 percent. The Butche soils are formed in loamy materials weathered from noncalcareous sandstone. The mean annual temperature ranges from 45 to 49 degrees F, and mean annual precipitation from 13 to 18 inches. Elevations range from 3000 to 5500 feet.

SAMSIL  
CLAY LOAM

Soil Mapping Unit "Sa"

Lab/BKS Sample ID: G08020805-001\_002

Typical Pedon: Samsil clay loam - on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-3 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; slightly alkaline (pH 7.5); noneffervescent.

**AC** - 3-10 inches. Gray (10YR 5/1D) clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; moderately alkaline (pH 8.4); strongly effervescent.

**Ck** - 10-18 inches. Very dark gray (10YR 3/1D) silt loam, moist; massive; hard, friable, sticky and plastic; common fine roots; about 50 percent by volume of fragments of soft shale; common distinct olive yellow (2.5Y 6/6) stains on faces of shale fragments; few fine and medium accumulations of carbonate; gradual wavy boundary; moderately alkaline (pH 8.2); strongly effervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 60 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-10 inches. Electrical conductivity was marginal at 10-18 inches. Sodium absorption ratio was marginal at 3-18 inches. Selenium was marginal at 10-18 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

PAUNSAUGUNT  
LOAM

Soil Mapping Unit "Pa"  
Lab/BKS Sample ID: G08020805-004\_006

Typical Pedon: Paunsaugunt loam-rangeland. (Colors are for dry soil unless otherwise stated.)

The Paunsaugunt series consists of well drained, moderately permeable soils that are shallow to limestone. They formed in residuum from limestone and calcareous sandstone. Paunsaugunt soils are on mesas and hillsides with slopes ranging from 2 to 70 percent. The average annual precipitation is about 15 inches. The mean annual temperature is about 43 degrees F.

**A** - 0-2 inches. Brown (10YR 5/3) loam, moist, crushed; weak medium subangular blocky structure that parts to weak fine granular structure; soft, friable, common fine and medium roots; common fine and very fine interstitial pores; 30 percent cobbles; strongly calcareous; carbonates are disseminated; clear smooth boundary; slightly acid (pH 6.4); noneffervescent.

**Bo** - 2-6 inches. Dark yellowish brown (10YR 4/4D) loam, moist, crushed; weak medium subangular blocky structure that parts to weak fine granular structure; soft, friable, common fine and medium roots; common fine and very fine interstitial pores; 30 percent cobbles; strongly calcareous; carbonates are disseminated; clear smooth boundary; neutral (pH 7.3); noneffervescent.

**Ck** - 6-18 inches. Very pale brown (10YR 7/4D) clay loam, moist; crushed; weak fine subangular blocky structure parting to weak fine granular structure; soft, friable; many medium and coarse roots; few fine and very fine pores; 45 percent cobbles; strongly calcareous; carbonates are disseminated; abrupt wavy boundary; moderately alkaline (pH 7.4); strongly effervescent.

Type Location - Garfield County, Utah; refer to waypoint 63 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The mean annual soil temperature is 41 to 47 degrees F., and a mean summer soil temperature immediately above bedrock of about 59 to 64 degrees F. The soil moisture regime is typic ustic.

The mollic epipedon is 4 to 12 inches thick and constitutes over one-third the thickness of soil above bedrock. The depth to bedrock ranges from 10 to 20 inches. Rock fragments average 35 to 60 percent in the particle-size control section. Clay content ranges from 15 to 27 percent.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry, and chroma of 1 to 3 dry and moist. Reaction is mildly to moderately alkaline.

The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry, 3 to 5 moist and chroma of 2 or 3. It is very channery, very gravelly or very cobbly loam, or very cobbly sandy loam.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Loamy-skeletal, mixed, superactive, frigid Lithic Haplustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 6 inches. Estimated stripping depth is 18 inches.

Geographic Setting (According to Official Series Description) - The Paunsaugunt soils are on undulating mesas, gently sloping to very steep hills, and mountainsides. Elevations range from 6,000 to 8,400 feet. The soils formed in residuum on limestone and calcareous sandstone. Slope gradients are 2 to 70 percent. The average annual precipitation is 16 to 22 inches and the freeze free period ranges from 70 to 100 days. The mean annual temperature is 39 to 45 degrees F., and the average summer temperature is 59 to 64 degrees F.

BONEEK  
SILTY CLAY LOAM

Soil Mapping Unit "Bo"  
Lab/BKS Sample ID: G08020805-007\_011

Typical Pedon: Boneek silty clay loam - on a northeast-facing plane slope of 4 percent under native grass at 3500 feet elevation. (Colors are for dry soil unless otherwise stated.)

The Boneek series consists of deep and very deep, well drained soils formed in silty sediments underlain by sandstone or siltstone. Permeability is moderately slow in the solum and moderate in the underlying material. Slopes range from 0 to 15 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 46 degrees F.

**A** - 0-6 inches. Dark yellowish brown (10YR 4/4D) silty clay loam, moist; moderate thin platy structure parting to weak fine granular; slightly hard, very friable; many fine roots; clear wavy boundary; neutral (pH 7.1); noneffervescent.

**Btk** - 6-17 inches. Brown (10YR 5/3D) silty clay loam, moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, friable, slightly sticky and slightly plastic; common fine roots; shiny films on faces of peds; clear wavy boundary; moderately alkaline (pH 8.1); noneffervescent.

**C1k** - 17-33 inches. Light yellowish brown (10YR 6/2D) silty clay loam, moist; weak medium and coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few fine roots; common fine and medium accumulations of carbonate; gradual wavy boundary; strongly alkaline (pH 8.5); strongly effervescent.

**C2k** - 33-42 inches. Grayish brown (10YR 5/2D) silty clay loam, moist; few fine and medium prominent mottles of strong brown (7.5YR 5/8) moist; weak coarse subangular blocky structure; very hard, friable; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); strongly effervescent.

**C3k** - 42-60 inches. Light olive brown (2.5Y 5/3D) silty clay loam, moist; thin platy rock structure; faces of fractures stained strong brown (7.5YR 5/6) moist; few coatings of carbonates on faces of fractures, but matrix is noncalcareous; moderately alkaline (pH 8.1); strongly effervescent.

Type Location - Butte County, South Dakota; refer to waypoint 64 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock is 40 to 60 inches or more. Depth to carbonates ranges from 11 to 24 inches. Thickness of the mollic epipedon ranges from 7 to 15 inches and extends into the Bt horizon of some pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 and 2 or 3 moist, and chroma of 2 or 3. It typically is silt loam, but some pedons are loam. It is slightly acid or neutral.

The Bt1 horizon has hue of 7.5YR or 5YR, value of 4 or 6 and 3 or 4 moist, and chroma of 2 to 4. It is silty clay loam or silty clay. Average clay content ranges from 35 to 45 percent with less than 15 percent fine sand or coarser. It is slightly acid or neutral.

The Bt2 horizon has hue of 10YR or 7.5Y, value of 5 or 6 and 3 or 5 moist, and chroma of 2 to 4. It is silty clay loam averaging between 30 and 40 percent clay and less than 15 percent fine sand or coarser. It is neutral or slightly alkaline.

The Bk and C horizons have hue of 10YR or 2.5Y, value of 5 through 7 and 4 or 5 moist, and chroma of 1 to 3. They typically are silt loam or silty clay loam, but some pedons are loam. They are slightly alkaline to strongly alkaline. Few to many, fine or medium accumulations of carbonate are in the Bk horizon.

The Cr horizon has hue of 10YR or 7.5YR.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - Electrical conductivity was marginal at 33-42 inches. pH was marginal (Alkaline) at 17-33 inches. Selenium was marginal at 33-42 inches. Strongly effervescent at 17 inches. Estimated stripping depth is 17 inches.

Geographic Setting (According to Official Series Description) - Boneek soils are nearly level to moderately sloping on high terraces and uplands. Surfaces are plane to slightly convex and slope gradients range from 0 to 15 percent. The soils formed in a silty mantle overlying sandstone or siltstones, or in loess or silty alluvium. Mean annual temperature ranges from 43 to 48 degrees, and mean annual precipitation ranges from 15 to 18 inches. Most of the precipitation comes in the spring and summer.

ARVADA  
SILTY CLAY LOAM

Soil Mapping Unit "Ar"

Lab/BKS Sample ID: G08020805-012\_016

Typical Pedon: Arvada silty clay loam - rangeland. (Colors are for dry soil unless otherwise stated.)

The Arvada series consists of very deep, well drained soils formed in alluvium and colluvium derived from sodic shale. Arvada soils are on alluvial fans, fan remnants, fan terraces and hillslopes. Slopes are 0 to 25 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 46 degrees F.

**A** - 0-3 inches. Light gray (10YR 7/2) silty clay loam, moist; moderate very thin platy structure parting to moderate very fine granular; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; abrupt smooth boundary; slightly acid (pH 6.3); noneffervescent.

**Bt** - 3-18 inches. Dark grayish brown (2.5Y 4/2DW) clay loam, moist; moderate medium columnar structure parting to moderate medium angular blocky; extremely hard, firm, sticky and very plastic; common medium roots; many prominent clay films on faces of peds and in root channels; ESP is 20 percent; clear smooth boundary; slightly alkaline (pH 7.6); noneffervescent.

**Btn** - 18-28 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 5/2W) silty clay, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 7.9); very slightly effervescent.

**C1n** - 28-43 inches. Grayish brown (2.5Y 5/2D, 2.5Y 4/2W) silt loam, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 8.2); very slightly effervescent.

**C2nsa** - 43-60 inches. Very dark grayish brown (10 YR 3/2DW) silt loam, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 8.3); slightly effervescent.

Type Location - Sheridan County, Wyoming; refer to waypoint 72 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to effervescent material ranges from 0 to 19 inches. Depth to layers with greater than 15 percent exchangeable sodium is 4 to 10 inches. The depth to the base of the Bt horizon is 15 inches or more. A thin A horizon occurs in some pedons. A light colored platy E horizon is generally present but is absent

in some pedons. Gravel is typically less than 5 percent but ranges from 0 to 15 percent. The moisture control section is usually dry for 60 consecutive days during the 90 day period following the summer solstice. The mean annual soil temperature is 47 to 53 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 195 days. The soil has an aridic moisture regime that borders on ustic.

The E and A horizons have hue of 10YR, 2.5Y or 5Y, value of 4 to 7, 4 or 5 moist, and chroma of 2 to 4. Texture is fine sandy loam, loam, silt loam, clay loam or very fine sandy loam. Reaction ranges from neutral through strongly alkaline. EC ranges from 0 to 4 mmhos/cm.

The Btn horizon has hue of 7.5YR, 10YR, 2.5Y or 5Y, value of 4 to 6 dry, 4 or 5 moist, and chroma of 2 to 4. Texture is clay, clay loam, silty clay or silty clay loam and has 35 to 60 percent clay, 10 to 50 percent silt, and 5 to 45 percent sand. This horizon is strongly alkaline or very strongly alkaline (pH 8.8 to 10.0), has 15 to 34 percent exchangeable sodium, and an EC of 4 to 16 mmhos/cm. Some pedons when buffered by gypsum are moderately alkaline. The Btkn horizon, when present, has a calcium carbonate equivalent of 3 to 12 percent and an exchangeable sodium percent of 10 to 30. A thin Bt horizon is present above the Btn in some pedons. Some pedons have a Btkny horizon.

The Bkny horizon has hue of 7.5YR, 10YR or 2.5Y, value of 5 or 6 dry, 4 or 5 moist. Textures are clay, clay loam, silty clay or silty clay loam. Reaction ranges from strongly alkaline or very strongly alkaline (pH 8.6 to 10.0). This horizon contains 4 to 15 percent calcium carbonate equivalent. Some pedons when buffered by gypsum are moderately alkaline. Exchangeable sodium typically ranges from 10 to 30 percent but decreases with increasing depth. Electrical conductivity is 4 to 16 mmhos/cm. Some pedons have a C horizon.

Some pedons have a C horizon below 40 inches. It has properties similar to those of the Bkny horizon.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Ustertic Natrargids

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 18-28 inches. Electrical conductivity was marginal at 28-60 inches. Sodium absorption ratio was marginal at 28-43 inches and was unsuitable at 43-60 inches. Selenium was marginal at 18-60 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 18 inches.

Geographic Setting (According to Official Series Description) - The Arvada soils are on alluvial fans, fan remnants, terraces and hillslopes. The soils formed in moderately fine textured alluvium and colluvium derived from sedimentary rocks. Slopes range from 0 to 25 percent. Elevations range from 2,600 to 6,000 feet. The average annual precipitation is about 12 inches but ranges from 9 to 14 inches with about half the precipitation occurring during April, May, and early June. The mean annual air temperature is about 43 to 53 degrees F., and the mean summer

temperature is 63 degrees F. The frost-free season is estimated to range from 100 to 160 day

LOHMILLER  
LOAM

Soil Mapping Unit "Lo"

Lab/BKS Sample ID: G08020805-017\_022

Typical Pedon: Lohmiller loam - on a plane slope of less than 1 percent in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

The Lohmiller series consists of very deep, well drained soils formed in alluvium on bottom lands. Permeability is slow or moderately slow. Slopes range from 0 to 8 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

**A** - 0-3 inches. Light gray (10YR 6/1) loam, moist; moderate medium granular structure; hard, friable; many fine roots; neutral; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

**AC** - 3-15 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; weak thin platy structure parting to weak fine granular; very hard, firm; common fine roots, clear smooth boundary; moderately alkaline (pH 7.9); noneffervescent.

**C1** - 15-23 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; slightly alkaline (pH 7.8); noneffervescent.

**C2n** - 22-34 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

**C3k** - 34-38 inches. Grayish brown (2.5Y 5/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

**C4n** - 38-60 inches. Dark grayish brown (2.5Y 4/2W) clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 73 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Carbonates are within 10 inches of the surface. The control section averages from 35 to 50 percent clay.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Some pedons have value of 4 dry and 3 moist in the upper 4 inches. It typically is silty clay loam or clay loam but is silty clay in some pedons. It ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 and 4 to 6 moist; and chroma of 2 to 4. It typically is clay loam or silty clay loam but is silty clay or clay in some pedons. It is stratified with thin layers of loamy sand, fine sandy loam, loam, sandy clay or silt loam. It is slightly alkaline or moderately alkaline. Some pedons have accumulations of carbonates.

Range in Characteristics (according to field observations, lab analysis): Textures have slightly more clay than typical for the series.

Taxonomic Class - Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-60 inches. Saturation percentage was marginal at 15-34 inches and 38-60 inches. Sodium absorption ratio was unsuitable at 3-60 inches. Electrical conductivity was marginal at 15-23 inches and was unsuitable at 23-60 inches. Selenium was marginal at 15-60 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Lohmiller soils are on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes. Slopes are typically less than 2 percent but range from 0 to 8 percent. The soils formed in calcareous alluvium from sedimentary rock. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 10 to 19 inches.

PIERRE  
SANDY CLAY LOAM

Soil Mapping Unit "Pe"

Lab/BKS Sample ID: G08020805-023\_028

Typical Pedon: Pierre sandy clay loam - on a convex slope of 7 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Pierre series consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. Permeability is very slow. Slopes range from 0 to 30 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

**A** - 0-3 inches. Grayish brown (2.5Y 5/2) sandy clay loam, moist; moderate fine subangular blocky structure parting to weak very fine granular; hard, firm, sticky and plastic; 1 percent pebbles; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

**AC**- 3-15 inches. Dark grayish brown (2.5Y 4/2W) sandy clay loam, moist; moderate medium and coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine accumulations of iron; 1 percent pebbles; gradual wavy boundary; moderately alkaline (pH 8.3); strongly effervescent.

**C1k** – 15-27 inches. Grayish brown (2.5Y 5/2W) clay loam, moist; moderate coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine nests of iron and common fine accumulations of gypsum; 1 percent pebbles; gradual wavy boundary; strongly alkaline (pH 8.5); violently effervescent.

**C2n** – 27-38 inches. Dark grayish brown (2.5Y 4/2W) loam, moist; common distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) iron stains; many fine accumulations of gypsum and carbonate; 1 percent pebbles; gradual wavy boundary; strongly alkaline (pH 8.5); slightly effervescent.

**C3k** – 38-51 inches. Dark grayish brown (2.5Y 4/2W) loam, moist; common distinct strong brown (7.5YR 5/6) iron stains; 1 percent pebbles; moderately alkaline (pH 8.4); strongly effervescent.

**C4n** – 51-60 inches. Dark grayish brown (2.5Y 4/2W) sand loam, moist; common distinct strong brown (7.5YR 5/6) iron stains; 1 percent pebbles; moderately alkaline (pH 8.4); very slightly effervescent.

Type Location - Haakon County, South Dakota; refer to waypoint 74 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil contains carbonates at or within 6 inches of the surface. The depth to soft shale bedrock ranges from 20 to 40 inches but commonly is at depths of 25 to 35 inches. The horizon above the shale has 0 to 60 percent, by volume soft shale fragments. The control section is 50 to 60 percent clay. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The soil does not have a mollic epipedon, but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. The soil has a SAR of 1 to 7.

The A horizon has hue of 10YR to 5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but is silty clay in some pedons. It ranges from slightly acid to moderately alkaline. When the soil is dry it has a light gray (2.5Y 7/2) smooth, porous, platy surface crust ranging from 1/4 to 1 inch in thickness. Where the horizon has mollic colors, it is too thin to be a mollic epipedon. Some pedons do not have an AB horizon.

The Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 1 to 3. They are extremely hard or very hard when dry and extremely firm to firm when moist. They range from neutral to moderately alkaline.

Bk and C horizons are present in some pedons.

The Cr horizon is soft shale bedrock and ranges from slightly acid to moderately alkaline. Bedding planes are evident in the partially weathered shale in some pedons. Gypsum and other salts are concentrated in very thin seams within the shale in some pedons.

Range in Characteristics (according to field observations, lab analysis): Textures are coarser and have less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Leptic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - pH was marginal (alkaline) at 15-38 inches. Sodium absorption ratio was unsuitable at 15-60 inches. Electrical conductivity was unsuitable at 27-60 inches. Selenium was marginal at 15-60 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 15 inches.

Geographic Setting (According to Official Series Description) - Pierre soils are on nearly level to steep uplands. Slope gradient typically is 3 to 15 percent, but ranges from 0 to 30 percent. The soils formed in residuum weathered from clay shale. Gilgai microrelief is in most areas. Mean annual air temperature is 44 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches. Growing season is 125 to 140 days; average growing season precipitation is 10 to 13 inches; and growing degree days are 2600 to 3100. Elevation is 1300 to 3600 feet.

HAVERSON  
CLAY LOAM

Soil Mapping Unit "Ha"  
Lab/BKS Sample ID: G08020805-029\_033

Typical Pedon: Haverson clay loam - grassland. (Colors are for dry soil unless otherwise stated.)

The Haverson series consists of very deep, well drained soils that formed in alluvium from mixed sources. Haverson soils are on floodplains and low terraces and have slopes of 0 to 9 percent. The mean annual precipitation is about 15 inches and the mean annual air temperature is about 49 degrees F.

**A** - 0-4 inches. Brown (10YR 4/3D, 10YR 4/2W) clay loam, moist; strong fine granular structure; slightly hard, very friable; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

**AC** - 4-15 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; weak coarse subangular blocky structure; very hard, friable; clear smooth boundary; slightly alkaline (pH 7.7); very slightly effervescent.

**C1** - 15-35 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; hard, friable; gradual smooth boundary; slightly alkaline (pH 7.6); slightly effervescent.

**C2n** - 35-46 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; slightly hard, very friable; few fine irregularly shaped masses and seams of lime; slightly alkaline (pH 7.8); slightly effervescent.

**C3** - 46-60 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; slightly hard, very friable; few fine irregularly shaped masses and seams of lime; slightly alkaline (pH 7.8); slightly effervescent.

Type Location - Weld County, Colorado; refer to waypoint 75 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Mean annual soil temperature ranges from 47 to 55 degrees F. and mean summer soil temperature ranges from 59 to 78 degrees F. Organic carbon ranges from 0.5 to 2.0 percent in the surface horizon but decreases irregularly with depth. The particle-size control section is stratified with strata ranging from sandy loam to clay loam, but averaging approximately loam. On a weighted average basis, clay ranges from 18 to 35 percent, silt from 10 to 50 percent, and sand from 20 to 60 percent with more than 15 percent but less than 35 percent being fine or coarser sand. Rock fragments are generally less than 5 percent and range from 0 to 20 percent. Some visible calcium carbonate may occur at any depth in these soils, but it is not concentrated into any consistent horizon of accumulation. This soil is not dry in all parts of the moisture control section for more than one-

half the time the soil temperature is above 41 degrees F. (195 to 210 days) and is not dry for 45 consecutive days following July 15.

The A horizon has hue of 2.5Y or 10YR, value of 4 to 6 dry, 3 to 5 moist and chroma of 2 or 3. When the value of the surface horizon is as dark as 5 dry and 3 moist, the horizon is thin enough so that if mixed to 7 inches it is too light colored or contains too little organic carbon to qualify as a mollic epipedon or are finely stratified. The A horizon usually has granular primary structure but it has subangular blocky structure in some pedons. It is soft or slightly hard. It is neutral through moderately alkaline.

The C horizon has hue of 2.5Y, 10YR or 7.5YR, value of 5 or 6 dry, 4 or 5 moist and chroma of 2 or 3. It is slightly alkaline to very strongly alkaline. It has from less-than-one to about 15 percent calcium carbonate equivalent, which differs erratically from stratum to stratum.

Range in Characteristics (according to field observations, lab analysis): Textures are finer and have more clay than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Aridic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Sodium absorption ratio was marginal at 15-35 inches and unsuitable at 35-60 inches. Estimated stripping depth is 35 inches.

Geographic Setting (According to Official Series Description) - The Haverson soils are on floodplains and low terraces of major rivers. Slope is 0 to 9 percent. The soils formed in highly stratified, calcareous, recent alluvium derived from mixed sources. At the type location the average annual precipitation is 14 to 18 inches with peak periods of precipitation occurring during the early spring and summer. The mean annual air temperature ranges from 47 to 52 degrees F. and the mean summer temperature is 77 degrees F. The frost-free season is 125 to 180 days.

DEMAR  
LOAM

Soil Mapping Unit "Dg"

Lab/BKS Sample ID: G08020805-034\_038

Typical Pedon: Demar loam - on a plane slope of less than 1 percent. When described the soil was moist to 5 inches and dry below. (Colors are for dry soil unless otherwise stated.)

The Demar series consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. These soils are on terraces. They have very slow permeability. Slopes range from 0 to 6 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-2 inches. Pale brown (10YR 6/3) loam, moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky; many roots; abrupt wavy boundary; strongly acid (pH 5.3); noneffervescent.

**Bt** - 2-21 inches. Grayish brown (2.5Y 5/2D) silty clay, moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; very few roots; clear smooth boundary; slightly alkaline (pH 7.7); noneffervescent.

**Btn** - 21-29 inches. Very dark grayish brown (2.5Y 3/2D) clay, moist; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; very few roots; common fine nests of gypsum and other salts; gradual boundary; neutral (pH 6.9); very slightly effervescent.

**C1** - 29-46 inches. Dark grayish brown (2.5Y 4/2D) silty clay loam, moist; many coarse prominent brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; very hard, very firm; partially weathered shale fragments make up about 40 percent by volume; common bands of crystals of gypsum; gradual boundary; slightly alkaline (pH 7.6); very slightly effervescent.

**C2** - 46-60 inches. Grayish brown (2.5Y 5/2D) silty clay loam, moist; many coarse prominent brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) iron stains along fractures; neutral (pH 7.3); very slightly effervescent.

Type Location - Butte County, South Dakota; refer to waypoint 76 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale ranges from 40 to 60 inches or more. These soils range from neutral to strongly acid in the upper 12 inches and from very strongly acid to extremely acid below this depth.

The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3.

It typically is loam but is clay loam in some pedons.

The Bt horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. The clay content of the Bt horizon is between 35 and 60 percent. Structure of the Bt horizon ranges from weak or moderate, medium or coarse columnar in the Bt1 horizon and moderate or strong, medium or coarse blocky in the Bt2 horizon.

The Bz horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 to 5 moist, and chroma of 2 to 3. It has common or many accumulations of gypsum and other salts.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It contains 20 to 50 percent fragments of shale.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, mesic Torrertic Haplustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-29 inches. Sodium absorption ratio was marginal at 2-29 inches and unsuitable at 29-60 inches. Selenium was marginal at 46-60 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Demar soils are on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief. Slope gradients range from 0 to 6 percent. These soils formed in clayey alluvium derived from acid clay shales. The mean annual air temperature ranges from 45 to 49 degrees F, and mean annual precipitation ranges from 12 to 18 inches.

PENROSE  
CLAY LOAM

Soil Mapping Unit "Pg"  
Lab/BKS Sample ID: G08020805-039\_042

Typical Pedon: Penrose clay loam-grassland. (Colors are for dry soil unless otherwise stated.)

The Penrose series consists of shallow, well and somewhat excessively drained, moderate to slowly permeable soils formed in thin, calcareous, loamy materials weathered in place from limestone and interbedded limy materials. Penrose soils are on hills, plains, ridges, hogbacks, cuestas, and mesa tops. Slopes are 1 to 65 percent. Mean annual precipitation is about 13 inches and mean annual temperature is about 51 degrees F.

**A** - 0-4 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; 25 percent channers; calcareous; clear smooth boundary; slightly alkaline (pH 7.6); slightly effervescent.

**C1k** - 4-17 inches. Dark grayish brown (10YR 4/2D) clay loam, moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 20 percent limestone channels; calcareous; abrupt smooth boundary; slightly alkaline (pH 7.7); strongly effervescent.

**C2k** - 17-36 inches. Grayish brown (10YR 5/2D) silt loam, limestone bedrock; moderately alkaline (pH 8.0); very slightly effervescent.

**Cr** - 36-48 inches. Grayish brown (10YR 5/2D) silt loam, limestone bedrock; slightly alkaline (pH 7.8); very slightly effervescent.

Type Location - Fremont County, Colorado; refer to waypoint 77 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) –

Soil moisture: The soil moisture control section is moist intermittently April through August; aridic moisture regime bordering on ustic.

Mean annual soil temperature: 52 to 59 degrees F.

Mean summer soil temperature: 68 to 76 degrees F.

Depth to lithic contact: 10 to 20 inches to limestone

Depth to secondary calcium carbonate: 0 to about 5 inches and is not more than 1/4 the thickness of the control section

Gypsum content: 0 to 1.5 percent by weight

Calcium carbonate equivalent: 40 to 75 percent

Electrical conductivity: 0 to 14 millimhos/cm in a major part of the control section

Continuous subhorizons of secondary calcium carbonate and/or sulfate do not occur within the control section although some visible accumulation occurs in some pedons

Particle-size control section (weighted average):

Clay content: 18 to 35 percent

Sand content: 15 to 70 percent  
Rock fragments: 0 to 35 percent, dominantly to 10 inches in diameter.

A horizon:  
Hue: 7.5YR through 2.5Y  
Value: 5 through 8, 3 through 6 moist  
Chroma: 1 through 4.  
Calcium carbonate equivalent: 35 to 70 percent  
Reaction: mildly alkaline or moderately alkaline.  
Rock fragments: 0 to 35 percent

C horizon:  
Hue: 7.5YR through 2.5Y  
Textures of the fine earth fraction: loam, silt loam, clay loam  
Clay content: 18 to 35 percent  
Rock fragments: 0 to 35  
Calcium carbonate equivalent: 40 to 75 percent  
Reaction: moderately alkaline or strongly alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Loamy, carbonatic, mesic Lithic Ustic Torriorthents

Suitability for Topsoil (According to WDEQ Guideline 1) – Boron was unsuitable at 36-48 inches. Strongly effervescent at 4 inches. Estimated stripping depth is 36 inches.

Geographic Setting (According to Official Series Description) –  
Parent material: residuum and slope alluvium derived from limestone and interbedded limy materials.  
Landform: hills, mesas, and ridges  
Slopes: 1 to 65 percent  
Elevation: 3,000 to 6,500 feet  
Mean annual temperature: 50 to 53 degrees F  
Mean annual precipitation: 11 to 15 inches  
Precipitation pattern: peak periods between April and August, dries between November and February  
Frost-free period: 125 to 165 days.

DEMAR  
SILTY CLAY LOAM

Soil Mapping Unit "Dg"  
Lab/BKS Sample ID: G08020805-043\_047

Typical Pedon: Demar silty clay loam - on a plane slope of less than 1 percent. When described the soil was moist to 5 inches and dry below. (Colors are for dry soil unless otherwise stated.)

The Demar series consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. These soils are on terraces. They have very slow permeability. Slopes range from 0 to 6 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-3 inches. Pale brown (10YR 6/3) silty clay loam, moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky; many roots; abrupt wavy boundary; slightly acid (pH 6.1); noneffervescent.

**Bt** - 3-17 inches. Very dark grayish brown (10YR 3/2D) silty clay, moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; very few roots; clear smooth boundary; extremely acid (pH 4.1); noneffervescent.

**C1** - 17-30 inches. Dark grayish brown (10YR 4/2D) clay, moist; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; very few roots; common fine nests of gypsum and other salts; gradual boundary; extremely acid (pH 3.6); noneffervescent.

**C2** - 30-42 inches. Dark grayish brown (10YR 4/2D) clay, moist; many coarse prominent brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; very hard, very firm; partially weathered shale fragments make up about 40 percent by volume; common bands of crystals of gypsum; gradual boundary; extremely acid (pH 3.7); noneffervescent.

**Cr** - 42-60 inches. Dark grayish brown (10YR 4/2D) clay, moist; many coarse prominent brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) iron stains along fractures; extremely acid (pH 3.6); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 79 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale ranges from 40 to 60 inches or more. These soils range from neutral to strongly acid in the upper 12 inches and from very strongly acid to extremely acid below this depth.

The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It typically is loam but is clay loam in some pedons.

The Bt horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. The clay content of the Bt horizon is between 35 and 60 percent. Structure of the Bt horizon ranges from weak or moderate, medium or coarse columnar in the Bt1 horizon and moderate or strong, medium or coarse blocky in the Bt2 horizon.

The Bz horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 to 5 moist, and chroma of 2 to 3. It has common or many accumulations of gypsum and other salts.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It contains 20 to 50 percent fragments of shale.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, mesic Torrertic Haplustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-60 inches. pH was unsuitable (acidic) at 3-60 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Demar soils are on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief. Slope gradients range from 0 to 6 percent. These soils formed in clayey alluvium derived from acid clay shales. The mean annual air temperature ranges from 45 to 49 degrees F, and mean annual precipitation ranges from 12 to 18 inches.

SATANTA  
LOAM

Soil Mapping Unit "Sc"

Lab/BKS Sample ID: G08020806-001\_005

Typical Pedon: Satanta loam - in a cultivated field. (Colors are for dry soil unless otherwise stated.)

The Satanta series consists of very deep well drained soils that formed in eolian deposits. These soils are on plains or high stream terraces in the Central High Tablelands (MLRA 72). Slopes range from 0 to 15 percent. Mean annual temperature is 13 degrees C. (56 degrees F.) and mean annual precipitation is 48 centimeters (19 inches) at the type location.

**A** - 0-4 inches. Dark grayish brown (10YR 4/2) loam, moist; weak fine granular and weak medium platy structure; friable, slightly hard; many fine and medium roots throughout; clear smooth boundary; strongly acid (pH 5.3); noneffervescent.

**Bt** - 4-12 inches. Dark yellowish brown (10YR 3/4D) clay loam, moist; weak medium platy structure; friable, slightly hard; many fine and medium roots throughout; abrupt smooth boundary; neutral (pH 7.1); noneffervescent.

**BC** - 12-17 inches. Brown (10YR 4/3D) sandy clay loam, moist; moderate medium subangular blocky and weak medium platy structure; friable, slightly hard; common fine roots throughout; 10 percent continuous distinct clay films on faces of peds; gradual smooth boundary; slightly alkaline (pH 7.6); strongly effervescent.

**C1k** - 17-28 inches. Brown (10YR 5/3D) sandy clay loam, moist; moderate medium subangular blocky and moderate medium prismatic structure; friable, hard; common fine roots throughout; common fine moderate continuity tubular pores; 10 percent continuous distinct clay films on faces of peds; gradual smooth boundary; moderately alkaline (pH 7.9); strongly effervescent.

**C2k** - 28-43 inches. Grayish brown (10YR 5/2D) sandy clay loam, moist; moderate medium prismatic and moderate medium subangular blocky structure; friable, hard; common fine roots throughout; common fine and medium moderate continuity tubular pores; 10 percent continuous distinct clay films on faces of peds; clear smooth boundary; moderately alkaline (pH 7.9); strongly effervescent.

Type Location - Haskell County, Kansas; refer to waypoint 82 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) -

Calcium carbonate equivalent in the series control section: less than 15 percent

Coarse fragments: 0 to 10 percent gravel by volume

Depth to carbonates: 30 to 91 centimeters (12 to 36 inches)

Mollic epipedon thickness: 20 to 51 centimeters (8 to 20 inches)

Phases recognized: Sandy substratum, gravelly substratum, dry, elevation greater than 1219 meters (4,000 feet)

A horizon:

Hue: 10YR

Value: 4 to 5, 2 to 3 moist

Chroma: 2 to 3

Reaction: slightly acid to slightly alkaline

Texture: loam, very fine sandy loam, clay loam, fine sandy loam

Comments: Some pedons have a BA horizon that is intermediate in color and texture between the A and Bt horizons.

Bt horizon:

Hue: 7.5YR to 2.5Y

Value: 4 to 6, 3 to 5 moist

Chroma: 2 to 4

Reaction: neutral to moderately alkaline

Texture: loam, sandy clay loam, clay loam with 15 to 35 percent fine and coarser sand and less than 50 percent sand

Bk or 2Bkb horizons:

Hue: 7.5YR to 2.5Y

Value: 4 to 6, 3 to 5 moist

Chroma: 2 to 6

Reaction: slightly to strongly alkaline

Texture: loam, sandy clay loam, clay loam with 15 to 35 percent fine and coarser sand and less than 50 percent sand

C or 3Ck horizons:

Hue: 10YR, 2.5Y

Value: 5 to 7, 4 to 6 moist

Chroma: 2 to 6

Reaction: slightly or moderately alkaline

Texture: loam, silt loam, clay loam, sandy clay loam, very fine sandy loam, loamy fine sand, fine sandy loam

Comments: Some pedons have a BCk horizon that has few carbonates that occur as seams, threads or concretions.

Range in Characteristics (according to field observations, lab analysis): Textures are coarser than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - pH was marginal (acidic) at 0-4 inches. Strongly effervescent at 12 inches. Estimated stripping depth is 43 inches.

Geographic Setting (According to Official Series Description) –

Landscape: terraces on nearly level to undulating plains

Landform: plains, high stream terraces

Slopes: 0 to 15 percent

Elevation: 610 to 1372 meters (2000 to 4500 feet)

Parent material: eolian deposits

Mean annual air temperature: 7 to 14 degrees C. (45 to 57 degrees F.)

Mean annual precipitation: 35 to 56 centimeters (14 to 22 inches)

Frost-free period: 140 to 200 days

Thornthwaite Annual PE Index: 25 to 40

SNOMO  
SILTY CLAY LOAM

Soil Mapping Unit "Gs"  
Lab/BKS Sample ID: G08020806-006\_011

Typical Pedon: Snomo silty clay loam- on an 8 percent north-facing slope in scattered trees with native grass understory. (Colors are for dry soil unless otherwise stated.)

The Snomo series consists of deep or very deep, well drained soils formed in clayey materials weathered from acid shale on the uplands. These soils have moderate permeability. Slopes range from 2 to 20 percent. Mean annual precipitation is about 17 inches and mean annual air temperature is about 45 degrees F.

**A** - 0-3 inches. Light gray (10YR 6/1) silty clay loam, moist; weak thick platy structure parting to weak fine granular; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; clear smooth boundary; very strongly acid (pH 4.8); noneffervescent.

**Bt1** - 3-17 inches. Grayish brown (10YR 5/2D) silty clay, moist, rubbed dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; very hard, friable, sticky and plastic; common fine roots; clear smooth boundary; very strongly acid (pH 4.8); noneffervescent.

**BtC** - 17-33 inches. Dark grayish brown (10YR 4/2D) silty clay, moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few fine roots; few fine fragments of shale; clear wavy boundary; moderately acid (pH 5.7); noneffervescent.

**C1n** - 33-42 inches. Grayish brown (10YR 5/2D) silt loam, moist; few fine distinct mottles of yellow (2.5Y 8/6) massive; slightly hard, friable, sticky and plastic; few fine roots; many fine fragments of shale, abrupt wavy boundary; slightly acid (pH 7.6); noneffervescent.

**C2n** - 42-52 inches. Brown (10YR 5/3D) silt loam, moist; massive; slightly hard, friable, sticky and plastic; many coarse fragments of brittle shale; extremely acid; clear wavy boundary; moderately acid (pH 7.9); noneffervescent.

**C3n** - 52-60 inches. Pale brown (10YR 6/3D) silt loam, moist; yellow (5Y 8/6) and yellowish red (5YR 5/8) coatings on fracture faces of shale; moderately acid (pH 7.9); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 83 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Bedded shale typically is between a depth of 40 and 60 inches but is below 60 inches in some pedons. Colors throughout the soil are inherent to the shale.

The A horizon has hue of 10YR, value of 5 to 7 and 3 or 4 moist, and chroma of 1 or 2. It is silty clay or clay and contains 0 to 15 percent by volume of fine fragments of shale less than 3 mm in size. It is extremely acid to slightly acid. Some pedons have a thin distinct E horizon as evidenced by prominent clean silt and sand grains.

The Bw horizon has hue of 10YR, 2.5Y, and 7.5YR, value of 5 or 6 and 3 or 4 moist, and chroma of 2 to 4. Moist value typically is one unit higher when rubbed. It has 0 to 20 percent by volume of fine fragments of shale less than 3 mm in size. It is strongly acid to extremely acid.

The BC and C horizons have hue of 10YR or 2.5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. Moist value typically is one unit higher when rubbed. They have 15 to 50 percent by volume of fine to coarse fragments of shale ranging from 1 to 25 mm in size. They are very strongly acid or extremely acid.

The Cr horizon is multicolored in hue of 10YR, 2.5Y, or 5Y; and is very hard and brittle but has a hardness of less than 3 on the Moh's scale of hardness. It is very strongly acid or extremely acid.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Torrertic Dystrustepts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-33 inches. pH was unsuitable (acidic) at 0-17 inches. Saturation percentage was marginal at 45-52 inches. Boron was unsuitable at 33-60 inches. Estimated stripping depth is 0 inches.

Geographic Setting (According to Official Series Description) - Snomo soils are on gently sloping to moderately steep uplands. Slope gradients range from 2 to 20 percent. The soil formed in clayey materials weathered from acid shale. Mean annual temperature ranges from 43 to 48 degrees F, and precipitation from 14 to 18 inches.

LOHMILLER  
SILTY CLAY LOAM

Soil Mapping Unit "Lo"  
Lab/BKS Sample ID: G08020806-012\_016

Typical Pedon: Lohmiller silty clay loam- on a plane slope of less than 1 percent in a cultivated field. (Colors are for dry soil unless otherwise stated.)

The Lohmiller series consists of very deep, well drained soils formed in alluvium on bottom lands. Permeability is slow or moderately slow. Slopes range from 0 to 8 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

**A** - 0-5 inches. Light gray (10YR 6/1) silty clay loam, moist; moderate medium granular structure; hard, friable; many fine roots; neutral; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

**C1n** - 5-18 inches. Very dark grayish brown (10YR 3/2D) silty clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.2); noneffervescent.

**C2n** - 18-37 inches. Brown (10YR 4/3D) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.4); noneffervescent.

**C3n** - 37-47 inches. Brown (10YR 5/3D) silty clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.3); very slightly effervescent.

**C4n** - 47-60 inches. Dark grayish brown (10YR 4/2D) clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.1); very slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 84 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Carbonates are within 10 inches of the surface. The control section averages from 35 to 50 percent clay.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Some pedons have value of 4 dry and 3 moist in the upper 4 inches. It typically is silty clay loam or clay loam but is silty clay in some pedons. It ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 and 4 to 6 moist; and chroma of 2 to 4. It typically is clay loam or silty clay loam but is silty clay or clay in some pedons. It is stratified with thin layers of loamy sand, fine sandy loam, loam, sandy clay or silt loam. It is

slightly alkaline or moderately alkaline. Some pedons have accumulations of carbonates.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 18-37 inches. Saturation percentage was marginal at 0-18 inches. Sodium absorption ratio was marginal at 5-18 inches and 37-47 inches and was unsuitable at 18-37 inches. Electrical conductivity was marginal at 5-18 inches and 37-60 inches and was unsuitable at 18-37 inches. Estimated stripping depth is 5 inches.

Geographic Setting (According to Official Series Description) - Lohmiller soils are on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes. Slopes are typically less than 2 percent but range from 0 to 8 percent. The soils formed in calcareous alluvium from sedimentary rock. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 10 to 19 inches.

KYLE  
LOAM

Soil Mapping Unit "Ky"  
Lab/BKS Sample ID: G08020806-017\_020

Typical Pedon: Kyle loam- on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-2 inches. Grayish brown (2.5YR 5/2) loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary; slightly acid (pH 6.3); noneffervescent.

**Bt1** - 2-7 inches. Very dark grayish brown (10YR 3/2D) silty clay loam, moist; weak coarse blocky structure parting to weak medium and fine blocky; very hard, very firm, sticky and plastic; common fine roots; gradual wavy boundary; neutral (pH 7.3); noneffervescent.

**Bt2** - 7-17 inches. Brown (10YR 4/3D) silty clay loam, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 7.9); strongly effervescent.

**Ck** - 17-30 inches. Brown (10YR 4/3D) clay loam, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); strongly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 85 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The control section averages 60 to 65 percent clay. The soil does not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Saturation percentage was marginal at 2-7 inches. Strongly effervescent at 7 inches. Estimated stripping depth is 30 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

SAMSIL  
NON CALCAREOUS VARIANT

Soil Mapping Unit "Sa"

Lab/BKS Sample ID: G08020806-021\_023

Typical Pedon: Samsil clay loam- on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**A** - 0-2 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; neutral (pH 6.7); noneffervescent.

**AC** - 2-9 inches. Light yellowish brown (2.5Y 6/3D) silty clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; slightly alkaline (pH 7.8); noneffervescent.

**C** - 9-18 inches. Grayish brown (2.5Y 5/2D) silt, moist; massive; hard, friable, sticky and plastic; common fine roots; about 50 percent by volume of fragments of soft shale; common distinct olive yellow (2.5Y 6/6) stains on faces of shale fragments; few fine and medium accumulations of carbonate; gradual wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 88 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-9 inches. Estimated stripping depth is 18 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

PIERRE  
SILTY CLAY LOAM

Soil Mapping Unit "Pe"

Lab/BKS Sample ID: G08020806-024\_027

Typical Pedon: Pierre silty clay loam - on a convex slope of 7 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Pierre series consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. Permeability is very slow. Slopes range from 0 to 30 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

**A** - 0-2 inches. Grayish brown (2.5Y 5/2) silty clay loam, moist; moderate fine subangular blocky structure parting to weak very fine granular; hard, firm, sticky and plastic; 1 percent pebbles; clear smooth boundary; strongly acid (pH 5.4); noneffervescent.

**Bt**- 2-18 inches. Brown (10YR 5/3) silty clay, moist; moderate medium and coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine accumulations of iron; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.7); strongly effervescent.

**C1n** – 18-31 inches. Grayish brown (10YR 5/2) silty clay, moist; moderate coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine nests of iron and common fine accumulations of gypsum; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.8); strongly effervescent.

**C2n** – 31-37 inches. Light brownish gray (2.5Y 6/2) silty clay, moist; common distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) iron stains; many fine accumulations of gypsum and carbonate; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.7); very slightly effervescent.

Type Location - Haakon County, South Dakota; refer to waypoint 89 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil contains carbonates at or within 6 inches of the surface. The depth to soft shale bedrock ranges from 20 to 40 inches but commonly is at depths of 25 to 35 inches. The horizon above the shale has 0 to 60 percent, by volume soft shale fragments. The control section is 50 to 60 percent clay. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The soil does not have a mollic epipedon, but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. The soil has a SAR of 1 to 7.

The A horizon has hue of 10YR to 5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 to 3. It

typically is clay but is silty clay in some pedons. It ranges from slightly acid to moderately alkaline. When the soil is dry it has a light gray (2.5Y 7/2) smooth, porous, platy surface crust ranging from 1/4 to 1 inch in thickness. Where the horizon has mollic colors, it is too thin to be a mollic epipedon. Some pedons do not have an AB horizon.

The Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 1 to 3. They are extremely hard or very hard when dry and extremely firm to firm when moist. They range from neutral to moderately alkaline.

Bk and C horizons are present in some pedons.

The Cr horizon is soft shale bedrock and ranges from slightly acid to moderately alkaline. Bedding planes are evident in the partially weathered shale in some pedons. Gypsum and other salts are concentrated in very thin seams within the shale in some pedons.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Leptic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-37 inches. pH was marginal (acid) at 0-2 inches. Strongly effervescent at 2 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Pierre soils are on nearly level to steep uplands. Slope gradient typically is 3 to 15 percent, but ranges from 0 to 30 percent. The soils formed in residuum weathered from clay shale. Gilgai microrelief is in most areas. Mean annual air temperature is 44 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches. Growing season is 125 to 140 days; average growing season precipitation is 10 to 13 inches; and growing degree days are 2600 to 3100. Elevation is 1300 to 3600 feet.

GRUMMIT  
SILTY CLAY

Soil Mapping Unit "Gr"

Lab/BKS Sample ID: G08020806-028\_030

Typical Pedon: Grummit silty clay - on a convex slope of 5 percent in native grass. When described, the soil was moist to bedded shale. (Colors are for dry soil unless otherwise stated.)

The Grummit series consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. Permeability is moderate or moderately slow. Slopes range from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual temperature is about 46 degrees F.

**A** - 0-2 inches. Light brownish gray (10YR 6/2) silty clay, moist; moderate fine granular structure; loose, friable; many fine roots; many very fine fragments of shale; clear smooth boundary; neutral (pH 6.8); noneffervescent.

**AC** - 2-8 inches. Grayish brown (10YR 5/2) silty clay, moist; weak coarse subangular blocky structure; hard, friable; many fine roots; 25 percent very fine fragments of shale; gradual wavy boundary; slightly alkaline (pH 7.4); noneffervescent.

**C** - 8-20 inches. Grayish brown (10YR 5/2) silty clay, moist; common distinct mottles of yellowish brown (10YR 5/6); weak coarse subangular blocky structure; hard, friable; partially weathered fragments of shale make up 35 percent by volume; common roots; clear smooth boundary; slightly alkaline (pH 7.7); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 90 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to shale ranges from 10 to 20 inches. Colors throughout the soil are inherited from the shale. The horizons overlying the bedded shales typically average 50 to 65 percent clay but ranges from 35 to 65 percent clay. The low clay percentage is due to sand-size shale fragments. Consistence ranges from loose to hard when dry but is friable when moist. The soil ranges from strongly acid to extremely acid.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 3 or 4 moist, and chroma of 1 or 2 dry or moist. It typically is clay but is clay loam in some pedons. It has weathered fragments of shale that make up 5 to 35 percent by volume. The A horizon contains less than 1 percent more organic matter than the C.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6 and 3 or 4 moist; and chroma of 1 or 2. Weathered fragments of shale make up 20 to over 50 percent by volume of the C horizon.

The fissile shale is very hard and brittle and will not disperse in water or in sodium hexametaphosphate.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Clayey, smectitic, acid, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 0-20 inches. Estimated stripping depth is 20 inches.

Geographic Setting (According to Official Series Description) - Grummit soils are gently sloping to very steep on uplands. Slope gradients range from 2 to 60 percent. The soil formed in clayey residuum weathered from acid shales. Mean annual temperature ranges from 43 to 50 degrees F, and mean annual precipitation is about 12 to 18 inches.

BONEEK  
CLAY LOAM

Soil Mapping Unit "Bo"

Lab/BKS Sample ID: G08020806-031\_035

Typical Pedon: Boneek clay loam - on a northeast-facing plane slope of 4 percent under native grass at 3500 feet elevation. (Colors are for dry soil unless otherwise stated.)

The Boneek series consists of deep and very deep, well drained soils formed in silty sediments underlain by sandstone or siltstone. Permeability is moderately slow in the solum and moderate in the underlying material. Slopes range from 0 to 15 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 46 degrees F.

**AC** - 0-4 inches. Very dark grayish brown (10YR 3/2D) clay loam, moist; moderate thin platy structure parting to weak fine granular; slightly hard, very friable; many fine roots; clear wavy boundary; slightly alkaline (pH 7.6); very slight effervescent.

**C1n** - 4-19 inches. Dark grayish brown (10YR 4/2D) silt loam, moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, friable, slightly sticky and slightly plastic; common fine roots; shiny films on faces of ped; clear wavy boundary; slightly alkaline (pH 7.8); slight effervescent.

**C2n** - 19-40 inches. Brown (10YR 4/3D) silt loam, moist; weak medium and coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few fine roots; common fine and medium accumulations of carbonate; gradual wavy boundary; moderately alkaline (pH 8.4); noneffervescent.

**C3n** - 40-48 inches. Dark yellowish brown (10YR 4/4D) silty clay loam, moist; few fine and medium prominent mottles of strong brown (7.5YR 5/8); weak coarse subangular blocky structure; very hard, friable; few fine roots; clear wavy boundary; moderately alkaline (pH 8.4); noneffervescent.

**C4n** - 48-60 inches. Very dark grayish brown (10YR 3/2D) silt loam, moist; thin platy rock structure; faces of fractures stained strong brown (7.5YR 5/6) moist; few coatings of carbonates on faces of fractures, but matrix is noncalcareous; moderately alkaline (pH 8.3); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 91 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock is 40 to 60 inches or more. Depth to carbonates ranges from 11 to 24 inches. Thickness of the mollic epipedon ranges from 7 to 15 inches and extends into the Bt horizon of some pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 and 2 or 3 moist, and chroma of 2 or 3.

It typically is silt loam, but some pedons are loam. It is slightly acid or neutral.

The Bt1 horizon has hue of 7.5YR or 5YR, value of 4 or 6 and 3 or 4 moist, and chroma of 2 to 4. It is silty clay loam or silty clay. Average clay content ranges from 35 to 45 percent with less than 15 percent fine sand or coarser. It is slightly acid or neutral.

The Bt2 horizon has hue of 10YR or 7.5Y, value of 5 or 6 and 3 or 5 moist, and chroma of 2 to 4. It is silty clay loam averaging between 30 and 40 percent clay and less than 15 percent fine sand or coarser. It is neutral or slightly alkaline.

The Bk and C horizons have hue of 10YR or 2.5Y, value of 5 through 7 and 4 or 5 moist, and chroma of 1 to 3. They typically are silt loam or silty clay loam, but some pedons are loam. They are slightly alkaline to strongly alkaline. Few to many, fine or medium accumulations of carbonate are in the Bk horizon.

The Cr horizon has hue of 10YR or 7.5YR.

Range in Characteristics (according to field observations, lab analysis): Textures have slightly less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - Saturation percentage was marginal at 4-19 inches and 40-60 inches. Sodium absorption ratio was unsuitable at 19-60 inches. Electrical conductivity was unsuitable at 19-60. Selenium was marginal at 48-60 inches. Estimated stripping depth is 19 inches.

Geographic Setting (According to Official Series Description) - Boneek soils are nearly level to moderately sloping on high terraces and uplands. Surfaces are plane to slightly convex and slope gradients range from 0 to 15 percent. The soils formed in a silty mantle overlying sandstone or siltstones, or in loess or silty alluvium. Mean annual temperature ranges from 43 to 48 degrees, and mean annual precipitation ranges from 15 to 18 inches. Most of the precipitation comes in the spring and summer.

SAMSIL  
SILTY CLAY LOAM

Soil Mapping Unit "Sa"

Lab/BKS Sample ID: G08020806-021\_023

Typical Pedon: Samsil silty clay loam - on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

**AC** - 0-7 inches. Dark grayish brown (10YR 4/2D) silty clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; slightly alkaline (pH 7.5); very slightly effervescent.

**C** - 7-19 inches. Dark grayish brown (10YR 4/2D) silty clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; slightly alkaline (pH 7.6); slightly effervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 92 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to

4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 7-19 inches. Saturation percentage was marginal at 7-19 inches Estimated stripping depth is 7 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

SHINGLE  
LOAM

Soil Mapping Unit "Sn"  
Lab/BKS Sample ID: G08020806-021\_023

Typical Pedon: Shingle loam-rangeland. (Colors are for dry soil unless otherwise stated.)

The Shingle series consists of well drained soils that are very shallow or shallow to bedrock. They formed in residuum and colluvium derived from interbedded shale and sandstone or in alluvium from mudstone. Shingle soils are on bedrock controlled hillslopes and ridges. Slopes are 0 to 80 percent. The mean annual precipitation is about 13 inches, and the mean annual temperature is 45 degrees F.

**A** - 0-4 inches. Light brownish gray (10YR 6/2) loam, moist; moderate very fine granular structure; soft, very friable, moderately sticky and moderately plastic; calcium carbonate disseminated; clear smooth boundary; neutral (pH 7.2); very slightly effervescent.

**C** - 4-8 inches. Light yellowish brown (2.5Y 6/3) loam, moist; weak medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; calcium carbonate disseminated; gradual smooth boundary; slightly alkaline (pH 7.5); strongly effervescent.

Type Location - Goshen County, Wyoming; refer to waypoint 93 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to soft bedrock and paralithic contact ranges from 4 to 20 inches. The mean annual soil temperature is 47 to 53 degrees F. The soils commonly are calcareous throughout, but some pedons are leached to 6 inches. The particle size control section averages 20 to 35 percent clay and has more than 15 percent but less than 35 percent fine or coarser sand. The soil is usually dry. The moisture control section is usually moist in April, May and early June. It is dry for 60 consecutive days or more during the 90 day period following the summer solstice. EC is 0 to 2 mmhos throughout.

The A horizon has hue of 5Y through 7.5YR, value of 5 through 7 dry, 3 through 6 moist, and chroma of 1 through 6. Reaction is neutral through strongly alkaline. Some pedons have a light gravel lag on the surface. Texture is loam, silt loam, clay loam, silty clay loam, cobbly loam, and gravelly clay loam. Rock fragments or shale channers range from 0 to 35 percent.

A Bw or AC horizon, when present, has the combined properties of the A and C horizons.

The C horizon has hue of 5Y through 7.5YR, value of 4 through 7 dry, 3 through 6 moist, and chroma of 1 through 6. It is loam, silt loam, clay loam or silty clay loam. Rock fragments or shale channers range from 0 to 35 percent. Reaction is slightly alkaline through strongly alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures have less clay than typical for the series.

Taxonomic Class - Loamy, mixed, superactive, calcareous, mesic, shallow Ustic Torriorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 4 inches. Estimated stripping depth is 8 inches.

Geographic Setting (According to Official Series Description) - The Shingle soils occur on all hillslope positions. Slopes are 0 to 80 percent. These soils formed in colluvium and residuum weathered from soft, interbedded sandstone and shale or in alluvium from mudstone. Elevation is 3,200 to 6,500 feet. The mean annual precipitation is about 10 to 14 inches, most of which falls in April, May, and June. The mean annual temperature is about 45 degrees F. but ranges from 43 to 51 degrees F. The frost-free season is about 105 to 130 days.

BONEEK  
NONCALCAREOUS VARIANT

Soil Mapping Unit "Bo"  
Lab/BKS Sample ID: G08020806-040\_045

Typical Pedon: Boneek silty clay - on a northeast-facing plane slope of 4 percent under native grass at 3500 feet elevation. (Colors are for dry soil unless otherwise stated.)

The Boneek series consists of deep and very deep, well drained soils formed in silty sediments underlain by sandstone or siltstone. Permeability is moderately slow in the solum and moderate in the underlying material. Slopes range from 0 to 15 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 46 degrees F.

**A** - 0-2 inches. Brown (10YR 5/3) silty clay, moist; moderate thin platy structure parting to weak fine granular; slightly hard, very friable; many fine roots; clear wavy boundary; neutral (pH 6.9) noneffervescent.

**C1** - 2-8 inches. Very dark grayish brown (10YR 3/2D) silty clay, moist; weak coarse subangular blocky structure; hard, very friable; many fine roots; clear wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

**C2n** - 8-20 inches. Very dark grayish brown (10YR 3/2D) silty clay, moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, friable, slightly sticky and slightly plastic; common fine roots; shiny films on faces of peds; clear wavy boundary; slightly alkaline (pH 7.5); noneffervescent.

**C3n** - 20-32 inches. Very dark grayish brown (10YR 3/2D) silty clay loam, moist; weak medium and coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few fine roots; gradual wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

**C4n** - 32-44 inches. Very dark grayish brown (10YR 3/2D) silty clay, moist; weak coarse subangular blocky structure; very hard, friable; few fine roots; violent; clear wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

**C5n** - 44-60 inches. Dark brown (10YR 3/3D) silty clay, moist; thin platy rock structure; faces of fractures stained strong brown (7.5YR 5/6) moist; few coatings of carbonates on faces of fractures, but matrix is noncalcareous; slightly alkaline (pH 7.8); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 94 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock is 40 to 60 inches or more. Depth to carbonates ranges from 11 to 24 inches. Thickness of the mollic epipedon ranges from 7 to 15 inches and extends into the Bt horizon of some pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 and 2 or 3 moist, and chroma of 2 or 3. It typically is silt loam, but some pedons are loam. It is slightly acid or neutral.

The Bt1 horizon has hue of 7.5YR or 5YR, value of 4 or 6 and 3 or 4 moist, and chroma of 2 to 4. It is silty clay loam or silty clay. Average clay content ranges from 35 to 45 percent with less than 15 percent fine sand or coarser. It is slightly acid or neutral.

The Bt2 horizon has hue of 10YR or 7.5Y, value of 5 or 6 and 3 or 5 moist, and chroma of 2 to 4. It is silty clay loam averaging between 30 and 40 percent clay and less than 15 percent fine sand or coarser. It is neutral or slightly alkaline.

The Bk and C horizons have hue of 10YR or 2.5Y, value of 5 through 7 and 4 or 5 moist, and chroma of 1 to 3. They typically are silt loam or silty clay loam, but some pedons are loam. They are slightly alkaline to strongly alkaline. Few to many, fine or medium accumulations of carbonate are in the Bk horizon.

The Cr horizon has hue of 10YR or 7.5YR.

Range in Characteristics (according to field observations, lab analysis): Textures have slightly more clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-20 inches and 32-60 inches. Saturation percentage was marginal at 0-60 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Boneek soils are nearly level to moderately sloping on high terraces and uplands. Surfaces are plane to slightly convex and slope gradients range from 0 to 15 percent. The soils formed in a silty mantle overlying sandstone or siltstones, or in loess or silty alluvium. Mean annual temperature ranges from 43 to 48 degrees, and mean annual precipitation ranges from 15 to 18 inches. Most of the precipitation comes in the spring and summer.

BONEEK  
LOAM

Soil Mapping Unit "Bo"

Lab/BKS Sample ID: G08020806-046\_050

Typical Pedon: Boneek loam - on a northeast-facing plane slope of 4 percent under native grass at 3500 feet elevation. (Colors are for dry soil unless otherwise stated.)

The Boneek series consists of deep and very deep, well drained soils formed in silty sediments underlain by sandstone or siltstone. Permeability is moderately slow in the solum and moderate in the underlying material. Slopes range from 0 to 15 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 46 degrees F.

**A** - 0-2 inches. Brown (10YR 5/3) loam, moist; moderate thin platy structure parting to weak fine granular; slightly hard, very friable; many fine roots; clear wavy boundary; neutral (pH 7.1) noneffervescent.

**Bt** - 2-8 inches. Brown (7.5 YR 4/3D) loam, moist; weak coarse subangular blocky structure; hard, very friable; many fine roots; clear wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

**C1k** - 8-17 inches. Brown (7.5 YR 5/3D) loam, moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, friable, slightly sticky and slightly plastic; common fine roots; shiny films on faces of peds; clear wavy boundary; moderately alkaline (pH 7.9); strongly effervescent.

**C2k** - 17-24 inches. Brown (10YR 5/3D) loam, moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, friable, slightly sticky and slightly plastic; common fine roots; many fine and medium accumulations of carbonate; gradual wavy boundary; moderately alkaline (pH 8.3); strongly effervescent.

**C3k** - 24-38 inches. Dark grayish brown (10YR 4/2D) clay loam, moist; weak medium and coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few fine roots; common fine and medium accumulations of carbonate; gradual wavy boundary; moderately alkaline (pH 8.3); strongly effervescent.

Type Location - Butte County, South Dakota; refer to waypoint 95 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to bedrock is 40 to 60 inches or more. Depth to carbonates ranges from 11 to 24 inches. Thickness of the mollic epipedon ranges from 7 to 15 inches and extends into the Bt horizon of some pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 and 2 or 3 moist, and chroma of 2 or 3.

It typically is silt loam, but some pedons are loam. It is slightly acid or neutral.

The Bt1 horizon has hue of 7.5YR or 5YR, value of 4 or 6 and 3 or 4 moist, and chroma of 2 to 4. It is silty clay loam or silty clay. Average clay content ranges from 35 to 45 percent with less than 15 percent fine sand or coarser. It is slightly acid or neutral.

The Bt2 horizon has hue of 10YR or 7.5Y, value of 5 or 6 and 3 or 5 moist, and chroma of 2 to 4. It is silty clay loam averaging between 30 and 40 percent clay and less than 15 percent fine sand or coarser. It is neutral or slightly alkaline.

The Bk and C horizons have hue of 10YR or 2.5Y, value of 5 through 7 and 4 or 5 moist, and chroma of 1 to 3. They typically are silt loam or silty clay loam, but some pedons are loam. They are slightly alkaline to strongly alkaline. Few to many, fine or medium accumulations of carbonate are in the Bk horizon.

The Cr horizon has hue of 10YR or 7.5YR.

Range in Characteristics (according to field observations, lab analysis): Textures are coarser and have less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - Selenium was marginal at 24-38 inches. Strongly effervescent at 8 inches. Estimated stripping depth is 24 inches.

Geographic Setting (According to Official Series Description) - Boneek soils are nearly level to moderately sloping on high terraces and uplands. Surfaces are plane to slightly convex and slope gradients range from 0 to 15 percent. The soils formed in a silty mantle overlying sandstone or siltstones, or in loess or silty alluvium. Mean annual temperature ranges from 43 to 48 degrees, and mean annual precipitation ranges from 15 to 18 inches. Most of the precipitation comes in the spring and summer.

BARNUM  
CLAY

Soil Mapping Unit "Bc"

Lab/BKS Sample ID: C08100918-001\_005

Typical Pedon: Barnum clay-rangeland. (Colors are for dry soil unless otherwise stated.)

The Barnum series consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. Barnum soils are on flood plains and alluvial terraces. Slopes are simple and range from 0 to 8 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 47 degrees F.

**A** - 0 to 3 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate very fine granular structure; soft, very friable; noneffervescent; neutral (pH 7.3); clear smooth boundary. (3 to 6 inches thick)

**ACk** - 3 to 7 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate very fine granular structure; soft, very friable; strongly effervescent, calcium carbonate disseminated; slightly alkaline (pH 7.6); clear smooth boundary.

**Ck1** - 7 to 12 inches; reddish brown (2.5YR 5/5) clay, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; slightly alkaline (pH 7.6).

**Ck2** - 12 to 25 inches; reddish brown (2.5YR 5/5) loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; slightly alkaline (pH 7.5).

**Ckn** - 25 to 38 inches; reddish brown (2.5YR 5/5) silt loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.2).

**C** - 38 to 44 inches; reddish brown (2.5YR 5/5) sandy loam to sandy clay loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; slightly effervescent; moderately alkaline (pH 8.3).

**Ck3** - 44 to 48 inches; reddish brown (2.5YR 5/5) sandy loam to sandy clay loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.3).

Type Location - Johnson County, Wyoming; refer to waypoint 103 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - These soils typically contain free carbonates throughout but may be leached a few inches in some pedons. Organic carbon ranges from .6 to 3 percent in the upper 10 inches and decreases irregularly with depth. The mean annual soil temperature is about 47 to 53 degrees F. The particle size control section is highly stratified and typically averages loam or light clay loam with 18 to 35 percent clay and more than 15 percent fine or coarser sand. Strata of sandy loam, silt loam, silty clay loam, and fine sandy loam are common. Rock fragments are variable between strata but average from 0 to 10 percent pebbles. Exchangeable sodium ranges from 4 to 15 percent throughout the soil. EC typically ranges from 2 to 8 mmhos throughout under natural conditions but may range to 16 mmhos where poorly irrigated.

The A horizon has hue of 7.5YR through 2.5YR, value of 4 through 6 dry, 3 through 5 moist, and chroma of 2 through 6. Reaction is slightly through strongly alkaline.

The C horizon has hue of 5YR through 10R, value of 4 through 7 dry, 3 through 5 moist, and chroma of 2 through 6. Some strata have visual accumulations of salts and carbonates which are typically discontinuous throughout the extent of the pedon. Reaction is slightly through strongly alkaline. Some pedons may have buried horizons below 40 inches.

Range in Characteristics (according to field observations, lab analysis): Textures in the top 12 inches are finer than typical for this series. A natric horizon was identified within the profile, which is not typical of this series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifuvents

Suitability for Topsoil (According to WDEQ Guideline 1) – Electrical conductivity was marginal from 25-48 inches. Saturation percentage was marginal from 38-48. Clay percentage was marginal from 0-12 inches. Estimated stripping depth is 25 inches.

Geographic Setting (According to Official Series Description) - Barnum soils are on flood plains and alluvial terraces. These soils formed in calcareous alluvium derived from red beds containing siltstone, shale, and sandstone. Slopes are 0 to 8 percent. Elevations are 4,000 to 6,600 feet. The mean annual precipitation is about 12 inches and ranges from 10 to 14 inches with about half falling as snow or rain in April, May, and early June. The mean annual temperature is about 43 to 49 degrees F. The frost-free season is estimated to range from 110 to 135 days depending upon elevation, aspect, and air drainage.

NUNN  
CLAY

Soil Mapping Unit "Nu"  
Lab/BKS Sample ID: C08100918-006\_010

Typical Pedon: Nunn clay-grassland. (Colors are for dry soil unless otherwise stated.)

The Nunn series consists of very deep, well drained soils that formed in loess and mixed alluvium. Nunn soils are on terraces or alluvial fans, and in drainageways. Slopes range from 0 to 25 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 48 degrees F.

**A** - 0 to 2 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable; noneffervescent; slightly acid (pH 6.1); clear smooth boundary. (2 to 8 inches thick)

**E** - 2 to 9 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, very friable, sticky and plastic; few faint clay films on faces of peds; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary. (0 to 7 inches thick)

**Bt** - 9 to 26 inches; pale brown (10YR 6/3) heavy clay to clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; many distinct clay films on faces of peds; slightly effervescent; moderately alkaline (pH 7.9); clear smooth boundary. (6 to 24 inches thick)

**Bck** - 26 to 34 inches; pale brown (10YR 6/3) clay to clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; very hard, firm, very plastic; few faint clay films on faces of peds; visible calcium carbonate occurring as small concretions; strongly effervescent; moderately alkaline (pH 8.3); gradual smooth boundary. (0 to 10 inches thick)

**2Ckny1** - 34 to 38 inches; light yellowish brown (10YR 6/4) clay to clay loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; visible calcium carbonate occurring as concretions, thin seams and streaks; violently effervescent; moderately alkaline (pH 8.3); gradual smooth boundary.

**2Ckny2** - 38 to 42 inches; light yellowish brown (2.5Y 6/3) clay, light olive brown (2.5Y 5/3) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; some visible calcium carbonate but less than in the horizon above; violently effervescent; strongly alkaline (pH 8.9).

**2Ckny3** - 42 to 48 inches; light yellowish brown (2.5Y 6/3) clay, light olive brown (2.5Y 5/3) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; some visible

calcium carbonate but less than in the horizon above; violently effervescent; strongly alkaline (pH 8.9).

Type Location - Larimer County, Colorado; refer to waypoint 114 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Mean annual soil temperature at depth of 20 inches is 47 to 54 degrees F, and mean summer temperature is 59 to 79 degrees F. The mollic epipedon is 7 to 19 inches thick, depth to lime is 10 to 30 inches, and the solum is 16 to 46 inches thick. Organic carbon in the mollic epipedon ranges from .8 to 3 percent. The soil is typically 90 to 100 percent base-saturated. Rock fragments are typically less than 5 percent and range from 0 to 15 percent. The soil temperature at depth of 20 inches is 41 degrees F or warmer for about 200 to 240 days. The soils are moist in some part of the moisture control section for about 56 to 152 days while the soil temperature is 41 degrees F or above.

The A horizon has hue of 5Y to 7.5YR, value of 4 or 5, 2 or 3 moist, and chroma of 1 to 3. Usually it has granular or crumb structure but the structure is subangular blocky in some pedons. This horizon is soft or slightly hard. It is slightly acid to slightly alkaline.

The Bt horizon has hue of 5Y to 7.5YR, value of 3 to 7, 2 to 6 moist, and chroma of 2 to 5. It is typically clay, silty clay loam or clay loam and has 35 to 50 percent clay, 15 to 45 percent silt, and 15 to 45 percent sand with more than 15 percent, being fine sand or coarser. Some pedons have sandy clay loam textures in the lower parts of the argillic layer, however, the weighted clay average is greater than 35 percent in the control section. It is slightly acid to moderately alkaline. CEC of the Bt horizon ranges from 60 to 90 millequivalents per 100 grams of clay.

The Bk or C horizon has hue of 5Y to 7.5YR, value of 5 to 7, 4 to 6 moist, and chroma of 2 to 4. They are typically clay loam with more than 28 percent clay, however, where the C horizon has less than 28 percent clay it contains more than 15 percent fine or coarser sand and has a texture of sandy clay loam, loam or sandy loam. These horizons are slightly alkaline to strongly alkaline and have 4 to 15 percent calcium carbonate equivalent.

Range in Characteristics (according to field observations, lab analysis): An E horizon was identified in place of a BA. Three natric and gypsic C horizons were identified at the bottom of this profile, which is not typical.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) – Electrical conductivity was marginal from 26-38 inches and unsuitable from 38-48 inches. pH was marginal from 38-48 inches. Sodium absorption ratio was unsuitable from 26-38 inches. Clay percentage was marginal from 0-2 inches and 9-48 inches. Estimated stripping depth is 26 inches.

Geographic Setting (According to Official Series Description) - The Nunn soils are on terraces or alluvial fans, or in drainageways. Slope gradients range from 0 to 25 percent. The soils formed in

mixed alluvium. At the type location the average annual precipitation is 13 inches, 9 inches of which falls during the months of April through September. Mean annual air temperature is 47 to 53 degrees F, and an average summer temperature is 67 degrees F. The frost-free period is 120 to 210 days.

CANYON  
SANDY CLAY LOAM

Soil Mapping Unit "Cd"  
Lab/BKS Sample ID: C08100918-011\_013

Typical Pedon: Canyon sandy clay loam on an 8 percent convex slope in rangeland. (Colors are for dry soil unless otherwise stated.)

The Canyon series consists of well drained soils that are shallow to weakly cemented limestone or very fine grain sandstone. These soils formed in loamy, calcareous residuum on uplands. Saturated hydraulic conductivity is moderately high. Slopes range from 0 to 60 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 50 degrees F.

**A** - 0 to 3 inches; grayish brown (10YR 5/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, very friable; slightly effervescent; slightly alkaline (pH 7.7); abrupt smooth boundary. (3 to 6 inches thick)

**C** - 3 to 19 inches; light brownish gray (10YR 6/2) very fine sandy loam to sandy clay loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure; slightly hard, friable; 5 percent by volume sandstone gravel; moderate effervescence; moderately alkaline (pH 8.2); clear smooth boundary.

**Ck** - 19 to 27 inches; very pale brown (10YR 8/3) very fine sandy loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; 10 percent by volume sandstone gravel; strong effervescence; moderately alkaline (pH 8.2); abrupt wavy boundary. (0 to 8 inches thick)

**Cr** - 27 inches; very pale brown (10YR 8/3) weakly cemented fine grained sandstone; violent effervescence.

Type Location – Box Butte County, Nebraska; refer to waypoint 115 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) –

Thickness of the solum: 6 to 12 inches

Depth to bedrock: typically is about 16 inches, but the full range is 6 to 20 inches

Depth to carbonates: 0 to 6 inches

Reaction: slightly alkaline or moderately alkaline throughout

Sandstone gravel content: is typically 0 to 15 percent but ranges from 0 to 25 percent.

The soil above the paralithic material has 12 to 25 percent clay and 35 to 70 percent sand throughout.

A horizon:

Hue: 10YR

Value: 4 to 7 and 3 to 6 moist

Chroma: 2 or 3

Texture: loam and ranges to include silt loam, sandy loam, fine sandy loam, very fine sandy loam, gravelly loam, or gravelly sandy loam

AC horizon:

Hue of 10YR

Value: 5 to 8 and 4 to 7 moist

Chroma: 1 to 4

Texture: loam and ranges to include silt loam, sandy loam, fine sandy loam, very fine sandy loam, gravelly loam, or gravelly sandy loam

C horizon:

Hue: 10YR or 2.5Y

Value: 6 to 8 and 4 to 7 moist

Chroma: 2 to 4

Texture: loam and ranges to include very fine sandy loam, silt loam, or gravelly loam

Range in Characteristics (according to field observations, lab analysis): The texture found for the A horizon is slightly finer than typical.

Taxonomic Class - Loamy, mixed, superactive, calcareous, mesic, shallow Ustic Torriorthents

Suitability for Topsoil (According to WDEQ Guideline 1) – Saturation percentage was marginal from 19-27 inches. Estimated stripping depth is 27 inches.

Geographic Setting (According to Official Series Description) –

Landscape: hills, plains, tablelands and uplands

Landform: side slopes and ridgetops

Slope: 0 to 60 percent

Parent material: weakly cemented limestone or very fine grain sandstone which is Tertiary in age

Mean annual air temperature: 48 to 55 degrees F

Mean annual precipitation: 14 to 19 inches

WINETTI  
SANDY CLAY LOAM

Soil Mapping Unit "Wt"

Lab/BKS Sample ID: C08100918-014\_017

Typical Pedon: Winetti sandy clay loam-woodland. (Colors are for dry soil unless otherwise stated.)

The Winetti series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils that formed in mixed alluvium from sedimentary rocks. Slopes range from 0 to 8 percent. The mean annual temperature is 44 degrees F. and the mean annual precipitation is 16 inches.

**A** - 0 to 2 inches; brown (7.5YR 5/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; common fine interstitial pores; noneffervescent; neutral (pH 7.1); clear smooth boundary. (1 to 6 inches thick)

**AC** - 2 to 5 inches; brown (7.5YR 5/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; common fine interstitial pores; noneffervescent; neutral (pH 7.1); clear smooth boundary.

**Ck1** - 5 to 18 inches; light yellowish brown (10YR 6/4) gravelly very fine sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; loose; common fine roots; common fine interstitial pores; 20 percent pebbles; violently calcareous; moderately alkaline (pH 8.2); clear wavy boundary.

**Ck2** - 18 to 36 inches; light yellowish brown (10YR 6/4) gravelly very fine sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; common medium interstitial pores; 35 percent pebbles; strongly to violently calcareous; strongly alkaline (pH 8.6); clear wavy boundary. (8 to 18 inches thick)

**Ck3** - 36 to 48 inches; brown (7.5YR 5/4) and light yellowish brown (10YR 6/4) gravelly very fine sandy loam to sandy clay loam, dark brown (7.5YR 4/4) moist; weak thick platy structure; soft, friable, slightly sticky and nonplastic; common very fine and coarse roots; few fine interstitial and tubular pores; 25 percent pebbles; strongly calcareous; strongly alkaline (pH 8.7); clear wavy boundary. (0 to 12 inches thick)

Type Location – Kane County, Utah; refer to waypoint 116 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) – Rock fragments in the particle-size control section average 35 to 50 percent. The mean annual soil temperature is about 44 to 47 degrees F., and the mean summer soil temperature at depths of 20 inches is about 49 to 64 degrees F. The organic matter content appears to decrease irregularly with depth. These soils

are noncalcareous to strongly calcareous in the A horizon and moderately calcareous or strongly calcareous in the C horizons.

The A horizon has hue of 5YR to 10YR, value of 5 or 6 dry, 3 or 4 moist and chroma of 2 to 4.

The C horizon has hue of 5YR to 10YR, value of 5 to 7 dry, 4 to 6 moist and chroma of 2 to 6. It is stratified gravelly and very gravelly loamy sand, gravelly and very gravelly sandy loam, sandy loam, loamy sand and gravelly loam.

Range in Characteristics (according to field observations, lab analysis): A slightly higher than normal clay percentage was found throughout this profile.

Taxonomic Class - Loamy-skeletal, mixed, superactive, calcareous, frigid Typic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) – Saturation percentage was marginal from 36-48 inches. pH was marginal from 18-48 inches. Estimated stripping depth is 36 inches.

Geographic Setting (According to Official Series Description) – Winetti soils are on long, narrow, gently sloping bottoms or valleys and strongly sloping toeslopes at elevations of 7,100 to 8,000 feet. They formed in mixed alluvium from sandstone, limestone and shale. Slope gradients are 0 to 8 percent. The average annual precipitation is 12 to 18 inches and the freeze-free period ranges from 80 to 100 days. The mean annual temperature is 42 to 45 degrees F., and the average summer temperature is 59 to 64 degrees F.

This page intentionally left blank

**ADDENDUM D-7-D**  
**ORIGINAL LABORATORY DATA SHEETS**

This page intentionally left blank

**ENERGY LABORATORIES**  
 ENERGY LABORATORIES, INC. • 400 W Boxelder Rd • Gillette, WY 82718-5315  
 Toll Free 866.686.7175 • FAX 307.682.4625 • gillette@energylab.com

**LABORATORY ANALYTICAL REPORT**

Client: Knight Plesold and Company  
 Project: 451b Dewey-Burdock Soils  
 Workorder: G08020803

Report Date: 03/28/08  
 Date Received: 02/28/08

Sample ID	Client Sample ID	Depth	Analysis		OM %	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	SAT	pH-sat s_u	EC-sat paste mmhos/cm	Ca-sat paste meq/L	Mg-sat paste meq/L	Na-sat paste meq/L	SAR-sat paste unitless
			Results	Units													
G08020803-001	Hole #17	0-3	3.0	< 0.1	8	46	46	58	75.7	SIC	3.00	0.73	0.24	0.2	0.2	0.2	0.2
G08020803-002	Hole #17	3-8	1.6	< 0.1	5	45	45	57	72.0	SIC	2.36	0.54	0.27	0.2	0.2	0.2	0.2
G08020803-003	Hole #17	8-24	1.7	< 0.1	3	44	44	57	80.0	SIC	5.44	1.49	0.73	0.4	0.4	0.4	0.4
G08020803-004	Hole #17	24-40	1.3	< 0.1	< 1	46	46	58	75.9	SIC	7.52	3.76	2.02	0.8	0.8	0.8	0.8
G08020803-005	Hole #17	40-54	0.8	< 0.1	1	48	48	50	78.9	SIC	24.5	23.0	4.43	0.9	0.9	0.9	0.9
G08020803-006	Hole #17	54-60	0.9	< 0.1	9	46	46	45	75.7	SIC	23.4	30.8	4.78	0.9	0.9	0.9	0.9
G08020803-007	Hole #27	0-2	2.5	< 0.1	9	58	58	7.4	63.3	SiCL	2.41	1.14	2.41	1.8	1.8	1.8	1.8
G08020803-008	Hole #27	2-17	1.3	< 0.1	4	47	49	7.9	83.5	SIC	24.2	10.3	29.0	7.0	7.0	7.0	7.0
G08020803-009	Hole #27	17-24	1.2	4.5	4	43	53	8.0	77.5	SIC	22.7	14.0	50.3	11.7	11.7	11.7	11.7
G08020803-010	Hole #27	24-39	1.0	1.8	3	47	50	7.9	84.5	SIC	22.3	13.3	43.4	10.3	10.3	10.3	10.3
G08020803-011	Hole #27	39-60	0.8	< 0.1	5	50	45	7.9	58.8	SIC	21.9	15.9	44.7	10.3	10.3	10.3	10.3
G08020803-012	Hole #36	0-2	2.1	1.9	14	32	32	8.0	68.0	SiCL	2.10	0.88	3.61	3.0	3.0	3.0	3.0
G08020803-013	Hole #36	2-15	1.3	< 0.1	9	46	45	8.0	84.2	SIC	23.8	11.1	34.0	8.1	8.1	8.1	8.1
G08020803-014	Hole #36	15-26	1.1	< 0.1	4	45	45	8.0	78.6	SIC	16.2	16.2	47.7	10.7	10.7	10.7	10.7
G08020803-015	Hole #36	26-36	0.9	< 0.1	9	41	41	8.0	84.1	SIC	28.6	24.6	60.4	11.7	11.7	11.7	11.7
G08020803-016	Hole #36	36-60	0.8	< 0.1	11	39	39	8.0	77.4	C	22.7	21.3	45.8	9.8	9.8	9.8	9.8
G08020803-017	Hole #39	0-2	4.1	< 0.1	19	55	26	6.8	50.0	SIL	3.04	1.95	0.14	< 0.1	< 0.1	< 0.1	< 0.1
G08020803-018	Hole #39	2-15	1.9	4.3	17	46	37	7.3	63.7	SiCL	2.40	1.58	0.42	0.3	0.3	0.3	0.3
G08020803-019	Hole #39	15-32	1.0	1.7	31	37	32	8.0	58.4	CL	2.67	2.76	2.60	1.6	1.6	1.6	1.6
G08020803-020	Hole #39	32-52	0.7	< 0.1	27	36	37	8.0	62.6	CL	22.6	51.2	10.7	1.8	1.8	1.8	1.8
G08020803-021	Hole #39	52-60	0.7	< 0.1	21	72	7	8.1	75.4	SIL	23.5	54.5	10.1	1.6	1.6	1.6	1.6
G08020803-022	Hole #40	0-4	4.2	< 0.1	17	50	33	6.6	71.4	SiCL	3.15	1.47	0.14	0.1	0.1	0.1	0.1
G08020803-023	Hole #40	4-14	2.4	< 0.1	12	55	33	7.1	60.7	SiCL	3.54	1.48	0.50	0.3	0.3	0.3	0.3
G08020803-024	Hole #40	14-27	1.5	< 0.1	7	58	35	7.8	57.8	SiCL	4.25	1.64	1.95	1.1	1.1	1.1	1.1
G08020803-025	Hole #40	27-38	1.6	< 0.1	1	52	47	8.1	74.8	SIC	4.42	2.01	9.67	5.4	5.4	5.4	5.4
G08020803-026	Hole #40	38-60	1.7	< 0.1	3	51	46	7.9	75.8	SIC	24.0	11.3	25.1	6.0	6.0	6.0	6.0
G08020803-027	Hole #41	0-4	4.2	3.9	25	56	19	7.7	45.5	SIL	7.70	2.69	0.23	0.1	0.1	0.1	0.1
G08020803-028	Hole #41	4-21	1.1	1.7	11	54	35	7.7	64.2	SiCL	27.7	20.1	8.30	1.7	1.7	1.7	1.7
G08020803-029	Hole #41	21-36	0.6	1.2	< 1	95	5	8.6	63.8	Si	25.3	100	148	18.7	18.7	18.7	18.7
G08020803-030	Hole #41	36-45	0.8	1.8	18	64	18	8.7	42.4	SIL	27.9	122	216	25.0	25.0	25.0	25.0
G08020803-031	Hole #41	45-60	0.5	0.9	34	49	17	8.7	33.6	L	25.9	107	175	21.4	21.4	21.4	21.4
G08020803-032	Hole #42	0-6	3.4	1.5	22	62	16	7.8	44.6	SIL	28.7	54.2	37.2	5.8	5.8	5.8	5.8
G08020803-033	Hole #42	6-17	1.3	6.0	26	60	14	8.3	40.2	SIL	30.9	191	135	12.9	12.9	12.9	12.9
G08020803-034	Hole #42	17-39	0.6	< 0.1	28	62	10	8.6	35.0	SIL	31.2	187	125	12.0	12.0	12.0	12.0
G08020803-035	Hole #42	39-60	0.6	< 0.1	30	56	14	8.5	37.1	SIL	28.5	109	83.5	10.1	10.1	10.1	10.1
G08020803-036	Hole #43	0-2	11.7	1.1	24	48	28	6.2	63.7	CL	5.45	3.92	0.61	0.3	0.3	0.3	0.3
G08020803-037	Hole #43	2-14	2.1	< 0.1	22	36	42	7.4	68.8	C	5.28	3.27	0.87	0.4	0.4	0.4	0.4
G08020803-038	Hole #43	14-38	1.0	< 0.1	32	36	32	8.5	43.3	CL	1.13	1.12	4.10	3.9	3.9	3.9	3.9
G08020803-039	Hole #43	38-60	0.8	< 0.1	50	28	22	8.8	39.8	L	1.25	1.76	15.3	12.5	12.5	12.5	12.5
G08020803-040	Hole #50	0-2	2.3	2.6	44	38	18	6.6	30.8	L	1.97	1.10	0.14	0.1	0.1	0.1	0.1



ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

**Client:** Knight Plesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020803  
**Report Date:** 03/28/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis	Depth	Units	OM		Coarse Fragments		Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
					%	Results	%	Results											
G08020803-041	Hole #50	2-7	1.8	2.6	32	34	34	34	34	34	CL	46.9	7.4	0.58	3.72	2.03	0.29	0.2	
G08020803-042	Hole #50	7-13	1.9	2.4	26	38	36	36	36	36	CL	66.8	8.1	0.42	2.37	1.47	0.42	0.3	
G08020803-043	Hole #50	13-25	1.0	3.1	44	29	27	27	27	27	CL	39.1	8.3	0.48	1.53	1.52	1.62	1.3	
G08020803-044	Hole #56	0-3	6.0	<0.1	16	56	28	28	28	28	SiCL	74.9	7.4	0.96	7.78	1.33	0.09	<0.1	
G08020803-045	Hole #56	3-14	2.5	<0.1	<1	72	28	28	28	28	SiCL	48.0	7.7	1.07	8.69	1.92	0.29	0.1	
G08020803-046	Hole #56	14-26	2.2	<0.1	8	60	32	32	32	32	SiCL	50.8	7.6	3.08	32.2	8.13	1.42	0.3	
G08020803-047	Hole #56	26-36	2.0	1.5	18	56	26	26	26	26	Sil	46.4	7.5	3.43	36.7	9.58	2.45	0.5	
G08020803-048	Hole #56	36-60	1.2	3.0	34	44	22	22	22	L	39.2	7.7	3.70	36.9	12.1	2.29	0.5		
G08020803-049	Hole #57	0-2	2.1	5.4	22	42	36	36	36	36	CL	73.1	7.6	2.49	32.1	1.11	0.23	<0.1	
G08020803-050	Hole #57	2-8	0.7	<0.1	32	38	30	30	30	30	CL	64.3	7.6	2.55	30.7	3.92	0.35	<0.1	



ENERGY LABORATORIES, INC. • 400 W Boxelder Rd • Gillette, WY 82718-5315  
 Toll Free 866.686.7175 • 307.686.7175 • FAX 307.682.4625 • gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Report Date: 03/28/08  
 Date Received: 02/28/08

Client: Knight Piesold and Company  
 Project: 451b Dewey-Burdock Soils  
 Workorder: G08020803

Sample ID	Client Sample ID	Analysis		Se-Hot H2O		
		Units	Depth		B-Hot H2O	mg/kg
G08020803-001	Hole #17	0-3		0.3		< 0.01
G08020803-002	Hole #17	3-8		0.3		< 0.01
G08020803-003	Hole #17	8-24		0.5		< 0.01
G08020803-004	Hole #17	24-40		0.6		< 0.01
G08020803-005	Hole #17	40-54		0.8		< 0.01
G08020803-006	Hole #17	54-60		0.8		< 0.01
G08020803-007	Hole #27	0-2		0.3		< 0.01
G08020803-008	Hole #27	2-17		2.0		0.03
G08020803-009	Hole #27	17-24		2.3		0.07
G08020803-010	Hole #27	24-39		1.6		0.06
G08020803-011	Hole #27	39-60		1.1		0.08
G08020803-012	Hole #36	0-2		0.4		< 0.01
G08020803-013	Hole #36	2-15		1.7		0.02
G08020803-014	Hole #36	15-26		2.3		0.03
G08020803-015	Hole #36	26-36		2.3		0.03
G08020803-016	Hole #36	36-60		1.5		0.03
G08020803-017	Hole #39	0-2		0.2		< 0.01
G08020803-018	Hole #39	2-15		0.3		< 0.01
G08020803-019	Hole #39	15-32		0.4		< 0.01
G08020803-020	Hole #39	32-52		0.9		0.04
G08020803-021	Hole #39	52-60		2.5		0.03
G08020803-022	Hole #40	0-4		0.3		< 0.01
G08020803-023	Hole #40	4-14		0.3		< 0.01
G08020803-024	Hole #40	14-27		0.4		< 0.01
G08020803-025	Hole #40	27-38		0.8		0.02
G08020803-026	Hole #40	38-60		0.7		0.06
G08020803-027	Hole #41	0-4		0.4		< 0.01
G08020803-028	Hole #41	4-21		0.7		0.03
G08020803-029	Hole #41	21-36		7.7		0.25
G08020803-030	Hole #41	36-45		4.2		0.24
G08020803-031	Hole #41	45-60		1.5		0.22
G08020803-032	Hole #42	0-6		1.0		0.07
G08020803-033	Hole #42	6-17		1.1		0.15
G08020803-034	Hole #42	17-39		1.8		0.09
G08020803-035	Hole #42	39-60		1.2		0.04
G08020803-036	Hole #43	0-2		0.4		< 0.01
G08020803-037	Hole #43	2-14		0.2		< 0.01
G08020803-038	Hole #43	14-38		0.5		< 0.01
G08020803-039	Hole #43	38-60		0.8		0.01
G08020803-040	Hole #50	0-2		0.1		< 0.01



ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

**Client:** Knight Piesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020803  
**Report Date:** 03/28/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis		Se-Hot H2O			
		Units	Depth		B-Hot H2O	mg/kg	mg/kg
G08020803-041	Hole #50		2-7	0.1	< 0.01		
G08020803-042	Hole #50		7-13	0.3	< 0.01		
G08020803-043	Hole #50		13-25	0.2	< 0.01		
G08020803-044	Hole #56		0-3	0.2	< 0.01		
G08020803-045	Hole #56		3-14	0.3	< 0.01		
G08020803-046	Hole #56		14-26	0.3	< 0.01		
G08020803-047	Hole #56		26-36	0.3	< 0.01		
G08020803-048	Hole #56		36-60	0.2	< 0.01		
G08020803-049	Hole #57		0-2	0.3	< 0.01		
G08020803-050	Hole #57		2-8	0.3	< 0.01		

**ENERGY LABORATORIES**  
 ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

**LABORATORY ANALYTICAL REPORT**

**Client:** Knight Piesolid and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workerder:** G08020805  
**Report Date:** 03/31/08  
**Date Received:** 02/29/08

Sample ID	Client Sample ID	Analysis Units	Depth	OM %	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	SAT wt%	pH-sat s.u.	EC-sat paste mmhos/cm	Ca-sat paste meq/L	Mg-sat paste meq/L	Na-sat paste meq/L	SAR-sat paste unitless	Results	
																	Results	Results
G08020805-001	Hole #60	0-3	3.4	<0.1	30	40	30	CL	69.2	7.5	0.75	4.69	2.03	1.47	0.8			
G08020805-002	Hole #60	3-10	1.8	<0.1	20	38	42	C	74.1	8.4	1.55	1.18	1.86	13.5	11			
G08020805-003	Hole #60	10-18	1.3	4.8	24	70	6	SiL	69.5	8.2	9.21	22.1	61.0	79.7	12			
G08020805-004	Hole #63	0-2	3.0	14.3	52	36	12	L	33.2	6.4	0.79	5.94	1.88	0.56	0.3			
G08020805-005	Hole #63	2-6	1.9	8.8	39	38	23	L	40.1	7.3	0.92	8.85	1.68	0.34	0.2			
G08020805-006	Hole #63	6-18	1.9	8.2	22	51	27	CL	40.1	7.4	2.99	30.1	9.02	5.25	1.2			
G08020805-007	Hole #64	0-6	2.4	<0.1	14	53	33	SiCL	62.6	7.1	0.97	6.25	4.69	0.35	0.2			
G08020805-008	Hole #64	6-17	1.7	<0.1	8	59	33	SiCL	64.7	8.1	0.67	2.87	2.96	1.74	1.0			
G08020805-009	Hole #64	17-33	0.8	<0.1	6	61	33	SiCL	54.2	8.5	2.27	1.80	5.81	16.0	8.3			
G08020805-010	Hole #64	33-42	0.7	<0.1	10	61	29	SiCL	48.8	8.0	8.02	27.8	61.1	50.6	7.6			
G08020805-011	Hole #64	42-60	0.6	<0.1	16	57	27	SiCL	45.9	8.1	7.62	27.7	50.5	45.2	7.2			
G08020805-012	Hole #72	0-3	3.3	<0.1	17	51	32	SiCL	53.4	6.3	0.52	2.98	1.09	0.32	0.2			
G08020805-013	Hole #72	3-18	1.2	<0.1	26	39	35	CL	55.3	7.6	0.49	1.74	0.51	2.86	2.7			
G08020805-014	Hole #72	18-28	1.2	2.8	10	47	43	SiC	69.7	7.9	4.52	20.2	12.3	30.1	7.5			
G08020805-015	Hole #72	28-43	1.0	1.7	16	69	15	SiL	69.0	8.2	8.21	23.5	50.0	8.2	8.8			
G08020805-016	Hole #72	43-60	0.8	2.1	22	53	25	SiL	67.4	8.3	10.0	21.9	73.5	94.0	14			
G08020805-017	Hole #73	0-3	3.1	<0.1	44	35	21	L	51.1	7.4	0.99	5.50	3.21	2.31	1.1			
G08020805-018	Hole #73	3-15	1.7	<0.1	16	41	43	SiC	77.6	7.9	6.51	8.5	9.4	52.4	18			
G08020805-019	Hole #73	15-23	0.9	<0.1	2	58	40	SiC	97.4	7.8	11.2	24.7	26.4	113	22			
G08020805-020	Hole #73	23-34	1.1	<0.1	<1	60	40	SiC	95.5	8.0	12.9	35.5	35.5	134	22			
G08020805-021	Hole #73	34-38	0.9	<0.1	6	42	52	SiC	75.1	8.0	13.8	34.0	36.9	142	24			
G08020805-022	Hole #73	38-60	0.9	<0.1	4	31	65	C	97.7	8.0	12.2	33.0	31.8	123	22			
G08020805-023	Hole #74	0-3	1.6	<0.1	59	16	25	SCL	36.0	7.8	0.73	5.47	2.04	0.79	0.4			
G08020805-024	Hole #74	3-15	0.8	<0.1	54	19	27	SCL	46.2	8.3	0.69	1.62	1.45	4.66	3.8			
G08020805-025	Hole #74	15-27	0.6	<0.1	36	35	29	CL	51.5	8.5	5.68	5.4	15.9	55.9	17			
G08020805-026	Hole #74	27-38	1.3	<0.1	40	37	23	L	37.9	8.5	13.7	28.2	95.0	162	21			
G08020805-027	Hole #74	38-51	0.5	<0.1	50	31	19	L	34.3	8.4	13.2	25.9	92.3	150	20			
G08020805-028	Hole #74	51-60	0.4	<0.1	64	17	19	SL	33.1	8.4	12.7	23.9	82.0	143	20			
G08020805-029	Hole #75	0-4	2.5	<0.1	28	45	27	CL	60.4	7.8	0.84	4.62	1.79	2.13	1.2			
G08020805-030	Hole #75	4-15	2.2	<0.1	14	53	33	SiCL	63.9	7.7	1.78	7.76	2.94	8.47	3.7			
G08020805-031	Hole #75	15-35	1.3	<0.1	16	55	29	SiCL	52.2	7.6	6.61	28.4	15.6	48.5	10			
G08020805-032	Hole #75	35-46	1.0	<0.1	15	58	27	SiCL	53.9	7.8	8.46	28.3	24.1	74.1	14			
G08020805-033	Hole #75	46-60	1.0	<0.1	12	59	29	SiCL	54.5	7.8	8.23	27.4	24.2	69.8	14			
G08020805-034	Hole #76	0-2	1.9	<0.1	48	39	13	L	31.5	5.3	1.04	3.70	2.44	2.75	1.6			
G08020805-035	Hole #76	2-21	1.3	<0.1	14	42	44	SiC	69.1	7.7	5.77	19.6	14.2	43.2	11			
G08020805-036	Hole #76	21-29	0.9	<0.1	20	39	41	C	67.0	6.9	6.84	23.5	16.7	53.1	12			
G08020805-037	Hole #76	29-46	1.0	5.7	19	45	36	SiCL	60.6	7.6	4.87	7.22	6.07	43.4	17			
G08020805-038	Hole #76	46-60	0.6	<0.1	10	58	32	SiCL	53.8	7.3	4.57	3.85	3.15	44.1	24			
G08020805-039	Hole #77	0-4	2.0	1.7	36	37	27	CL	52.6	7.6	0.54	4.10	1.14	0.43	0.3			
G08020805-040	Hole #77	4-17	1.5	<0.1	22	41	37	CL	68.4	7.7	1.21	6.47	3.13	4.01	1.8			



ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

**Client:** Knight Priesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020805  
**Report Date:** 03/31/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis	Depth	OM		Coarse Fragments		Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
				%	Results	%	Results											
G08020805-041	Hole #77	17-36	0.9	< 0.1	22	73	5	SIL	67.2	8.0	5.66	23.7	44.8	27.1	4.6			
G08020805-042	Hole #77	36-48	0.8	< 0.1	24	61	15	SIL	64.9	7.8	6.62	23.8	62.6	32.0	4.9			
G08020805-043	Hole #79	0-3	5.1	< 0.1	18	46	36	SICL	56.5	6.1	0.78	1.65	1.19	4.02	3.4			
G08020805-044	Hole #79	3-17	1.6	< 0.1	12	41	47	SIC	73.7	4.1	4.61	22.4	22.1	22.9	4.9			
G08020805-045	Hole #79	17-30	0.9	6.8	18	33	49	C	72.4	3.6	4.75	24.7	20.4	21.9	4.6			
G08020805-046	Hole #79	30-42	0.9	5.0	22	32	46	C	65.1	3.7	2.50	11.4	7.65	9.50	3.1			
G08020805-047	Hole #79	42-60	0.9	9.5	16	37	47	C	61.9	3.6	2.30	10.1	6.32	7.31	2.6			

**ENERGY LABORATORIES**  
 ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company  
 Project: 451b Dewey-Burdock Soils  
 Workorder: G08020805

Report Date: 03/31/08  
 Date Received: 02/28/08

Sample ID	Client Sample ID	Analysis	B-Hot H2O		Se-Hot H2O	
			Units	Depth	Results	Results
G08020805-001	Hole #60	0-3	0.2	0.2	<0.01	<0.01
G08020805-002	Hole #60	3-10	0.4	0.4	0.01	0.01
G08020805-003	Hole #60	10-18	1.5	1.1	0.11	0.11
G08020805-004	Hole #63	0-2	0.1	0.1	<0.01	<0.01
G08020805-005	Hole #63	2-6	<0.1	<0.1	<0.01	<0.01
G08020805-006	Hole #63	6-18	0.3	0.3	<0.01	<0.01
G08020805-007	Hole #64	0-6	<0.1	<0.1	<0.01	<0.01
G08020805-008	Hole #64	6-17	0.2	0.2	<0.01	<0.01
G08020805-009	Hole #64	17-33	1.1	0.03	0.12	0.12
G08020805-010	Hole #64	33-42	2.7	0.12	0.06	0.06
G08020805-011	Hole #64	42-60	1.5	0.06	<0.01	<0.01
G08020805-012	Hole #72	0-3	0.2	0.2	<0.01	<0.01
G08020805-013	Hole #72	3-18	0.2	0.2	<0.01	<0.01
G08020805-014	Hole #72	18-28	1.1	0.12	0.27	0.27
G08020805-015	Hole #72	28-43	2.0	0.27	0.10	0.10
G08020805-016	Hole #72	43-60	1.6	0.10	<0.01	<0.01
G08020805-017	Hole #73	0-3	0.2	0.2	0.06	0.06
G08020805-018	Hole #73	3-15	0.8	0.06	0.34	0.34
G08020805-019	Hole #73	15-23	2.5	0.34	0.44	0.44
G08020805-020	Hole #73	23-34	2.3	0.44	0.37	0.37
G08020805-021	Hole #73	34-38	1.7	0.42	<0.01	<0.01
G08020805-022	Hole #73	38-60	1.8	0.37	<0.01	<0.01
G08020805-023	Hole #74	0-3	0.2	0.2	<0.01	<0.01
G08020805-024	Hole #74	3-15	0.2	0.2	0.08	0.08
G08020805-025	Hole #74	15-27	1.1	0.08	0.21	0.21
G08020805-026	Hole #74	27-38	2.5	0.21	0.16	0.16
G08020805-027	Hole #74	38-51	1.7	0.20	<0.01	<0.01
G08020805-028	Hole #74	51-60	1.3	0.16	<0.01	<0.01
G08020805-029	Hole #75	0-4	0.3	<0.01	<0.01	<0.01
G08020805-030	Hole #75	4-15	0.4	<0.01	<0.01	<0.01
G08020805-031	Hole #75	15-35	0.5	<0.01	<0.01	<0.01
G08020805-032	Hole #75	35-46	0.7	<0.01	<0.01	<0.01
G08020805-033	Hole #75	46-60	0.9	0.01	0.02	0.02
G08020805-034	Hole #76	0-2	0.2	0.2	<0.01	<0.01
G08020805-035	Hole #76	2-21	1.2	0.02	<0.01	<0.01
G08020805-036	Hole #76	21-29	0.8	<0.01	0.04	0.04
G08020805-037	Hole #76	29-46	0.6	0.04	0.17	0.17
G08020805-038	Hole #76	46-60	0.5	0.17	<0.01	<0.01
G08020805-039	Hole #77	0-4	0.2	0.2	<0.01	<0.01
G08020805-040	Hole #77	4-17	0.5	<0.01	<0.01	<0.01



ENERGY LABORATORIES, INC. • 400 W Boxelder Rd • Gillette, WY 82718-5315  
 Toll Free 866.686.7175 • 307.686.7175 • FAX 307.682.4625 • gillette@energylab.com

LABORATORY ANALYTICAL REPORT

**Client:** Knight Piesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020805  
**Report Date:** 03/31/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis		Se-Hot H2O		
		Units	Depth		B-Hot H2O	mg/kg
G08020805-041	Hole #77	17-36		4.4	0.03	
G08020805-042	Hole #77	36-48		6.3	0.04	
G08020805-043	Hole #79	0-3		0.6	< 0.01	
G08020805-044	Hole #79	3-17		0.9	< 0.01	
G08020805-045	Hole #79	17-30		0.6	< 0.01	
G08020805-046	Hole #79	30-42		0.4	< 0.01	
G08020805-047	Hole #79	42-60		0.3	< 0.01	

**ENERGY LABORATORIES, INC.** \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com



**LABORATORY ANALYTICAL REPORT**

**Client:** Knight Piesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020806

**Report Date:** 04/07/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis	OM %	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	SAT w%	pH-sat paste s_u	EC-sat paste mmhos/cm	Ca-sat paste meq/L	Mg-sat paste meq/L	Na-sat paste meq/L	SAR-sat paste unitless
G08020806-001	Hole #82	0-4	3.0	0.9	51	32	17	L	35.7	5.3	1.78	8.96	4.91	0.19	0.08
G08020806-002	Hole #82	4-12	1.9	2.0	40	27	33	CL	49.3	7.1	1.16	5.93	3.57	1.95	0.89
G08020806-003	Hole #82	12-17	1.6	<0.1	54	24	22	SCL	40.7	7.6	0.98	5.10	3.38	1.46	0.71
G08020806-004	Hole #82	17-28	1.3	<0.1	54	24	22	SCL	39.0	7.9	0.99	3.09	3.19	3.75	2.12
G08020806-005	Hole #82	28-43	0.7	<0.1	58	22	20	SCL	39.2	7.9	2.98	6.68	12.5	14.1	4.55
G08020806-006	Hole #83	0-3	3.2	<0.1	14	53	33	SiCL	53.3	4.8	1.23	1.23	0.72	1.20	1.22
G08020806-007	Hole #83	3-17	1.6	<0.1	14	43	43	SiC	52.2	4.8	0.31	0.40	0.23	1.82	3.23
G08020806-008	Hole #83	17-33	1.0	<0.1	9	47	44	SiC	69.4	5.7	4.85	25.3	25.0	22.3	4.44
G08020806-009	Hole #83	33-42	0.6	<0.1	6	69	25	SiL	78.1	7.6	5.71	26.5	35.1	30.4	5.47
G08020806-010	Hole #83	42-52	0.5	<0.1	8	69	23	SiL	82.3	7.9	6.61	26.0	46.3	38.3	6.37
G08020806-011	Hole #83	52-60	0.4	<0.1	12	79	9	SiL	74.9	7.9	6.67	24.4	42.7	42.6	7.36
G08020806-012	Hole #84	0-5	8.0	<0.1	4	59	37	SiCL	87.0	7.4	1.87	1.83	6.46	12.7	6.22
G08020806-013	Hole #84	5-18	1.8	<0.1	9	52	39	SiCL	83.2	8.2	11.8	24.5	105	112	14.0
G08020806-014	Hole #84	18-37	0.8	<0.1	12	46	42	SiC	76.8	8.4	14.0	22.8	149	148	15.9
G08020806-015	Hole #84	37-47	1.1	<0.1	6	55	39	SiCL	70.8	8.3	11.6	23.5	103	108	13.5
G08020806-016	Hole #84	47-60	0.6	<0.1	32	37	31	CL	59.7	8.1	8.14	21.8	60.2	61.6	9.63
G08020806-017	Hole #85	0-2	4.2	<0.1	32	48	20	L	51.5	6.3	0.43	2.37	1.44	0.23	0.16
G08020806-018	Hole #85	2-7	2.3	<0.1	20	41	39	SiCL	80.6	7.3	0.71	4.24	2.39	0.73	0.40
G08020806-019	Hole #85	7-17	1.6	<0.1	16	46	38	SiCL	68.9	7.9	0.71	2.58	1.79	2.93	1.98
G08020806-020	Hole #85	17-30	1.3	<0.1	22	40	38	CL	65.4	8.0	1.71	4.81	4.08	9.26	4.39
G08020806-021	Hole #88	0-2	3.0	2.1	21	46	33	CL	64.7	6.7	0.54	3.27	1.99	0.43	0.26
G08020806-022	Hole #88	2-9	1.8	<0.1	11	43	46	SiC	77.9	7.8	0.80	4.04	1.88	2.48	1.44
G08020806-023	Hole #88	9-18	1.3	<0.1	14	82	4	Si	77.9	7.6	3.99	31.4	13.3	13.6	2.88
G08020806-024	Hole #89	0-2	4.4	3.1	12	54	34	SiCL	72.4	5.4	0.80	4.78	2.49	0.32	0.17
G08020806-025	Hole #89	2-18	2.4	3.7	9	45	46	SiC	87.3	7.7	1.41	5.88	4.12	5.67	2.54
G08020806-026	Hole #89	18-31	1.5	<0.1	6	43	51	SiC	83.7	7.8	3.75	23.8	14.0	16.3	3.75
G08020806-027	Hole #89	31-37	1.5	<0.1	3	49	48	SiC	86.0	7.7	3.98	27.7	15.5	16.0	3.44
G08020806-028	Hole #90	0-2	2.5	<0.1	1	48	51	SiC	84.1	6.8	0.37	2.25	0.89	0.42	0.34
G08020806-029	Hole #90	2-8	1.8	<0.1	2	44	54	SiC	89.8	7.4	0.44	2.82	0.78	0.76	0.56
G08020806-030	Hole #90	8-20	1.5	<0.1	6	41	53	SiC	89.0	7.7	0.78	4.84	1.35	1.86	1.06
G08020806-031	Hole #91	0-4	2.0	<0.1	26	44	30	CL	65.3	7.6	1.21	10.9	3.22	0.65	0.24
G08020806-032	Hole #91	4-19	1.2	<0.1	22	67	11	SiL	85.3	7.8	4.65	25.3	14.5	26.3	5.89
G08020806-033	Hole #91	19-40	0.5	<0.1	16	74	10	SiL	79.9	8.4	12.7	81.7	144	144	19.8
G08020806-034	Hole #91	40-48	0.8	<0.1	19	47	34	SiCL	80.9	8.4	13.7	23.4	98.1	156	20.0
G08020806-035	Hole #91	48-60	0.6	<0.1	10	68	22	SiL	94.3	8.3	14.4	25.1	109	170	20.7
G08020806-036	Hole #92	0-7	2.3	<0.1	18	44	38	SiCL	74.9	7.5	4.99	4.99	1.58	2.09	1.15
G08020806-037	Hole #92	7-19	1.6	<0.1	12	48	40	SiC	88.2	7.6	3.32	27.6	9.68	10.4	2.42
G08020806-038	Hole #93	0-4	2.9	<0.1	50	38	12	L	41.8	7.2	0.77	6.13	1.94	0.22	0.11
G08020806-039	Hole #93	4-8	2.1	<0.1	50	32	18	L	39.4	7.5	6.25	1.80	1.80	0.14	0.07
G08020806-040	Hole #94	0-2	6.3	<0.1	8	48	44	SiC	85.7	6.9	0.92	4.54	3.22	1.06	0.54

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

**ENERGY LABORATORIES**  
 ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

**Client:** Knight Priesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020806

**Report Date:** 04/07/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Analysis	Depth	OM	Coarse Fragments		Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
					%	Results											
G08020806-041	Hole #94	2-8	1.8	<0.1	8	48	44	SIC	87.8	7.6	0.66	3.55	1.58	1.61	1.00		
G08020806-042	Hole #94	8-20	1.2	6.0	19	41	40	SIC	85.6	7.5	2.27	20.6	5.30	3.89	1.08		
G08020806-043	Hole #94	20-32	1.0	3.1	16	45	39	SICL	82.6	7.6	3.00	26.0	9.46	5.36	1.27		
G08020806-044	Hole #94	32-44	1.2	8.9	9	49	42	SIC	87.2	7.6	3.81	26.2	18.1	13.4	2.84		
G08020806-045	Hole #94	44-60	0.9	5.0	12	47	41	SIC	87.0	7.8	5.22	23.7	27.5	29.4	5.82		
G08020806-046	Hole #95	0-2	3.6	<0.1	39	43	18	L	46.4	7.1	0.70	5.33	2.36	0.10	0.05		
G08020806-047	Hole #95	2-8	2.0	<0.1	41	39	20	L	43.8	7.6	0.93	7.16	2.64	0.40	0.18		
G08020806-048	Hole #95	8-17	1.2	<0.1	40	41	19	L	39.5	7.9	0.85	3.56	2.66	0.71	0.40		
G08020806-049	Hole #95	17-24	0.7	<0.1	35	39	26	L	51.3	8.3	0.90	1.18	2.30	5.73	4.34		
G08020806-050	Hole #95	24-38	1.0	<0.1	34	33	33	CL	62.7	8.3	6.10	15.6	37.7	41.7	8.08		

**ENERGY LABORATORIES**  
 ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

**LABORATORY ANALYTICAL REPORT**

**Client:** Knight Piesold and Company  
**Project:** 451b Dewey-Burdock Soils  
**Workorder:** G08020806

**Report Date:** 04/07/08  
**Date Received:** 02/28/08

Sample ID	Client Sample ID	Depth	Analysis		Se-Hot H2O
			B-Hot H2O	mg/kg	
G08020806-001	Hole #82	0-4	0.3	0.3	< 0.01
G08020806-002	Hole #82	4-12	0.3	0.3	< 0.01
G08020806-003	Hole #82	12-17	0.3	0.3	< 0.01
G08020806-004	Hole #82	17-28	0.3	0.3	< 0.01
G08020806-005	Hole #82	28-43	0.5	0.5	< 0.01
G08020806-006	Hole #83	0-3	0.3	0.3	< 0.01
G08020806-007	Hole #83	3-17	0.3	0.3	< 0.01
G08020806-008	Hole #83	17-33	1.9	1.9	< 0.01
G08020806-009	Hole #83	33-42	5.4	5.4	0.02
G08020806-010	Hole #83	42-52	8.4	8.4	0.04
G08020806-011	Hole #83	52-60	5.2	5.2	0.07
G08020806-012	Hole #84	0-5	1.0	1.0	< 0.01
G08020806-013	Hole #84	5-18	1.6	1.6	0.02
G08020806-014	Hole #84	18-37	2.8	2.8	0.05
G08020806-015	Hole #84	37-47	2.9	2.9	0.02
G08020806-016	Hole #84	47-60	1.8	1.8	< 0.01
G08020806-017	Hole #85	0-2	0.2	0.2	< 0.01
G08020806-018	Hole #85	2-7	0.2	0.2	< 0.01
G08020806-019	Hole #85	7-17	0.5	0.5	< 0.01
G08020806-020	Hole #85	17-30	0.8	0.8	< 0.01
G08020806-021	Hole #88	0-2	0.2	0.2	< 0.01
G08020806-022	Hole #88	2-9	0.4	0.4	< 0.01
G08020806-023	Hole #88	9-18	1.2	1.2	< 0.01
G08020806-024	Hole #89	0-2	0.3	0.3	< 0.01
G08020806-025	Hole #89	2-18	0.5	0.5	< 0.01
G08020806-026	Hole #89	18-31	1.3	1.3	0.02
G08020806-027	Hole #89	31-37	1.5	1.5	0.01
G08020806-028	Hole #90	0-2	0.3	0.3	< 0.01
G08020806-029	Hole #90	2-8	0.4	0.4	< 0.01
G08020806-030	Hole #90	8-20	0.8	0.8	< 0.01
G08020806-031	Hole #91	0-4	0.2	0.2	< 0.01
G08020806-032	Hole #91	4-19	0.3	0.3	0.02
G08020806-033	Hole #91	19-40	1.5	1.5	0.07
G08020806-034	Hole #91	40-48	1.0	1.0	0.08
G08020806-035	Hole #91	48-60	1.0	1.0	0.10
G08020806-036	Hole #92	0-7	0.2	0.2	< 0.01
G08020806-037	Hole #92	7-19	0.7	0.7	< 0.01
G08020806-038	Hole #93	0-4	< 0.1	< 0.1	< 0.01
G08020806-039	Hole #93	4-8	0.1	0.1	< 0.01
G08020806-040	Hole #94	0-2	0.6	0.6	< 0.01



ENERGY LABORATORIES, INC. \* 400 W Boxelder Rd \* Gillette, WY 82718-5315  
 Toll Free 866.686.7175 \* 307.686.7175 \* FAX 307.682.4625 \* gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company  
 Project: 451b Dewey-Burdock Soils  
 Workorder: G08020806  
 Report Date: 04/07/08  
 Date Received: 02/28/08

Sample ID	Client Sample ID	Analysis	Units		Se-Hot H2O
			B-Hot H2O	mg/kg	
		Depth	Results	Results	Results
G08020806-041	Hole #94	2-8	0.4	< 0.01	< 0.01
G08020806-042	Hole #94	8-20	0.5	< 0.01	< 0.01
G08020806-043	Hole #94	20-32	0.7	< 0.01	< 0.01
G08020806-044	Hole #94	32-44	1.1	< 0.01	< 0.01
G08020806-045	Hole #94	44-60	0.8	0.02	0.02
G08020806-046	Hole #95	0-2	0.2	< 0.01	< 0.01
G08020806-047	Hole #95	2-8	0.1	< 0.01	< 0.01
G08020806-048	Hole #95	8-17	0.1	< 0.01	< 0.01
G08020806-049	Hole #95	17-24	0.2	< 0.01	< 0.01
G08020806-050	Hole #95	24-38	1.5	0.15	0.15

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment



ENERGY LABORATORIES, INC. • 2393 Salt Creek Highway (82601) • P.O. Box 3258 • Casper, WY 82602  
 Toll Free 888.235.0515 • 307.235.0515 • Fax 307.234.1639 • casper@energylab.com • www.energylab.com

LABORATORY ANALYTICAL REPORT

Report Date: 12/29/08  
 Date Received: 10/21/08

Client: BKS Environmental Associates Inc  
 Project: 451B Dewey-Burdock Baseline Soils  
 Workorder: C08100918

Sample ID	Client Sample ID	Analysis Units	Depth	EC SatPst	Saturation SatPst	pH SatPst	Ca SatPst	Mg SatPst	Na SatPst	SAR	Sand %	Silt %	Clay %	Texture	Coarse Frags %	Se-ABDTPA mg/kg-dry
C08100918-001	103	0-3	1.91	37.7	7.3	14.8	4.22	2.35	0.76	33	21	46	C	1	0.009	
C08100918-002	103	3-12	2.60	34.6	7.6	23.3	12.1	1.98	0.47	23	27	50	C	3	0.011	
C08100918-003	103	12-25	3.75	31.2	7.5	36.9	18.6	2.5	0.48	31	49	20	L	<1	0.011	
C08100918-004	103	25-38	10.3	28.5	8.2	33.8	89.7	48.7	5.87	25	65	10	SL	2	0.064	
C08100918-005	103	38-48	9.66	23.4	8.3	31.3	84.7	38.7	5.12	57	23	20	SL - SCL	3	0.097	
C08100918-006	114	0-2	1.57	49.6	6.1	11.7	4.05	2.27	0.81	23	33	44	C	2	0.011	
C08100918-007	114	2-9	1.03	26.6	7.4	6.88	2.66	2.09	0.95	32	38	30	CL	5	0.022	
C08100918-008	114	9-26	4.58	36.7	7.9	25.7	8.1	29.1	7.10	31	29	40	C - CL	9	0.028	
C08100918-009	114	26-38	9.19	41.5	8.3	20.7	11.1	94.4	23.7	35	25	40	C - CL	6	0.021	
C08100918-010	114	38-48	20.6	39.7	8.9	24.1	29.4	267	51.9	39	19	42	C	6	0.039	
C08100918-011	115	0-3	2.08	25.7	7.7	20.5	4.19	3.14	0.80	49	25	26	SCL	4	0.013	
C08100918-012	115	3-19	0.58	26.0	8.2	3.80	2.23	0.65	0.37	55	25	20	SL - SCL	<1	0.010	
C08100918-013	115	19-27	0.73	22.8	8.2	3.18	3.41	1.83	1.01	57	25	18	SL	2	0.003	
C08100918-014	116	0-5	1.47	29.6	7.1	12.0	3.77	2.27	0.81	53	15	32	SCL	<1	0.009	
C08100918-015	116	5-18	2.31	26.8	8.2	8.99	6.27	13.0	4.70	59	17	24	SCL	7	0.007	
C08100918-016	116	18-38	0.94	25.7	8.6	0.90	2.79	6.45	4.78	53	17	30	SCL	<1	0.006	
C08100918-017	116	38-48	2.54	23.1	8.7	2.33	7.94	17.2	7.65	69	11	20	SL - SCL	2	0.064	

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment



ENERGY LABORATORIES, INC. • 2393 Salt Creek Highway (82601) • P.O. Box 3258 • Casper, WY 82602  
 Toll Free 888.235.0515 • 307.235.0515 • Fax 307.234.1639 • casper@energylab.com • www.energylab.com

LABORATORY ANALYTICAL REPORT

Report Date: 12/29/08  
 Date Received: 10/21/08

Client: BKS Environmental Associates Inc  
 Project: 451B Dewey-Burdock Baseline Soils  
 Workorder: C08100918

Sample ID	Client Sample ID	Analysis		B-CACL2		Organic Matter	
		Units	Depth	mg/kg-dry	Results	%	Results
C08100918-001	103		0-3		1.0		3.9
C08100918-002	103		3-12		1.0		1.9
C08100918-003	103		12-25		0.91		0.8
C08100918-004	103		25-38		1.4		0.7
C08100918-005	103		38-48		1.5		0.3
C08100918-006	114		0-2		0.83		7.1
C08100918-007	114		2-9		0.67		2.0
C08100918-008	114		9-26		0.93		1.1
C08100918-009	114		26-38		1.2		0.8
C08100918-010	114		38-48		3.1		0.5
C08100918-011	115		0-3		< 0.43		1.3
C08100918-012	115		3-19		< 0.44		0.8
C08100918-013	115		19-27		< 0.43		0.5
C08100918-014	116		0-5		< 0.43		2.1
C08100918-015	116		5-18		< 0.44		1.0
C08100918-016	116		18-35		0.85		0.7
C08100918-017	116		36-48		2.2		0.4

**ADDENDUM D-7-E**  
**PRIME FARMLAND DESIGNATION**

This page intentionally left blank

POWERTECH (USA), INC.  
Dewey-Burdock ISR Uranium Project  
Pre-Mining Soil Assessment

---

United States Department of Agriculture



Natural Resources Conservation Service  
200 Fourth Street SW  
Huron, South Dakota 57350

Phone: (605) 352-1200  
Fax: (605) 352-1270

September 5, 2008

Mr. Adam Beilke  
BKS Environmental Associates, Inc.  
P.O. Box 3467  
Gillette, Wyoming 82717

RE: Maps for Custer and Fall River Counties, South Dakota (SD)

Dear Mr. Beilke:

Attached are the prime and important farmland maps you requested for the Sections in Township 6 and 7 North and Range 1 East in Custer and Fall River Counties in SD.

Important farmland is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oil seed crops. Criteria for defining and delineating this land are to be determined by the appropriate state agency or agencies.

Generally, additional farmlands of statewide importance include those that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmlands if conditions are favorable. Below is the criteria we use in determining important farmland in South Dakota:

A map unit is "Farmland of Statewide Importance" if 50 percent or more of named Components meet the Criteria and the Land Capability Class of all named components is Class 4 or less.

Mesic or frigid temperature regime  
Available Water Capacity (AWC): 5.00 or Better (high) in top 40 inches.  
pH: 4.5 - 8.4 in top 24 inches  
EC: less than 8 in top 24 inches  
SAR: less than 15 in top 24 inches  
Surface Fragments > 3 in: less than 10%  
Water erosion: Kw\*slope Representative Value < 3.  
Wind Erosion: I\*C < 60.  
Flooding or Ponding: Less than Frequent  
Wetness: High Water table > 6 inches.  
Mapunit is not prime farmland under all conditions

If I can be a further assistance, do not hesitate to let me know.

Sincerely,

DANIEL SHURTLIFF  
Acting State Soil Scientist

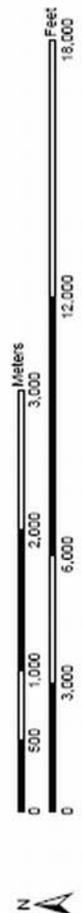
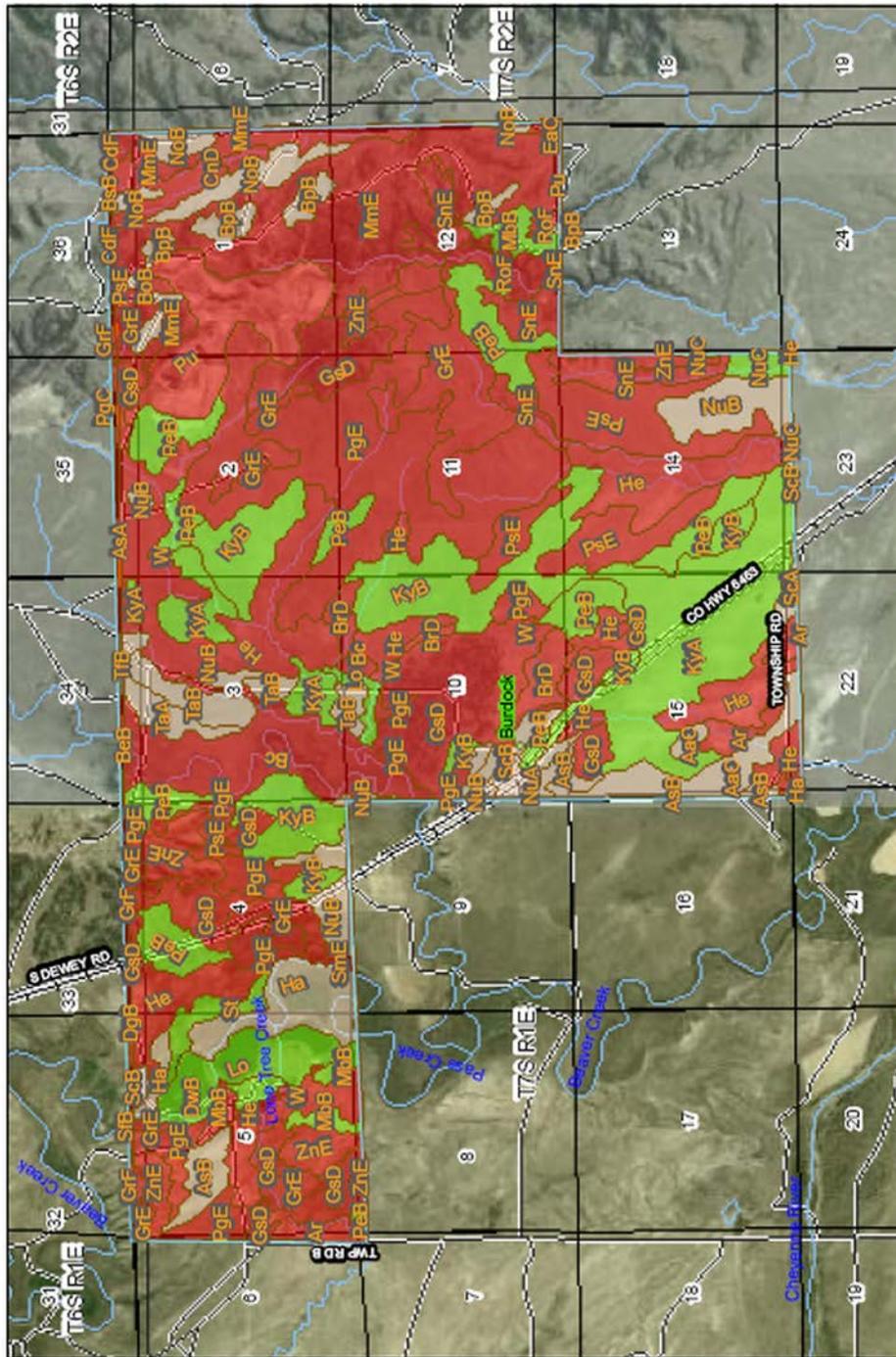
Attachments

cc: Kory Bossert, DC, NRCS, Hot Springs FO

Helping People Help the Land  
An Equal Opportunity Provider and Employer

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Farmland Classification—Custer and Pennington Counties, Black Hills Parts, South Dakota, and Fall River County, South Dakota  
 (BKS ENV 75 1E)

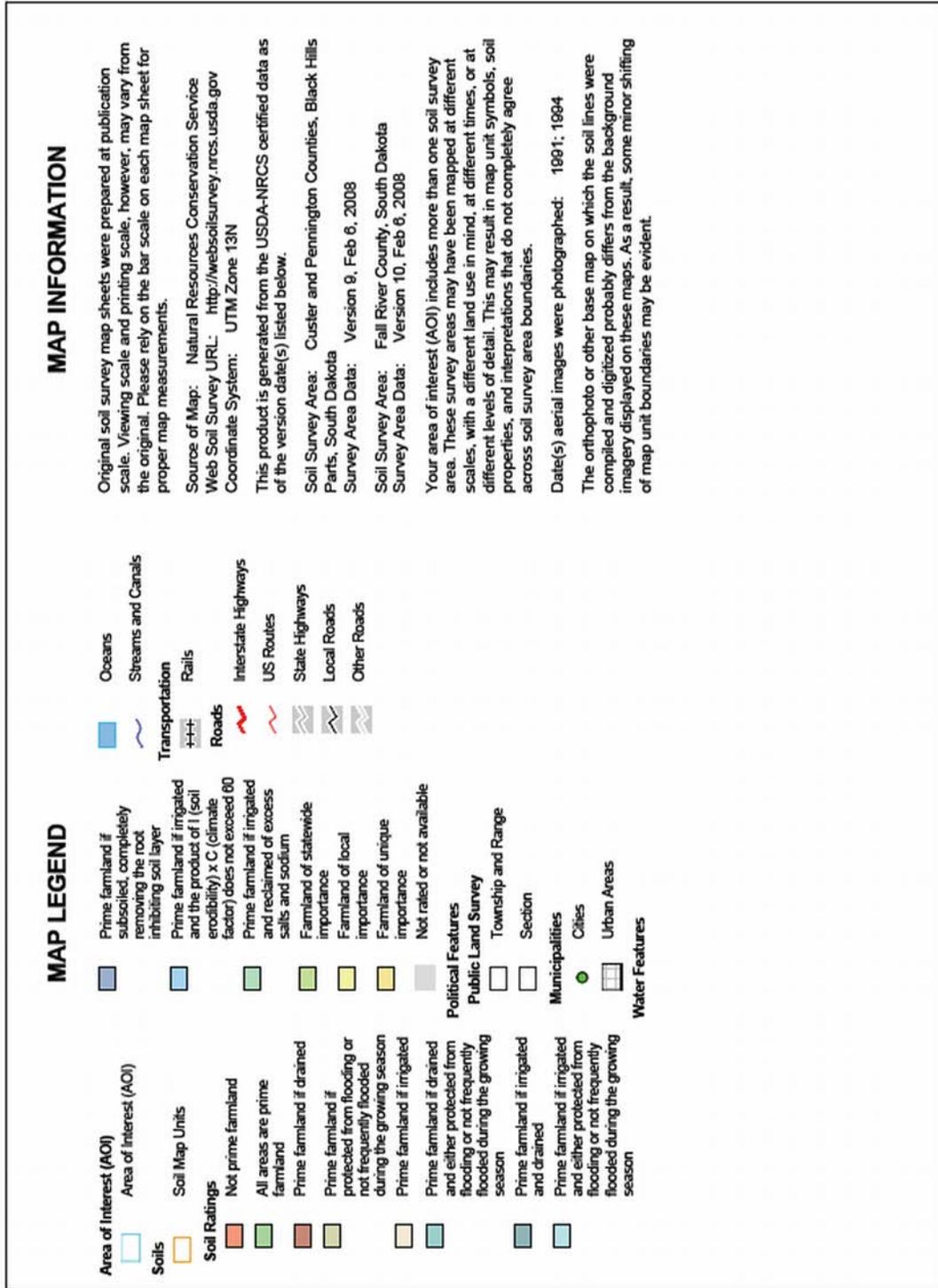


Natural Resources  
 Conservation Service

Web Soil Survey 2.0  
 National Cooperative Soil Survey

8/8/2008  
 Page 1 of 5

Farmland Classification—Custer and Pennington Counties, Black Hills Parts, South Dakota, and Fall River County, South Dakota  
 (BKS Env 7S 1E)



## Farmland Classification

Farmland Classification— Summary by Map Unit — Custer and Pennington Counties, Black Hills Parts, South Dakota				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
A&A	Arvada-Sticksots complex, 0 to 3 percent slopes	Not prime farmland	11.1	0.2%
BeB	Bamun-Wnetll complex, 0 to 6 percent slopes	Not prime farmland	5.0	0.1%
BrB	Buffal silt loam, 3 to 6 percent slopes	Not prime farmland	1.2	0.0%
BsB	Buffal-Cordeston silt loams, 2 to 9 percent slopes	Not prime farmland	2.7	0.0%
CoF	Canyon-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland	6.7	0.1%
DgB	Demar-Grummit-Sticksots complex, 0 to 6 percent slopes	Not prime farmland	5.2	0.1%
GrD	Grummit-Rock outcrop complex, 6 to 15 percent slopes	Not prime farmland	1.5	0.0%
GrF	Grummit-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland	14.6	0.2%
H&A	Haverson loam, 0 to 2 percent slopes	Prime farmland if irrigated	0.7	0.0%
NfE	Nihil-Zigweid complex, 15 to 50 percent slopes	Not prime farmland	1.8	0.0%
PgC	Pierre-Grummit clays, 2 to 9 percent slopes	Not prime farmland	7.8	0.1%
StB	Satanta-Arvada complex, 2 to 6 percent slopes	Not prime farmland	2.5	0.0%
TfB	Tilford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated	3.5	0.1%
ZnD	Zigweid-Nihil complex, 6 to 15 percent slopes	Not prime farmland	1.5	0.0%

Farmland Classification— Summary by Map Unit — Fall River County, South Dakota				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
AaC	Alloe fine sandy loam, 2 to 9 percent slopes	Prime farmland if irrigated	59.8	1.5%
Ar	Arvada loam	Not prime farmland	69.0	1.0%
AsB	Ascalon fine sandy loam, 0 to 6 percent slopes	Prime farmland if irrigated	66.4	1.0%

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Farmland Classification—Custer and Pennington Counties, Black Hills Parts,  
 South Dakota; and Fall River County, South Dakota

BKS Env 7S 1E

Farmland Classification— Summary by Map Unit — Fall River County, South Dakota				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Bc	Bamum silt loam	Not prime farmland	251.7	3.8%
BoB	Boneek silt loam, 2 to 6 percent slopes	Prime farmland if irrigated	19.1	0.3%
BpB	Boneek silt loam, bedrock substratum, 2 to 6 percent slopes	Prime farmland if irrigated	56.2	0.9%
BrD	Broadhurst clay, 2 to 15 percent slopes	Not prime farmland	66.4	1.0%
CnD	Colby-Norka silt loams, 6 to 15 percent slopes	Not prime farmland	99.5	1.5%
DwB	Dwyer loamy fine sand, 2 to 6 percent slopes	Not prime farmland	13.7	0.2%
EaC	Eckley loam, 0 to 9 percent slopes	Not prime farmland	5.0	0.1%
GrE	Grummit-Rock outcrop complex, 3 to 40 percent slopes	Not prime farmland	327.9	5.0%
GsD	Grummit-Snomo clays, 3 to 15 percent slopes	Not prime farmland	523.3	7.9%
Ha	Haverson loam	Prime farmland if irrigated	130.0	2.0%
He	Hisle-Slickspots complex	Not prime farmland	733.9	11.1%
KyA	Kyle clay, 0 to 2 percent slopes	Farmland of statewide importance	466.2	7.1%
KyB	Kyle clay, 2 to 6 percent slopes	Farmland of statewide importance	421.1	6.4%
Lo	Lohniller silty clay loam	Farmland of statewide importance	131.5	2.0%
MbB	Manzanola silty clay loam, 2 to 6 percent slopes	Farmland of statewide importance	75.0	1.1%
MmE	Mathias-Midway-Rock outcrop complex, 15 to 30 percent slopes	Not prime farmland	512.2	7.7%
NoB	Norka silt loam, 2 to 6 percent slopes	Prime farmland if irrigated	92.5	1.4%
NuA	Nunn clay loam, 0 to 2 percent slopes	Prime farmland if irrigated	28.0	0.4%
NuB	Nunn clay loam, 2 to 6 percent slopes	Prime farmland if irrigated	160.5	2.4%
NuC	Nunn clay loam, 6 to 9 percent slopes	Farmland of statewide importance	25.3	0.4%
PeB	Pierre clay, 2 to 6 percent slopes	Farmland of statewide importance	322.0	4.9%
PgE	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland	747.0	11.3%
PsE	Pierre-Samsil clays, 6 to 25 percent slopes	Not prime farmland	289.6	4.4%

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Farmland Classification—Custer and Pennington Counties, Black Hills Parts,  
 South Dakota; and Fall River County, South Dakota

BKS Env 7S 1E

Farmland Classification— Summary by Map Unit — Fall River County, South Dakota				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
Pu	Pits, mine	Not prime farmland	214.8	3.2%
RoF	Rock outcrop-Mathias-Butche complex, 30 to 75 percent slopes	Not prime farmland	52.7	0.8%
SoA	Satanta loam, 0 to 2 percent slopes	Prime farmland if irrigated	13.3	0.2%
SoB	Satanta loam, 2 to 6 percent slopes	Prime farmland if irrigated	38.6	0.6%
SoC	Satanta loam, 6 to 9 percent slopes	Farmland of statewide importance	0.0	0.0%
SmE	Schamber-Eckley complex, 9 to 40 percent slopes	Not prime farmland	7.1	0.1%
SnE	Shingle-Penrose-Rock outcrop complex, 15 to 40 percent slopes	Not prime farmland	158.7	2.4%
St	Stetter clay	Farmland of statewide importance	36.0	0.5%
TaA	Tiford silt loam, 0 to 2 percent slopes	Prime farmland if irrigated	42.7	0.6%
TaB	Tiford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated	75.0	1.1%
W	Water	Not prime farmland	9.9	0.1%
ZnE	Zigweid-Nihill complex, 6 to 20 percent slopes	Not prime farmland	160.5	2.4%
Totals for Area of Interest (AOI)			6,609.1	100.0%

## Description

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

## Rating Options

*Aggregation Method:* No Aggregation Necessary

*Tie-break Rule:* Lower

## Prime and other Important Farmlands

This table lists the map units in the survey area that are considered important farmlands. Important farmlands consist of prime farmland, unique farmland, and farmland of statewide or local importance. This list does not constitute a recommendation for a particular land use.

In an effort to identify the extent and location of important farmlands, the Natural Resources Conservation Service, in cooperation with other interested Federal, State, and local government organizations, has inventoried land that can be used for the production of the Nation's food supply.

*Prime farmland* is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. The water supply is dependable and of adequate quality. Prime farmland is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 8 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

For some of the soils identified in the table as prime farmland, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures.

A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

*Unique farmland* is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. It has the special combination of soil quality, growing season, moisture supply, temperature, humidity, air drainage, elevation, and aspect needed for the soil to economically produce sustainable high yields of these crops when properly managed. The water supply is dependable and of adequate quality. Nearness to markets is an additional consideration. Unique farmland is not based on national criteria. It commonly is in areas where there is a special microclimate, such as the wine country in California.

In some areas, land that does not meet the criteria for prime or unique farmland is considered to be *farmland of statewide importance* for the production of food, feed, fiber, forage, and oilseed crops. The criteria for defining and delineating farmland of statewide importance are determined by the appropriate State agencies.

Generally, this land includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some areas may produce as high a yield as prime farmland if conditions are favorable. Farmland of statewide importance may include tracts of land that have been designated for agriculture by State law.

In some areas that are not identified as having national or statewide importance, land is considered to be *farmland of local importance* for the production of food, feed, fiber, forage, and oilseed crops. This farmland is identified by the appropriate local agencies. Farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance.

### Report—Prime and other Important Farmlands

Prime and other Important Farmlands—Custer and Pennington Counties, Black Hills Parts, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
AsA	Arvada-Slickspots complex, 0 to 3 percent slopes	Not prime farmland
BeB	Barnum-Winetti complex, 0 to 6 percent slopes	Not prime farmland
BrB	Bullflat silt loam, 3 to 6 percent slopes	Not prime farmland
BsB	Bullflat-Corderston silt loams, 2 to 9 percent slopes	Not prime farmland
CdF	Canyon-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland
DgB	Demar-Grummit-Slickspots complex, 0 to 6 percent slopes	Not prime farmland
GrD	Grummit-Rock outcrop complex, 6 to 15 percent slopes	Not prime farmland
GrF	Grummit-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland
HaA	Haverson loam, 0 to 2 percent slopes	Prime farmland if irrigated
NtE	Nihili-Zigweid complex, 15 to 50 percent slopes	Not prime farmland
PgC	Pierre-Grummit clays, 2 to 9 percent slopes	Not prime farmland
SfB	Salanta-Arvada complex, 2 to 6 percent slopes	Not prime farmland
TtE	Tilford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated
ZnD	Zigweid-Nihili complex, 6 to 15 percent slopes	Not prime farmland

Prime and other Important Farmlands— Fall River County, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
AaC	Alice fine sandy loam, 2 to 9 percent slopes	Prime farmland if irrigated
Ar	Arvada loam	Not prime farmland
AsB	Ascaion fine sandy loam, 0 to 6 percent slopes	Prime farmland if irrigated
Bc	Barnum silt loam	Not prime farmland
BoB	Boneek silt loam, 2 to 6 percent slopes	Prime farmland if irrigated
BpB	Boneek silt loam, bedrock substratum, 2 to 6 percent slopes	Prime farmland if irrigated

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Prime and other Important Farmlands—Custer and Pennington Counties, Black Hills Plains, South Dakota, and Fall River County, South Dakota

BKS Env 7S 1E

Prime and other Important Farmlands— Fall River County, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
BrD	Broadhurst clay, 2 to 15 percent slopes	Not prime farmland
CnD	Colby-Norka silt loams, 6 to 15 percent slopes	Not prime farmland
DwB	Dwyer loamy fine sand, 2 to 6 percent slopes	Not prime farmland
EaC	Eckley loam, 0 to 9 percent slopes	Not prime farmland
GrE	Grummit-Rock outcrop complex, 3 to 40 percent slopes	Not prime farmland
GsD	Grummit-Snomo clays, 3 to 15 percent slopes	Not prime farmland
Ha	Haverson loam	Prime farmland if irrigated
He	Hisie-Slickspots complex	Not prime farmland
KyA	Kyle clay, 0 to 2 percent slopes	Farmland of statewide importance
KyB	Kyle clay, 2 to 6 percent slopes	Farmland of statewide importance
Lo	Lohmiller silty clay loam	Farmland of statewide importance
MtB	Manzanola silty clay loam, 2 to 6 percent slopes	Farmland of statewide importance
MmE	Mathias-Midway-Rock outcrop complex, 15 to 30 percent slopes	Not prime farmland
NoB	Norka silt loam, 2 to 6 percent slopes	Prime farmland if irrigated
NuA	Nunn clay loam, 0 to 2 percent slopes	Prime farmland if irrigated
NuB	Nunn clay loam, 2 to 6 percent slopes	Prime farmland if irrigated
NuC	Nunn clay loam, 6 to 9 percent slopes	Farmland of statewide importance
PeB	Pierre clay, 2 to 6 percent slopes	Farmland of statewide importance
PgE	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland
PsE	Pierre-Samsil clays, 6 to 25 percent slopes	Not prime farmland
Pu	Pits, mine	Not prime farmland
RoF	Rock outcrop-Mathias-Butche complex, 30 to 75 percent slopes	Not prime farmland
SoA	Salanta loam, 0 to 2 percent slopes	Prime farmland if irrigated
SoB	Salanta loam, 2 to 6 percent slopes	Prime farmland if irrigated
SoC	Salanta loam, 6 to 9 percent slopes	Farmland of statewide importance
SmE	Schamber-Eckley complex, 9 to 40 percent slopes	Not prime farmland
SnE	Shingle-Penrose-Rock outcrop complex, 15 to 40 percent slopes	Not prime farmland
St	Stetter clay	Farmland of statewide importance
TaA	Tilford silt loam, 0 to 2 percent slopes	Prime farmland if irrigated
TaB	Tilford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated
W	Water	Not prime farmland
ZnE	Zigweid-Nihili complex, 6 to 20 percent slopes	Not prime farmland

### Data Source Information

Soil Survey Area: Custer and Pennington Counties, Black Hills Parts, South Dakota

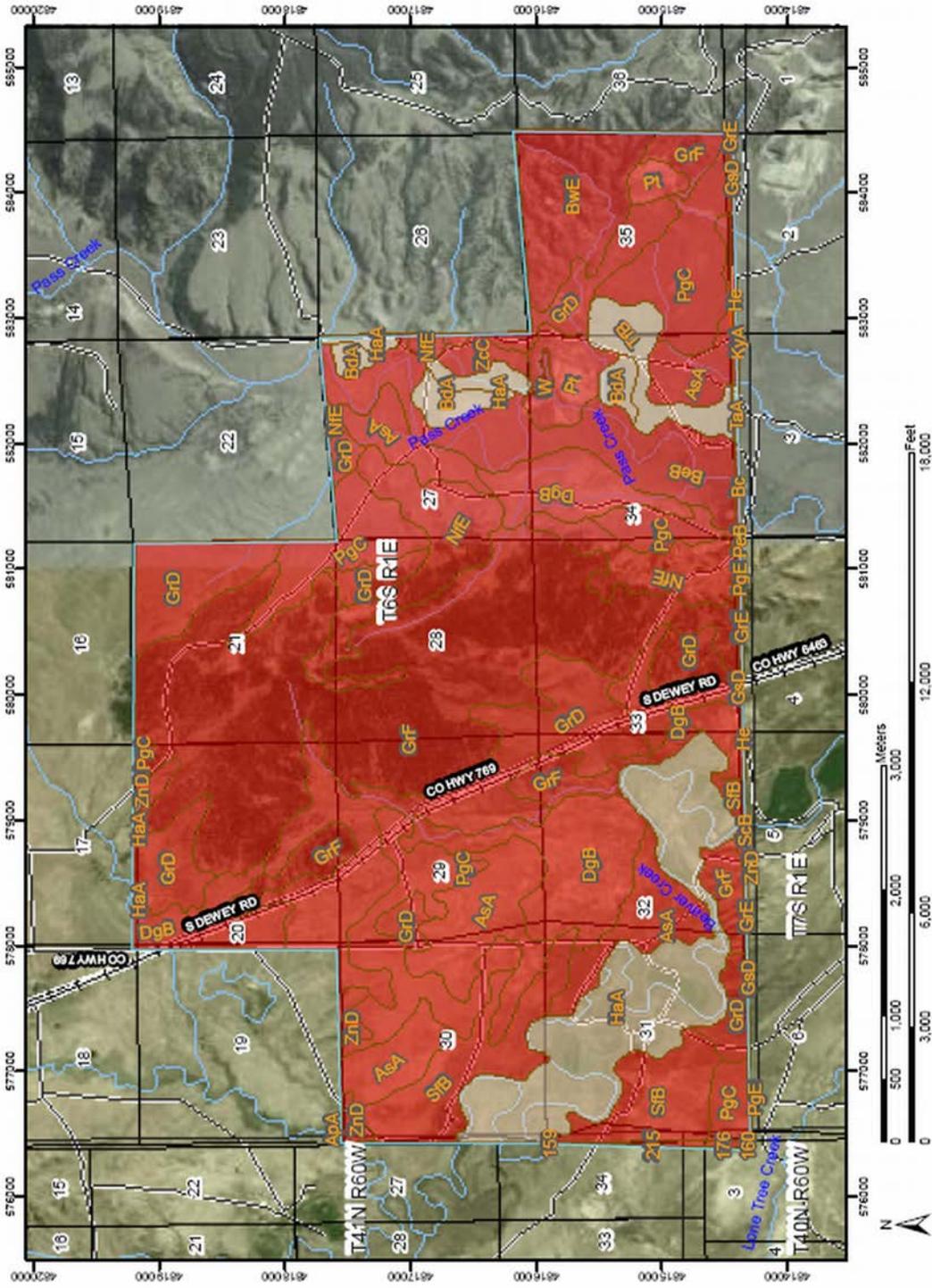
Survey Area Data: Version 9, Feb 6, 2008

Soil Survey Area: Fall River County, South Dakota

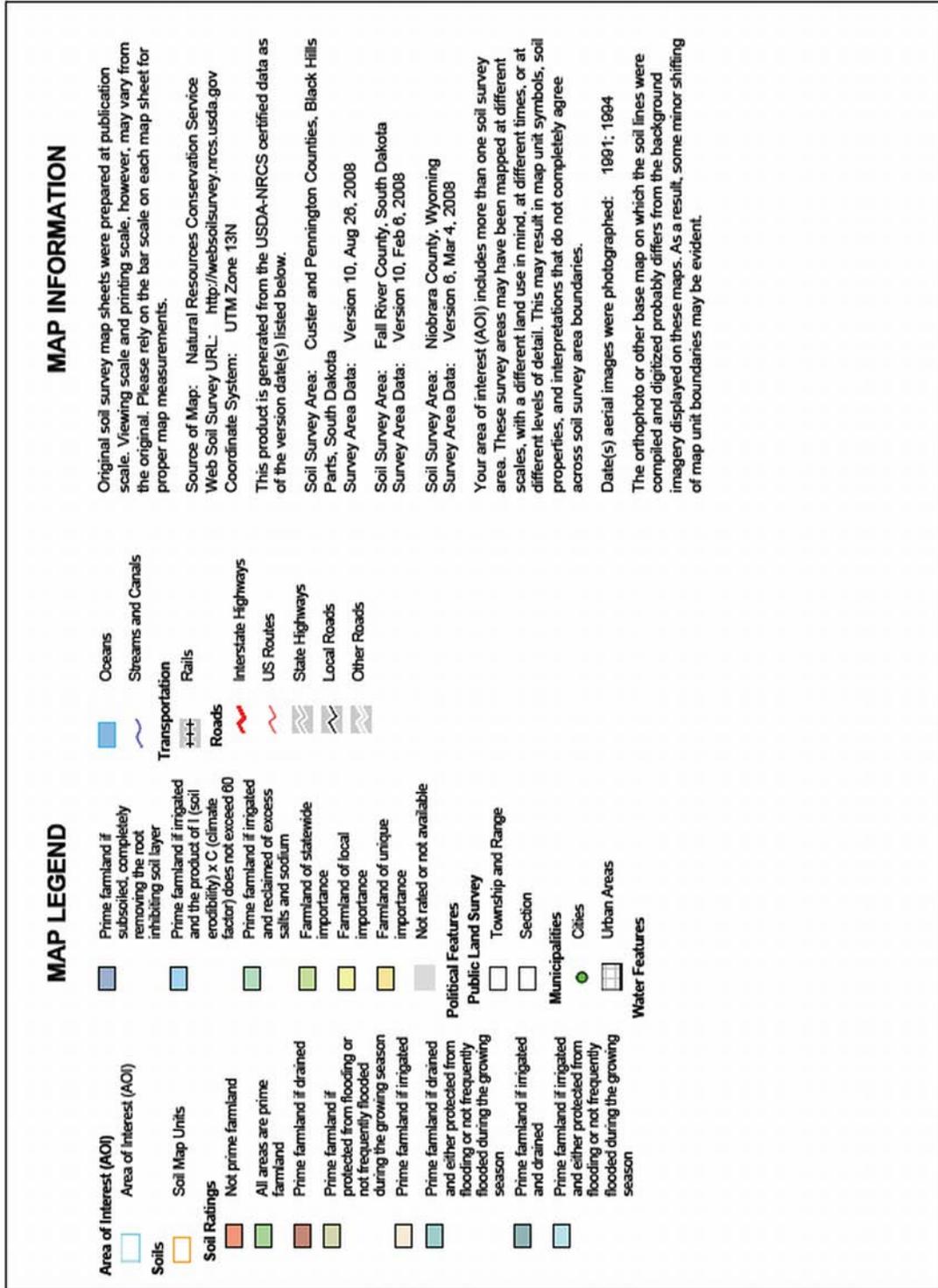
Survey Area Data: Version 10, Feb 6, 2008

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Farmland Classification—Custer and Pennington Counties, Black Hills Parts, South Dakota; Fall River County, South Dakota; and Niobrara County, Wyoming  
 (BKS\_Farmland\_4)



Farmland Classification—Custer and Pennington Counties, Black Hills Parts, South Dakota, Fall River County, South Dakota, and Niobrara County, Wyoming (BKS\_Farmland\_4)



## Farmland Classification

Farmland Classification— Summary by Map Unit — Custer and Pennington Counties, Black Hills Parts, South Dakota				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
AqA	Arvada variant loam, 0 to 2 percent slopes	Not prime farmland	6.8	0.1%
AsA	Arvada-Slickspots complex, 0 to 3 percent slopes	Not prime farmland	610.9	8.5%
BdA	Bamum very fine sandy loam, 0 to 3 percent slopes	Prime farmland if irrigated	87.5	1.2%
BeB	Bamum-Winnetli complex, 0 to 6 percent slopes	Not prime farmland	343.7	4.8%
BwE	Butche-Rock outcrop complex, 9 to 60 percent slopes	Not prime farmland	256.0	3.6%
DgB	Demar-Grummit-Slickspots complex, 0 to 6 percent slopes	Not prime farmland	602.8	8.4%
GrD	Grummit-Rock outcrop complex, 6 to 15 percent slopes	Not prime farmland	1,116.0	15.6%
GrF	Grummit-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland	1,657.8	23.2%
HaA	Haverson loam, 0 to 2 percent slopes	Prime farmland if irrigated	635.7	8.9%
NfE	Nihil-Zigweid complex, 15 to 50 percent slopes	Not prime farmland	373.1	5.2%
PgC	Pierre-Grummit clays, 2 to 9 percent slopes	Not prime farmland	697.2	9.7%
Pt	Pits, quarries	Not prime farmland	119.5	1.7%
SfB	Salanta-Arvada complex, 2 to 6 percent slopes	Not prime farmland	379.9	5.3%
TfB	Tiford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated	109.9	1.5%
W	Water	Not prime farmland	8.1	0.1%
ZcC	Zigweid-Canyon complex, 2 to 15 percent slopes	Not prime farmland	35.5	0.5%
ZnD	Zigweid-Nihil complex, 6 to 15 percent slopes	Not prime farmland	33.5	0.5%

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Farmland Classification—Custer and Pennington Counties, Black Hills Parts,  
 South Dakota; Fall River County, South Dakota; and Niobrara County, Wyoming

BKS\_Farmland\_4

Farmland Classification— Summary by Map Unit — Fall River County, South Dakota				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
Bc	Barnum silt loam	Not prime farmland	7.2	0.1%
GrE	Grummit-Rock outcrop complex, 3 to 40 percent slopes	Not prime farmland	10.7	0.1%
GsD	Grummit-Snomo clays, 3 to 15 percent slopes	Not prime farmland	13.3	0.2%
Ha	Haverson loam	Prime farmland if irrigated	0.5	0.0%
He	Hisle-Slickspots complex	Not prime farmland	19.7	0.3%
KyA	Kyle clay, 0 to 2 percent slopes	Farmland of statewide importance	0.1	0.0%
PeB	Pierre clay, 2 to 6 percent slopes	Farmland of statewide importance	2.0	0.0%
PgE	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland	4.7	0.1%
Pu	Pits, mine	Not prime farmland	0.1	0.0%
SoB	Satanta loam, 2 to 6 percent slopes	Prime farmland if irrigated	1.8	0.0%
TaA	Tilford silt loam, 0 to 2 percent slopes	Prime farmland if irrigated	4.9	0.1%
ZnE	Zigweid-Nihil complex, 6 to 20 percent slopes	Not prime farmland	1.3	0.0%
Farmland Classification— Summary by Map Unit — Niobrara County, Wyoming				
Map unit symbol	Map unit name	Rating	Acres In AOI	Percent of AOI
159	Lohmiller-Haverdad complex, saline, 1 to 4 percent slopes	Not prime farmland	0.0	0.0%
160	Manzanola silty clay loam, 0 to 6 percent slopes	Not prime farmland	1.1	0.0%
176	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland	4.1	0.1%
185	Samday-Savaeton-Bahl association, 3 to 10 percent slopes	Not prime farmland	0.4	0.0%
215	Ulm-Forkwood loams, 0 to 6 percent slopes	Not prime farmland	8.5	0.1%
Totals for Area of Interest (AOI)			7,153.3	100.0%

## Description

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

## Rating Options

*Aggregation Method:* No Aggregation Necessary

*Tie-break Rule:* Lower

## Prime and other Important Farmlands

This table lists the map units in the survey area that are considered important farmlands. Important farmlands consist of prime farmland, unique farmland, and farmland of statewide or local importance. This list does not constitute a recommendation for a particular land use.

In an effort to identify the extent and location of important farmlands, the Natural Resources Conservation Service, in cooperation with other interested Federal, State, and local government organizations, has inventoried land that can be used for the production of the Nation's food supply.

*Prime farmland* is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. The water supply is dependable and of adequate quality. Prime farmland is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 8 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

For some of the soils identified in the table as prime farmland, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures.

A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

*Unique farmland* is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. It has the special combination of soil quality, growing season, moisture supply, temperature, humidity, air drainage, elevation, and aspect needed for the soil to economically produce sustainable high yields of these crops when properly managed. The water supply is dependable and of adequate quality. Nearness to markets is an additional consideration. Unique farmland is not based on national criteria. It commonly is in areas where there is a special microclimate, such as the wine country in California.

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Prime and other Important Farmlands—Custer and Pennington Counties, Black Hills Parts, South Dakota; Fall River County, South Dakota; and Niobrara County, Wyoming

BKS\_Farmland\_4

In some areas, land that does not meet the criteria for prime or unique farmland is considered to be *farmland of statewide importance* for the production of food, feed, fiber, forage, and oilseed crops. The criteria for defining and delineating farmland of statewide importance are determined by the appropriate State agencies.

Generally, this land includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some areas may produce as high a yield as prime farmland if conditions are favorable. Farmland of statewide importance may include tracts of land that have been designated for agriculture by State law.

In some areas that are not identified as having national or statewide importance, land is considered to be *farmland of local importance* for the production of food, feed, fiber, forage, and oilseed crops. This farmland is identified by the appropriate local agencies. Farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance.

### Report—Prime and other Important Farmlands

Prime and other Important Farmlands—Custer and Pennington Counties, Black Hills Parts, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
ApA	Arvada variant loam, 0 to 2 percent slopes	Not prime farmland
AsA	Arvada-Slickspots complex, 0 to 3 percent slopes	Not prime farmland
BdA	Barnum very fine sandy loam, 0 to 3 percent slopes	Prime farmland if irrigated
BeB	Barnum-Winetti complex, 0 to 6 percent slopes	Not prime farmland
BwE	Butche-Rock outcrop complex, 9 to 60 percent slopes	Not prime farmland
DgB	Demar-Grummit-Slickspots complex, 0 to 6 percent slopes	Not prime farmland
GrD	Grummit-Rock outcrop complex, 6 to 15 percent slopes	Not prime farmland
GrF	Grummit-Rock outcrop complex, 15 to 60 percent slopes	Not prime farmland
HaA	Haverson loam, 0 to 2 percent slopes	Prime farmland if irrigated
NtE	Nihill-Zigweid complex, 15 to 50 percent slopes	Not prime farmland
PgC	Pierre-Grummit clays, 2 to 9 percent slopes	Not prime farmland
Pt	Pits, quarries	Not prime farmland
SfB	Salanta-Arvada complex, 2 to 6 percent slopes	Not prime farmland
TfB	Tilford silt loam, 2 to 6 percent slopes	Prime farmland if irrigated
W	Water	Not prime farmland
ZcC	Zigweid-Canyon complex, 2 to 15 percent slopes	Not prime farmland
ZnD	Zigweid-Nihill complex, 6 to 15 percent slopes	Not prime farmland

Prime and other Important Farmlands—Fall River County, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
Bc	Barnum silt loam	Not prime farmland
GrE	Grummit-Rock outcrop complex, 3 to 40 percent slopes	Not prime farmland
GsD	Grummit-Snomo clays, 3 to 15 percent slopes	Not prime farmland

POWERTECH (USA), INC.  
 Dewey-Burdock ISR Uranium Project  
 Pre-Mining Soil Assessment

Prime and other Important Farmlands—Custer and Pennington Counties, Black Hills Parts, South Dakota; Fall River County, South Dakota; and Niobrara County, Wyoming

BKS\_Farmland\_4

Prime and other Important Farmlands— Fall River County, South Dakota		
Map Symbol	Map Unit Name	Farmland Classification
Ha	Haverson loam	Prime farmland if irrigated
He	Hisle-Slickspots complex	Not prime farmland
KyA	Kyle clay, 0 to 2 percent slopes	Farmland of statewide importance
PeB	Pierre clay, 2 to 6 percent slopes	Farmland of statewide importance
PgE	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland
Pu	Pits, mine	Not prime farmland
SoB	Salanta loam, 2 to 6 percent slopes	Prime farmland if irrigated
TaA	Tilford silt loam, 0 to 2 percent slopes	Prime farmland if irrigated
ZnE	Zigweid-NHill complex, 6 to 20 percent slopes	Not prime farmland

Prime and other Important Farmlands— Niobrara County, Wyoming		
Map Symbol	Map Unit Name	Farmland Classification
159	Lohmiller-Haverdad complex, saline, 1 to 4 percent slopes	Not prime farmland
160	Manzanola silty clay loam, 0 to 6 percent slopes	Not prime farmland
176	Pierre-Grummit clays, 6 to 25 percent slopes	Not prime farmland
185	Samday-Savageton-Bahl association, 3 to 10 percent slopes	Not prime farmland
215	Ulm-Forkwood loams, 0 to 6 percent slopes	Not prime farmland

### Data Source Information

Soil Survey Area: Custer and Pennington Counties, Black Hills Parts, South Dakota

Survey Area Data: Version 10, Aug 26, 2008

Soil Survey Area: Fall River County, South Dakota

Survey Area Data: Version 10, Feb 6, 2008

Soil Survey Area: Niobrara County, Wyoming

Survey Area Data: Version 6, Mar 4, 2008

**ADDENDUM D-7-F**  
**PHOTOGRAPHS**

This page intentionally left blank



Photo 1: Hole 17 Profile



Photo 2: Hole 17 General View W



Photo 3: Hole 27 Profile



Photo 4: Hole 27 General View N



Photo 5: Hole 36 Profile



Photo 6: Hole 36 General View S



Photo 7: Hole 39 Profile



Photo 8: Hole 39 General View E



Photo 9: Hole 40 Profile



Photo 10: Hole 40 General View W



Photo 11: Hole 41 Profile



Photo 12: Hole 41 General View W



Photo 13: Hole 42 Profile



Photo 14: Hole 42 General View



Photo 15: Hole 43 Profile



Photo 16: Hole 43 General View NW



Photo 17: Hole 50 Profile



Photo 18: Hole 50 General View



Photo 19: Hole 56 Profile



Photo 20: Hole 56 General View



Photo 21: Hole 57 Profile



Photo 22: Hole 57 General View ESE



Photo 23: Hole 60 Profile



Photo 24: Hole 60 General View W



Photo 25: Hole 63 Profile



Photo 26: Hole 63 General View N



Photo 27: Hole 64 Profile



Photo 28: Hole 64 General View N



Photo 29: Hole 72 Profile



Photo 30: Hole 72 General View E

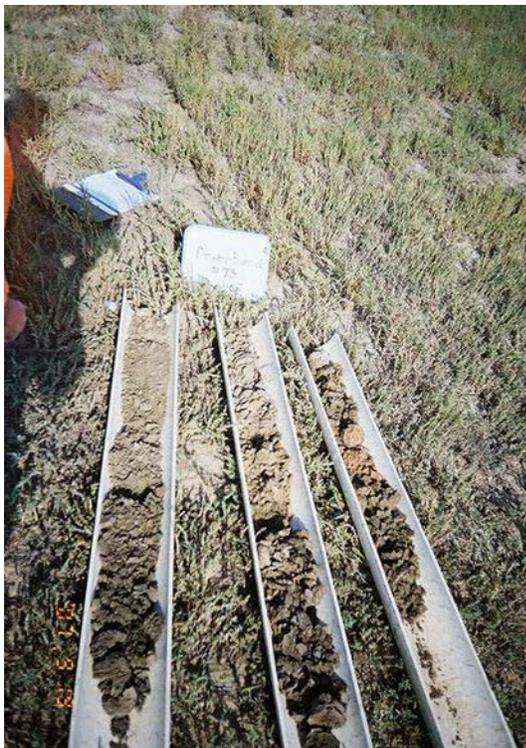


Photo 31: Hole 73 Profile



Photo 32: Hole 73 General View E



Photo 33: Hole 74 Profile



Photo 34: Hole 74 General View E



Photo 35: Hole 75 Profile



Photo 36: Hole 75 General View N



Photo 37: Hole 76 Profile



Photo 38: Hole 76 General View N



Photo 39: Hole 77 Profile



Photo 40: Hole 77 General View N



Photo 41: Hole 79 Profile



Photo 42: Hole 79 General View NE



Photo 43: Hole 82 Profile



Photo 44: Hole 82 General View E

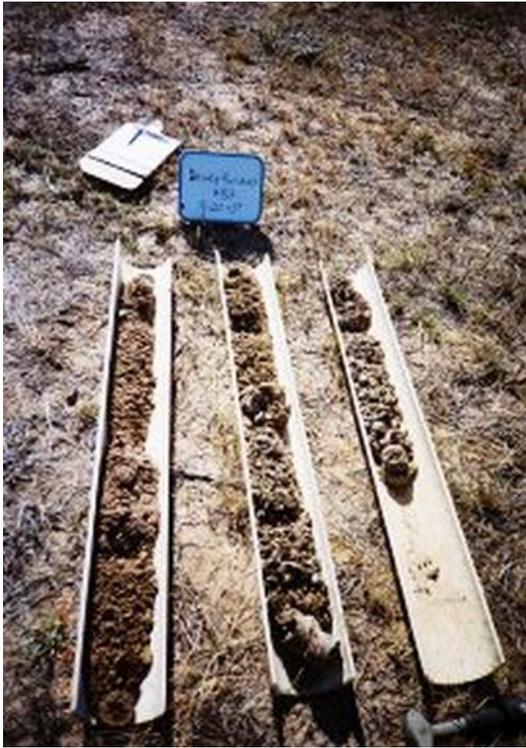


Photo 45: Hole 83 Profile



Photo 46: Hole 83 General View N



Photo 47: Hole 84 Profile



Photo 48: Hole 84 General View SE



Photo 49: Hole 85 Profile



Photo 50: Hole 85 General View S



Photo 51: Hole 88 Profile



Photo 52: Hole 88 General View



Photo 53: Hole 89 Profile



Photo 54: Hole 89 General View N



Photo 55: Hole 90 Profile



Photo 56: Hole 90 General View



Photo 57: Hole 91 Profile



Photo 58: Hole 91 General View N



Photo 59: Hole 92 Profile



Photo 60: Hole 92 General View N



Photo 61: Hole 93 Profile



Photo 62: Hole 93 General View N



Photo 63: Hole 94 Profile



Photo 64: Hole 94 General View SSE



Photo 65: Hole 95 Profile



Photo 66: Hole 95 General View N



Photo 67: Hole 96 Profile



Photo 68: Hole 96 General View N



Photo 69: Hole 97 Profile



Photo 70: Hole 97 General View NNE



Photo 71: Hole 98 Profile



Photo 72: Hole 98 General View SSE



Photo 73: Hole 99 Profile



Photo 74: Hole 99 General View N



Photo 75: Hole 100 Profile



Photo 76: Hole 100 General View WSW



Photo 77: Hole 101 Profile



Photo 78: Hole 101 General View NE



Photo 79: Hole 102 Profile



Photo 80: Hole 102 General View E



Photo 81: Hole 103 Profile



Photo 82: Hole 103 General View N



Photo 83: Hole 104 Profile



Photo 84: Hole 104 General View W



Photo 85: Hole 105 Profile



Photo 86: Hole 105 General View SE



Photo 87: Hole 106 Profile



Photo 88: Hole 106 General View NNE



Photo 89: Hole 107 Profile



Photo 90: Hole 107 General View SSE



Photo 91: Hole 108 Profile



Photo 92: Hole 108 General View NW



Photo 93: Hole 109 Profile



Photo 94: Hole 109 General View E



Photo 95: Hole 110 Profile



Photo 96: Hole 110 General View NE



Photo 97: Hole 111 Profile



Photo 98: Hole 111 General View NNW



Photo 99: Hole 112 Profile



Photo 100: Hole 112 General View NW



Photo 101: Hole 113 Profile



Photo 102: Hole 113 General View E



Photo 103: Hole 114 Profile



Photo 104: Hole 114 General View E



Photo 105: Hole 115 Profile



Photo 106: Hole 115 General View SE



Photo 107: Hole 116 Profile



Photo 108: Hole 116 General View SE

This page intentionally left blank

**ADDENDUM D-7-G**

**MAPS**

**Note: Refer to Plate 3.3-A for the soil map of the permit area.**

This page intentionally left blank