Stand Alone Report 4

Baseline Soil Assessment - Upton Plant Site

Baseline Soil Assessment
Upton Plant Site

Prepared for:

Rare Element Resources, Inc.
225 Union Blvd, Suite 250
Lakewood, Colorado 80228

Prepared by:

BKS Environmental Associates, Inc.
P.O. Box 3467
Gillette, Wyoming 82717

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D7-1.1 INTRODUCTION

Rare Element Resources, Inc. (RER) proposes to mine and recover rare earth elements (REE) in the Bear Lodge Mountains of northeastern Wyoming. The proposed Bear Lodge Project consists of the Bull Hill Mine and Upton Plant Site. The proposed Bull Hill Mine, located approximately 12 miles north of Sundance, Wyoming, in central Crook County, will consist of an open-pit mining operation and Physical Upgrading (PUG) Plant for REE mineral pre-concentration. REE mineral pre-concentrate produced at the PUG plant will be transported to the proposed Upton Plant Site which will consist of a Hydrometallurgical Plant and Tailings Storage Pond. The proposed Upton Plant Site Permit Area is located approximately 40 miles south of the proposed Bull Hill Mine approximately 2 miles northwest of Upton, Wyoming, in north-central Weston County.

The Upton Plant Site includes portions of Sections 28, 29, and 32 and all of Section 33, Township 48 North, Range 65 West.

This report presents baseline information on the soils occurring on the Upton Plant Site Permit Area. The area has been previously surveyed, on a large scale, by the U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) in 1990. The major objective of the 2012 assessment was to define the existing topsoil resource within the Upton Plant Site Permit Area and determine the extent, availability, and suitability of soils material for use in reclamation.

D7-1.2 METHODS

D7-1.2.1 General

Baseline soil inventories for the Upton Plant Site delineated the soils resource and were used to determine topsoil salvage depths and ultimate replacement depths over the entire Permit Area. The 1990 NRCS mapping for Weston County was used as a base map; topography was traversed and profiles were examined to delineate new polygons where appropriate.

D7-1.2.2 Review of Existing Literature

The soils in this portion of Weston County were studied and mapped to an Order 3 scale by the USDA, NRCS in 1982 and 1990. Information in Weston County is available electronically as well as hard copy. The NRCS has also

centralized dissemination of typical soil series descriptions; information is available on the internet at www.nrcs.usda.gov.

D7-1.2.3 Soil Survey

BKS Environmental Associates, Inc. performed the 2012 soil survey field work and compiled the resulting report. All soil analysis was handled by Rare Element Resources under separate contract with Energy Labs in Gillette. Samples were hand delivered by BKS to the Gillette office of Energy Labs within four months of collection.

Field mapping was conducted according to techniques and procedures outlined in the National Cooperative Soil Survey. Guideline No. 1 (August 1994 Revision) of the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ) was followed during all phases of the work.

A reconnaissance of the Upton Plant Site Permit Area familiarized field personnel with the area during June 2012. Soil profiles were examined on a widely scattered basis according to physiographic configuration. Information derived from these profiles was used to determine which soils were likely to occur on specific landscape positions.

Following the reconnaissance survey, a higher intensity Order 1-2 soil survey was conducted in June 2012. Actual soil boundaries were identified in the field by exposing additional soil profiles to determine the nature and extent of soil series on the Permit Area. The soil boundaries were delineated on a 1 inch=500 feet USDA 2011 NAIP true color ortho aerial imagery base map, for purposes of permit submittal. Refer to Table D-7.1 Soil Map Unit Acreages within the Upton Plant Site Permit Area for soil mapping unit acreages and total acreages.

A total of 856.20 acres were included in the final soil mapping of the Upton Plant Site area. Overall, 29 soil profile descriptions were used for soil mapping verification, and 12 locations were sampled for a total of 40 samples. Refer to Table D-7.2 for Soil Sample Locations within the Upton Plant Site Permit Area. Soils mapped by BKS are illustrated in Addendum D-7-G.

D7-1.2.4 Soil Sampling, Description, and Analysis

Sampling of soil series identified within the Upton Plant Site Permit Area generally followed WDEQ Guideline 1 recommendations of three sampled pedons for series encompassing greater than 160 acres, two sampled pedons

for series encompassing between 40 and 160 acres, and one sampled pedon for series encompassing less than 40 acres. See Tables D-7.1 and D-7.3 for the Soil Mapping Unit Acreages and the Soil Series Sample Summary within the Upton Plant Site Permit Area, respectively.

All soil samples were collected with a Giddings truck mounted auger or hand auger to paralithic contact or a maximum depth of 60", whichever was shallower; however, sample depths were restricted within multiple samples due to hardened subsoil conditions. Sample profiles were described in the field, to the extent possible, by the physical and chemical nature of each profile horizon. Backhoe pits were not utilized for soil sampling. Refer to Addendum D-7-F Photographs for site photographs.

Sample locations were identified on a NAIP 2011 base map, and global positioning system (GPS) locations were collected with a hand-held Garmin GPSmap 60CSX unit. Soil samples were placed in clean, labeled, polyethylene plastic bags, and sealed to limit drying. Samples were kept as cool as possible, but were not stored on ice. Samples were delivered to Energy Labs, Inc in Gillette when the sampling was completed for later shipment to Helena, Montana.

A total of 29 sites in the Upton Plant Site were evaluated while 12 were sampled for analysis. All had corresponding profile descriptions written. Refer to Table D-7.2 for Soil Sample Locations for the Upton Plant Site Permit Area.

Energy Labs in Gillette sends soil samples to the Helena lab for 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 for six months after date of receipt. Approximately five percent of the samples were run for duplicate analysis. Actual laboratory analysis followed the methodology outlined in WDEQ Guideline 1. Samples were analyzed within 14 days of receipt of the samples at the laboratory. All analytical data is presented in Addendum D-7-D, Soil Laboratory Analysis.

D7-1.3 Results and Discussion

D7-1.3.1 Soil Survey – General

General topography of the area includes gently rolling uplands, flat lowland floodplains, and vegetated breaks with a complex rill and gully drainage system. The soils occurring within the Upton Plant Site were generally clay loam or clay textured throughout. The Upton Plant Site contained moderately deep to very deep soils near floodplains and toeslopes with shallow to very shallow soils on upland hills, shoulder slopes, and breaks.

Soils in the Upton Plant Site are typical for semi-arid grasslands and shrublands in the western United States. Parent material included shales and claystone, alluvium, colluvium, and residuum. Soils were classified taxonomically as Ustic Torriorthents, Torrertic Ustifluvents, Aridic Ustorthents and, Ustic Haplocambids.

D7-1.3.2 Soil Mapping Unit Interpretation

The primary purpose of the 2012 fieldwork was to characterize the soils within the proposed Upton Plant Site area in terms of topsoil salvage depths and related physical and chemical properties. Refer to Addendum D-7-B and D-7-C for Soil Mapping Unit Descriptions and Soil Series Descriptions, respectively. Map units were based on existing NRCS format and tailored to fit actual findings within the Permit Area.

D7-1.3.3 Analytical Results

Analyzed parameters, as defined in WDEQ Guideline 1, are in Addendum D-7-D, Soil Laboratory Analysis. 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 Addendum D-7-C, Soil Series Descriptions. Where results were not typical for the series (e.g., according to field observations or laboratory analysis), it was noted in the “variation from typical series” section of the soil series descriptions.

D7-1.3.4 Evaluation of Soil Suitability as a Plant Growth Medium

Approximate salvage depths of each map unit series is presented in Table D-7.4, Approximate Soil Salvage Depths within the Upton Plant Site Permit Area, and ranged from 0.19 to 1.03 feet. Within the Upton Plant Site Permit Area, suitability of soil as a plant growth medium is generally limited by physical factors such as clay content. Chemical limiting factors include EC, SAR, pH, and calcium carbonates accumulation (as determined in the field). According to WDEQ Guideline 1, marginal material was found in all of the 12 profiles. Unsuitable material was found in 4 of the 12 profiles. Marginal or unsuitable parameter information for sampled profiles is identified in Table D-7.5, Marginal or Unsuitable Parameters for Sampled Profiles within the Upton Plant Site Permit Area. A summary of trends in marginal or unsuitable parameters as it relates to soil series is found in Table D-7.6, Trends in Marginal or Unsuitable Parameters for Soil Series within the Upton Plant Site Permit Area. Based on laboratory analysis and field observations, marginal material parameters primarily consisted of EC, SAR, saturation percentage, and texture; unsuitable parameters primarily consisted of pH and SAR.

D7-1.3.5 Topsoil Volume Calculations

Based on the 2012 fieldwork with associated field observations and subsequent chemical analysis, the recommended topsoil average salvage depth over the Upton Plant Site Permit Area was determined to be 0.81 feet. Topsoil depths within complexes were calculated as weighted averages of their respective soil series components. Refer to Table D-7.4, Approximate Soil Salvage Depths within the Upton Plant Site Permit Area.

D7-1.3.6 Soil Erosion Properties and Impacts

Based on the soil mapping unit descriptions, the hazard for both wind and water erosion within the Upton Plant Site project area is moderate. The potential for wind and water erosion is mainly a factor of soil surface characteristics, including texture and organic matter content. Given the fine, clayey nature of surface horizons throughout the majority of the Upton Plant Site project area, the soils are more susceptible to erosion from water than wind. Given the high variability and lack of official data, no erosional data has been included for Bentonite Pits-Reclaimed and Rock Outcrop soils. See Table D-7.7, Wind and Water Erosion Hazards with the Upton Plant Site Permit Area,

for a summary of wind and water erosion hazards within the Upton Plant Site Permit Area.

D7-1.3.7 Prime Farmland Assessment

Prime farmland was assessed by Timothy Kellogg, the NRCS District Conservationist out of Gillette, Wyoming. No prime farmland or agricultural land of statewide importance was indicated within the Upton Plant Site project area. Refer to Addendum D-7-E for the NRCS letter of negative determination.

D7-1.4 REFERENCES

National Resource Conservation Service, Soil Data Mart Website, http://soildatamart.nrcs.usda.gov

Kee, G.F., 1990. Soil Survey of Weston County, Wyoming. USDA-Soil Conservation Service. U.S. Government Printing Office.

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.

Addendum D-7-A Tables

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Table D-7.1: Soil Map Unit Acreages within the Upton Plant Site Permit Area.

Map Unit Symbol	Map Unit Name	Acres	% Total Amendment Area
Ba-Sv	Bahl-Savageton complex	539.43	63.00
BP-R	Bentonite Pits-Reclaimed	30.48	3.56
Lo	Lohmiller silty clay loam	60.61	7.08
Sm	Samday clay loam	37.9	4.43
Sm-RO	Samday-Rock outcrop complex	182.4	21.30
W	Water	5.38	0.63
Total		856.20	100.00

Table D-7.2: Soil Sample Locations for the Upton Plant Site Permit Area.

Soil Sample Number	Map Unit Designation	Soil Series
4,19	Ba-Sv	Savageton
8, 14, 22	Ba-Sv	Bahl
17	BP-R	Bentonite Pits-Reclaimed
10, 11	Lo	Lohmiller
25	Sm-RO	Orella
13, 26, 29	Sm/Sm-RO	Samday

Table D-7.3: Soil Series Sample Summary for the Upton Plant Site Permit Area.

Soil Series	Upton Plant Site Sample Numbers 2012
Bahl-Savageton complex	5
Bentonite Pits-Reclaimed	1
Lohmiller	2
Orella*	1
Samday**	3
Total	**12**

*The Orella series is contained within the Samday-Rock outcrop complex mapping unit.

**The Samday series is contained within the Samday clay loam and Samday-Rock outcrop complex mapping units.

Table D-7.4: Approximate Soil Salvage Depths within the Upton Plant Site Permit Area.

Map Symbol	Map Unit Description	Permit Acreage[1]	Salvage Depth[2] (feet)	Total Volume of Topsoil[3] (acre-feet)
Ba-Sv	Bahl-Savageton complex	539.43	1.03	555.61
BP-R	Bentonite Pits-Reclaimed	30.48	1.00	30.48
Lo	Lohmiller	60.61	0.92	55.76
Sm	Samday	37.90	0.42	15.92
Sm-RO	Samday-Rock outcrop complex	182.40	0.19	34.66
W	Water	5.38	0	0
Average Salvage Depth of Project Area[4]		**---**	**0.81**	**---**
Total		**856.20**	**---**	**692.43**

[1]Found in Table D-7.1 of this report.
[2]Found in Addendum D-7-B of this report, under Topsoil Suitability.
[3]Calculated by multiplying permit acreage by salvage depth in feet, as shown in Table II-1 (Topsoil Volume Summary) of WDEQ Guideline 1.
[4]Calculated as the weighted average of the Total Volume of Topsoil and Study Area Acreage.

Table D-7.5: Marginal and Unsuitable Parameters within Sampled Profiles for the Upton Plant Site Permit Area.

Soil Sample Number	Soils Series	Depth (in)	Marginal[1]	Unsuitable[1]
4	Savageton	0-4	Texture (Silty Clay)	---
		4-12	Texture (Silty Clay)	---
		12-20	Texture (Silty Clay), SAR	---
		20-32	Texture (Clay), SAR	---
8	Bahl	5-10	Texture (Silty Clay)	---
		10-30	EC, Texture (Silty Clay)	SAR
		30-48	EC, Texture (Silty Clay)	SAR
10	Lohmiller	0-10	Texture (Silty Clay)	---
		36-48	EC, SAR	---
11	Lohmiller	0-12	Texture (Silty Clay)	---
		12-24	EC, Saturation Percentage, Texture (SiC)	SAR
		24-36	SAR	---
13	Samday**	0-6	Texture (SiC)	---
		6-18	Saturation Percentage, Texture (Clay)	---
14	Bahl	10-30	SAR, Texture (Silty Clay)	---
		30-48	EC, Texture (Silty Clay)	SAR
17	Bentonite Pits-Reclaimed	0-4	Texture (SiC)	---
		4-10	Texture (SiC)	---
		10-24	Texture (SiC)	---

[1]Marginal and unsuitable parameters determined by comparing lab analysis with Table I-2 (Criteria to establish topsoil suitability) from WDEQ LQD Guideline 1.

*The Orella series is included within the Samday-Rock outcrop complex mapping unit.

Table D-7.5: Marginal and Unsuitable Parameters within Sampled Profiles for the Upton Plant Site Permit Area (continued).

Soil Sample Number	Soils Series	Depth (in)	Marginal[1]	Unsuitable[1]
19	Savageton	0-4	Texture (Silty Clay)	---
		4-13	Texture (Silty Clay)	---
		13-22	Texture (Silty Clay)	---
22	Bahl	---	---	---
25	Orella*	0-4	Texture (Silty Clay)	---
		4-10	Saturation Percentage, Texture (Silty Clay)	---
		10-28	Texture (Silty Clay)	
26	Samday**	0-6	Texture (Silty Clay)	---
		6-13	Texture (Clay)	---
29	Samday**	2-6	Texture (Silty Clay)	pH
		6-12	Texture (Silty Clay)	pH

[1]Marginal and unsuitable parameters determined by comparing lab analysis with Table I-2 (Criteria to establish topsoil suitability) from WDEQ LQD Guideline 1.

*The Orella series is included within the Samday-Rock outcrop complex mapping unit.

**The Samday series is contained within the Samday clay loam and Samday-Rock outcrop complex mapping units.

Table D-7.6: Trends in Marginal and Unsuitable Parameters for Soil Series within the Upton Plant Site Permit Area.

Soils Series	Unsuitable/Marginal Parameter[1]
Bahl	EC, SAR, Texture
Bentonite Pits-Reclaimed	Texture
Lohmiller	EC, SAR, Saturation Percentage, Texture
Orella*	Saturation Percentage, Texture
Samday**	Saturation Percentage, Texture
Savageton	pH, SAR, Texture

[1]Marginal and unsuitable parameters determined by comparing lab analysis with Table I-2 (Criteria to establish suitability of topsoil) from WDEQ Guideline 1.

*The Orella series is included in the Samday-Rock outcrop complex mapping unit.

**The Samday series is contained within the Samday clay loam and Samday-Rock outcrop complex mapping units.

Table D-7.7: Wind and Water Erosion Hazards within the Upton Plant Site Permit Area.

Map Unit Symbol	Soil Series	Water Erosion Hazard[1]	Wind Erosion Hazard[2]
Ba-Sv	Bahl	Moderate	Moderate
BP-R	Bentonite Pits-Reclaimed	-	-
Lo	Lohmiller	Moderate	Moderate
Sm-RO	Orella	Moderate	Moderate
Sm/Sm-RO	Samday	Moderate	Moderate
Ba-Sv	Savageton	Moderate	Moderate

[1]Based on Kw factor of A horizon from the NRCS Soil Data Mart {http://soildatamart.nrcs.usda.gov/}
[2]Based on Wind Erodibility Group from the NRCS Soil Data Mart {http://soildatamart.nrcs.usda.gov/

Addendum D-7-B Soil Mapping Unit Descriptions

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Ba-Sv – Bahl-Savageton complex[1]

This map unit consists of very deep, well drained soils formed on alluvial fans, fan aprons, hillslopes, and terraces in alluvium derived from clay shales at elevations of 3,500 to 5,000 feet. Slopes typically range from 0 to 20 percent. Mean annual precipitation is about 12 inches and the mean annual air temperature is 46 degrees F.

This complex consists of approximately 65% Bahl clay loam, and 35% Savageton clay loam.

Permeability within the Bahl-Savageton compelx is slow. The available water capacity is low to moderate (between 5.2 and 9.0 inches). Effective rooting depth ranges from 20 to greater than 60 inches. Surface runoff is slow to rapid. The hazard of water erosion is moderate and wind erosion hazard is moderate.

Topsoil Suitability

This mapping unit is a marginally suitable source of topsoil to a weighted average of 12.35-inches. Based on WDEQ Guideline 1, the following marginal and unsuitable parameters were found:
Bahl
Sample 8:
- 5-10” ------- Marginal Texture (Silty clay)
- 10-30” ------Marginal EC and Texture (Silty clay); Unsuitable SAR
- 30-48” ------Marginal EC and Texture (Silty clay); Unsuitable SAR

Sample 14:
- 10-30” ------Marginal SAR and Texture (Silty clay)
- 30-48” ------Marginal EC and Texture (Silty clay); Unsuitable SAR

Savageton
Sample 4:
- 0-4” ------- Marginal Texture (Silty clay)
- 4-12” ------- Marginal Texture (Silty clay)
- 12-20” ------Marginal SAR and Texture (Silty clay)
- 20-32” ------Marginal SAR and Texture (Silty clay)

Sample 19:
- 0-4” ------- Marginal Texture (Silty clay)
- 4-13” ------- Marginal Texture (Silty clay)
- 13-22” ------Marginal Texture (Silty clay)

The 12.35-inch salvage depth was used in Table D-7.4 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Bahl-Savageton complex.

[1]Map unit description based on 1990 Weston County NRCS information.

BP-R - Bentonite Pits-Reclaimed[1]

This map unit consists of very fine shallow soils derived from reclamation of past bentonite mining activities. The mean annual precipitation is 10 to 14 inches. Mean annual air temperature is 45 to 48 degrees F and the frost-free period is approximately 110 to 120 days. Effective rooting depth is about 20 to 40 inches.

Topsoil Suitability

This map unit is a marginally suitable source of topsoil to 12-inches. Based on WDEQ Guideline 1, the following marginal parameters were found:

Sample 17:

- 0-4" ------- Marginal Texture (Silty clay)
- 4-10" ------- Marginal Texture (Silty clay)
- 10-24" ------Marginal Texture (Silty clay)

The 12-inch salvage depth was used in Table D-7.4 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Bentonite Pits-Reclaimed unit.

[1]Map unit description based on 1990 Weston County NRCS information.

Lo – Lohmiller clay loam[1]

This map unit consists of very deep, well drained soils formed in alluvium on bottom lands. Lohmiller soils are found on flood plains, high bottom lands of rivers and streams, and on alluvial fans of foot slopes. Slopes range from 0 to 8 percent. The mean annual precipitation is ranges from 10 to 19 inches and the mean annual temperature is about 46 degrees F.

Permeability within the Lohmiller soil is slow or moderately slow. The available water capacity is high (about 9.0 inches). Effective rooting depth is generally greater than 60 inches. Surface runoff is low on nearly level areas and medium on more sloping areas. The hazard of water or wind erosion is moderate.

Topsoil Suitability

This map unit is a marginally suitable source of topsoil to 11-inches. Based on WDEQ Guideline 1, the following marginal and unsuitable parameters were found:

Sample 10:
- 0-10” ------- Marginal Texture (Silty clay)
- 36-48” ------Marginal EC and SAR

Sample 11:
- 0-12” ------- Marginal Texture (Silty clay)
- 12-24” ------Marginal EC, Saturation percentage, and Texture (SiC); Unsuitable SAR
- 24-36” ------Marginal SAR

The 11-inch salvage depth was used in Table D-7.4 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Lohmiller clay loam unit.

[1]Map unit description based on 1990 Weston County NRCS information.

Sa – Samday clay loam[1]

This map unit consists of very shallow or shallow to bedrock soils formed in residuum, slope alluvium, and colluvial slopewash derived from clay shale. The Samday soil occurs on upland ridgetops, shoulders, and backslope positions of hills at elevations of 3,500 to 6,500 feet. Slopes range from 0 to 60 percent. Mean annual precipitation is about 12 inches and the mean annual air temperature is about 46 degrees F.

Permeability within the Samday soil is slow. The available water capacity is very low (about 2.7 inches). Effective rooting depth is about 10 to 20 inches. Surface runoff is medium to rapid. The hazard of water or wind erosion is moderate.

Topsoil Suitability

This mapping unit is a marginally suitable source of topsoil to 4.2-inches. Based on WDEQ Guideline 1, the following marginal and unsuitable parameters were found:

Sample 13:
- 0-6" ------- Marginal Texture (Silty clay)
- 6-18" ------- Marginal Saturation percentage and Texture (Clay)
-

Sample 26:
- 0-6" ------- Marginal Texture (Silty clay)
- 6-13" ------- Marginal Texture (Clay)

Sample 29:
- 2-6" ------- Marginal Texture (Silty clay); Unsuitable pH
- 6-12" ------- Marginal Texture (Silty clay); Unsuitable pH

The 4.2-inch salvage depth was used in Table D-7.4 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Samday clay loam and Samday-Rock outcrop units.

[1]Map unit description based on 1990 Weston County NRCS information.

Sa-RO – Samday-Rock outcrop complex[1]

This map unit consists of very shallow or shallow to bedrock soils formed in residuum, slope alluvium, and colluvial slopewash derived from clay shale. The Samday soil occurs on upland ridgetops, shoulders, and backslope positions of hills at elevations of 3,500 to 6,500 feet. Slopes range from 0 to 60 percent. Mean annual precipitation is about 12 inches and the mean annual air temperature is about 46 degrees F.

The Samday-Rock outcrop unit consists of approximately 50% Samday clay loam, 5% Orella clay, and 45% Rock outcrops. A weighted average of these soil series was used to determine the stripping depth for this map unit.

Permeability within the Samday-Rock outcrop complex soil is slow. The available water capacity is very low (about 2.7 inches). Effective rooting depth ranges from about 10 to 30 inches. Surface runoff is medium to rapid. The hazard of water or wind erosion is moderate.

Topsoil Suitability

This mapping unit is a marginally suitable source of topsoil to 2.3-inches. Based on WDEQ Guideline 1, the following marginal parameters were found:

Orella
Sample 25:

- 0-4" ------- Marginal Texture (Silty clay)
- 4-10" ------- Marginal Saturation percentage and Texture (Silty clay)
- 10-28" ------Marginal Texture (Silty clay)

The 2.3-inch salvage depth was used in Table D-7.4 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Samday-Rock outcrop complex unit.

[1]Map unit description based on 1990 Weston County NRCS information.

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Addendum D-7-C Sampled Soil Series Descriptions

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BAHL SERIES

The Bahl series consists of very deep, well drained soils formed on alluvial fans, fan aprons, hillslopes, and terraces in alluvium from clay shales. Slopes range from 0 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 46 degrees F. This series was found as part of the Bahl-Savageton complex.

SOIL MAPPING UNIT: Ba-Sv

SOIL SAMPLE LOCATION: Waypoint 8

TYPICAL PEDON: Bahl clay loam- on north-facing terrace with slope of 3 percent; utilized as rangeland. (Colors are for dry soil unless otherwise stated)

A---0 to 6 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; common fine and medium roots; neutral (pH 7.3); clear wavy boundary. (4 to 6 inches thick)

AC--6 to 10 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; few fine and medium roots; slightly alkaline (pH 7.6); gradual wavy boundary (4 to 15 inches thick).

C1---10 to 30 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine roots; slightly effervescent, calcium carbonate is disseminated; slightly alkaline (pH 7.8).

C2---30 to 60 inches*; dark brownish gray silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine roots; slightly effervescent, calcium carbonate is disseminated; slightly alkaline (pH 7.8).

*Verified to 48 inches, machinery restricted due to hardened soil conditions. Remainder is assumed based on NRCS Official Series Description.

TYPE LOCATION: Waypoint 8, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: The soil is usually calcareous throughout but is noncalcareous in the upper few inches of some pedons. The particle size control section is clay or clay loam with 35 to 55 percent clay. Deep, wide cracks are present and are open for 6 to 8 months. 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. and is never moist in

some or all parts for as long as 60 consecutive days when the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, but 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 51 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days.

The A horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 3 through 5 moist, and chroma of 2 or 3. Texture is clay loam or clay, and clay ranges from 30 to 45 percent. EC ranges from 0 to 2 mmhos. Reaction is neutral through moderately alkaline.

The AC horizon, has the same ranges as allowed for the combined ranges of the A and C horizons. A Bw may be present in some pedons but does not meet the criteria for a cambic horizon.

Some pedons have a Bk horizon, that is not a calcic horizon, with properties similar to the C horizon. Pedons with Bk horizons may have an AB horizon with properties similar to the A and Bk horizons.

The C horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is typically clay but may be clay loam, and clay ranges from 35 to 55 percent. EC ranges from 2 to 4 mmhos. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Ustertic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 5 to 48 inches for texture (Silty clay) and from 10 to 48 inches for EC. Unsuitable parameters were found from 10 to 48 for SAR. Estimated salvage depth is 10 inches due to marginal texture, marginal EC, and unsuitable SAR.

GEOGRAPHIC SETTING: Bahl soils are on alluvial fans, fan aprons, hillslopes, and terraces. Slopes are simple and range from 0 to 20 percent. The soils formed in alluvium from clay shales. Elevation is 3,500 to 5,000 feet. The average annual precipitation is 10 to 17 inches of which about half falls in April, May, and June. The average annual temperature is 43 to 51 degrees F. The frost-free season is about 110 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Higher silt content throughout compared to the typical series.
- Lack of calcium carbonates within both A and AC horizons.
- Presence of two C horizons.
- Less effervescent in the C horizons than typically observed in the C horizon.

BAHL SERIES

The Bahl series consists of very deep, well drained soils formed on alluvial fans, fan aprons, hillslopes, and terraces in alluvium from clay shales. Slopes range from 0 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 46 degrees F. This series was found as part of the Bahl-Savageton complex.

SOIL MAPPING UNIT: Ba-Sv

SOIL SAMPLE LOCATION: Waypoint 14

TYPICAL PEDON: Bahl clay loam- on north-facing terrace with slope of 3 percent; utilized as rangeland. (Colors are for dry soil unless otherwise stated)

A--0 to 5 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; common fine and medium roots; slightly acid (pH 6.2); clear wavy boundary. (4 to 6 inches thick)

AC--5 to 10 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; few fine and medium roots; neutral (pH 6.7); gradual wavy boundary (4 to 15 inches thick).

C--10 to 60 inches*; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine roots; slightly effervescent, calcium carbonate is disseminated; slightly alkaline (pH 7.6).

*Verified to 48 inches, machinery restricted due to hardened soil conditions. Remainder is assumed based on NRCS Official Series Description.

TYPE LOCATION: Waypoint 14, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: The soil is usually calcareous throughout but is noncalcareous in the upper few inches of some pedons. The particle size control section is clay or clay loam with 35 to 55 percent clay. Deep, wide cracks are present and are open for 6 to 8 months. 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. and is never moist in some or all parts for as long as 60 consecutive days when the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, but 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 51 degrees F., and the soil

temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days.

The A horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 3 through 5 moist, and chroma of 2 or 3. Texture is clay loam or clay, and clay ranges from 30 to 45 percent. EC ranges from 0 to 2 mmhos. Reaction is neutral through moderately alkaline.

The AC horizon, has the same ranges as allowed for the combined ranges of the A and C horizons. A Bw may be present in some pedons but does not meet the criteria for a cambic horizon.

Some pedons have a Bk horizon, that is not a calcic horizon, with properties similar to the C horizon. Pedons with Bk horizons may have an AB horizon with properties similar to the A and Bk horizons.

The C horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is typically clay but may be clay loam, and clay ranges from 35 to 55 percent. EC ranges from 2 to 4 mmhos. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Ustertic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 10 to 48 for texture (Silty clay), from 30 to 48 inches for EC, and from 10 to 30 inches for SAR values. Unsuitable parameters were found from 30 to 48 for SAR values. Estimated salvage depth is 10 inches due to silty clay textures, marginal SAR values, and calcium carbonate accumulation, as observed in the field.

GEOGRAPHIC SETTING: Bahl soils are on alluvial fans, fan aprons, hillslopes, and terraces. Slopes are simple and range from 0 to 20 percent. The soils formed in alluvium from clay shales. Elevation is 3,500 to 5,000 feet. The average annual precipitation is 10 to 17 inches of which about half falls in April, May, and June. The average annual temperature is 43 to 51 degrees F. The frost-free season is about 110 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Higher silt content throughout than typically observed in the series.
- Lower pH value within the A horizon than typical.
- Lack of effervescence and disseminated carbonates within the A and AC horizons.

BAHL SERIES

The Bahl series consists of very deep, well drained soils formed on alluvial fans, fan aprons, hillslopes, and terraces in alluvium from clay shales. Slopes range from 0 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 46 degrees F. This series was found as part of the Bahl-Savageton complex.

SOIL MAPPING UNIT: Ba-Sv

SOIL SAMPLE LOCATION: Waypoint 22

TYPICAL PEDON: Bahl clay loam- on north-facing terrace with slope of 3 percent; utilized as rangeland. (Colors are for dry soil unless otherwise stated)

A--0 to 8 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; common fine and medium roots; slightly acid (pH 6.4); clear wavy boundary. (4 to 6 inches thick)

Bw--8 to 18 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak angular blocky structure; very hard, very firm, very sticky and plastic; few fine and medium roots; neutral (pH 7.3); gradual wavy boundary (4 to 15 inches thick).

C1--18 to 36 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine roots; strongly effervescent, calcium carbonate is disseminated; slightly alkaline (pH 7.8).

C2--36 to 60 inches*; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and plastic; few fine roots; strongly effervescent, calcium carbonate is disseminated; moderately alkaline (pH 8.1).

*Verified to 48 inches, machinery restricted due to hardened soil conditions. Remainder is assumed based on NRCS Official Series Description.

TYPE LOCATION: Waypoint 22, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: The soil is usually calcareous throughout but is noncalcareous in the upper few inches of some pedons. The particle size control section is clay or clay loam with 35 to 55 percent clay. Deep, wide cracks are present and are open for 6 to 8 months. 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. and is never moist in

some or all parts for as long as 60 consecutive days when the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, but 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 51 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days.

The A horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 3 through 5 moist, and chroma of 2 or 3. Texture is clay loam or clay, and clay ranges from 30 to 45 percent. EC ranges from 0 to 2 mmhos. Reaction is neutral through moderately alkaline.

The AC horizon, has the same ranges as allowed for the combined ranges of the A and C horizons. A Bw may be present in some pedons but does not meet the criteria for a cambic horizon.

Some pedons have a Bk horizon, that is not a calcic horizon, with properties similar to the C horizon. Pedons with Bk horizons may have an AB horizon with properties similar to the A and Bk horizons.

The C horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is typically clay but may be clay loam, and clay ranges from 35 to 55 percent. EC ranges from 2 to 4 mmhos. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Ustertic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, no marginal or unsuitable parameters were found. Suitable topsoil is found to 18 inches. Material from 18 to 60 inches is unsuitable for topsoil due strong effervescence, as observed in the field, and presence of parent material. Estimated salvage depth is 18 inches due to calcium carbonate accumulation and presence of parent material.

GEOGRAPHIC SETTING: Bahl soils are on alluvial fans, fan aprons, hillslopes, and terraces. Slopes are simple and range from 0 to 20 percent. The soils formed in alluvium from clay shales. Elevation is 3,500 to 5,000 feet. The average annual precipitation is 10 to 17 inches of which about half falls in April, May, and June. The average annual temperature is 43 to 51 degrees F. The frost-free season is about 110 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Lack of calcium carbonates within the A and Bw horizons.
- The typical C horizon was split into C1 and C2 horizons.
- The C2 horizon was coarser than typical with a lower clay content.
- Lower pH than typical in the A horizon.

BENTONITE PITS-RECLAIMED MAP UNIT

The Bentonite Pits-Reclaimed map unit consists of very fine shallow soils derived from reclamation of past bentonite mining activities.

SOIL MAPPING UNIT: BP-R

SOIL SAMPLE LOCATION: Waypoint 17

TYPICAL PEDON: Bentonite Pits-Reclaimed, on the shoulder of a densely vegetated, very gradually sloped reclamation. (Colors are for dry soil unless otherwise stated)

A--0 to 4 inches; light brown silty clay; fine roots throughout; neutral (pH 6.9); visible salt accumulation; gradual wavy boundary.

AC--4 to 10 inches; light brown silty clay; fine roots throughout; neutral (pH 7.3); visible salt accumulation; gradual wavy boundary.

C--10 to 24 inches; light grayish brown silty clay; few fine roots; neutral (pH 7.3); visible salt accumulation; clear smooth boundary.

Cr--24+ inches; gray shale from mining spoil.

TYPE LOCATION: Waypoint 17, Weston County, Wyoming; refer to the map included in this report.

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 0 to 24 inches for texture (Silty clay). Salt accumulation was visible from 0 to 24 inches. Estimated salvage depth is 10 inches due to marginal texture, presence of C horizon, and visible salt accumulation.

LOHMILLER SERIES

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.

SOIL MAPPING UNIT: Lo

SOIL SAMPLE LOCATION: Waypoint 10

TYPICAL PEDON: Lohmiller silty clay 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.)

A--0 to 10 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak thin platy structure parting to weak fine granular; very hard, firm; common fine roots, slightly acid (pH 6.1); clear smooth boundary. (Combined A horizons 4 to 10 inches thick)

C--10 to 60 inches*; grayish brown (2.5Y 5/2) silty clay loam, stratified with layers of loam, fine sandy loam, silt loam, and clay loam; dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; slightly effervescence; visible calcium carbonate accumulation; slightly alkaline (pH 7.7).

*Verified to 48 inches, machinery restricted due to hardened soil conditions. Remainder is assumed based on NRCS Official Series Description.

TYPE LOCATION: Waypoint 10, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: 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.

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 0 to 10 inches for texture (silty clay) and from 36 to 48 for EC and SAR values. Slight effervescence, as observed in the field, was found throughout the profile. Estimated salvage depth is 10 inches due to marginal texture, slight effervescence, and presence of parent material.

GEOGRAPHIC SETTING: 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.

VARIATION FROM TYPICAL SERIES:

- Lower pH than typical within the A horizon.

LOHMILLER SERIES

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.

SOIL MAPPING UNIT: Lo

SOIL SAMPLE LOCATION: Waypoint 11

TYPICAL PEDON: Lohmiller silty clay 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.)

A--0 to 12 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak thin platy structure parting to weak fine granular; very hard, firm; common fine roots, neutral (pH 7.3); clear smooth boundary. (Combined A horizons 4 to 10 inches thick)

C1--12 to 24 inches; grayish brown (2.5Y 5/2) silty clay, stratified with layers of loam, fine sandy loam, silt loam, and silty clay loam; dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; slight effervescence; slightly alkaline (pH 8.0)
.
C2--24 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, stratified with layers of loam, fine sandy loam, silt loam, and clay loam; dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; slight effervescence; slightly alkaline (pH 7.4).

*Verified to 48 inches, machinery restricted due to hardened soil conditions. Remainder is assumed based on NRCS Official Series Description.

TYPE LOCATION: Waypoint 11, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: 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.

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 0 to 12 inches for texture (Silty clay), from 12 to 24 inches for EC, Saturation Percentage, and texture (Silty clay), and from 24 to 36 inches for SAR values. Unsuitable parameters were found from 12 to 24 inches for SAR values. Estimated salvage depth is 12 inches due to unsuitable SAR values.

GEOGRAPHIC SETTING: 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.

VARIATION FROM TYPICAL SERIES:

- Slightly thicker than typical A horizon.
- Presence of C1 and C2 horizons.

SAMDAY SERIES

The Samday series consists of well drained very shallow or shallow to bedrock soils formed in residuum, slope alluvium, and colluvial slopewash derived from clay shale. Samday soils occur on upland ridgetops, shoulders, and backslope positions of hills. This series is found both alone, and as part of the Samday-Rock outcrop complex.

SOIL MAPPING UNIT: Sm-RO

SOIL SAMPLE LOCATION: Waypoint 13

TYPICAL PEDON: Samday clay loam-rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 2 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; moderate coarse platy structure parting to weak fine granular; slightly hard, friable, moderately sticky and moderately plastic; neutral (pH 7.2); gradual wavy boundary. (2 to 6 inches thick)

Bw--2 to 6 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; strong coarse subangular blocky structure parting to moderate fine subangular blocky; hard, firm, very sticky and very plastic; neutral (pH 7.2); gradual wavy boundary. (0 to 8 inches thick)

BCky--6 to 18 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; hard, firm, very sticky and very plastic; slightly effervescent, lime as common soft masses, filaments, and threads; few gypsum crystals; approximately 20 percent soft weathered shale chips which break down on pretreatment; slightly alkaline (pH 7.7); clear wavy boundary. (4 to 10 inches thick)

Cr--18+ inches; gray calcareous shale.

TYPE LOCATION: Waypoint 13, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: Depth to bedrock and the paralithic contact ranges from 6 to 20 inches. Depth to carbonates is 0 to 6 inches. The control section is a clay, heavy clay loam, or silty clay with 35 to 50 percent clay. Coarse fragments range from 0 to 35 percent but are soft shale chips and break down with pretreatment. 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 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 52 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 4 mmhos throughout.
The A horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay loam, clay, silty clay loam or silty clay. Reaction is typically neutral through moderately alkaline but may be strongly alkaline due to disturbance.

The Bw horizon, when present, has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. The base of any Bw horizon is typically 10 inches or less or, if deeper, is not a diagnostic cambic horizon. Reaction is slightly alkaline through strongly alkaline.
Some pedons have an AB horizon.

The BC or BCky horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. Carbonates and gypsum appear to be autogenetic, but secondary accumulations are present in some pedons. Carbonates range from 4 to 10 percent. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Ustic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994):
According to WDEQ Guideline 1, marginal parameters were found from 0 to 6 inches for texture (Silty clay), from 6 to 18 inches for texture (Clay), and from 6 to 18 inches for saturation percentage. Slight effervescence, as observed in the field, was found from 6 to 18 inches. Estimated salvage depth is 6 inches due to marginal texture, slight effervescence, and visible salt accumulations.

GEOGRAPHIC SETTING: Samday soils are on largely unstable upland ridgetops, shoulders, and backslopes of ridges and low hills. These soils formed in fine textured shale residuum, slope alluvium, and colluvial slopewash. Slopes are 0 to 45 percent. Elevation is 3,500 to 6,500 feet. Precipitation ranges from 10 to 17 inches with over half of the annual precipitation falling in each month of July, August, September, and October. The mean annual temperature ranges from 44 to 49 degrees F. The frost-free season is about 105 to 130 days.

VARIATION FROM TYPICAL SERIES:
- Slightly thicker BCky horizon than typical.

ORELLA CLAY

The Orella series consists of shallow, well drained soils formed in residuum from sodium-enriched claystone on pediment surfaces in badlands landscapes. Slopes range from 1 to 45 percent. Mean annual precipitation is about 405 mm, and the mean annual air temperature is about 9 degrees C. This series is found as part of the Samday-Rock outcrop complex.

SOIL MAPPING UNIT: Sm-RO

SOIL SAMPLE LOCATION: Waypoint 25

TYPICAL PEDON: Orella clay, on a southwest facing slope of 14 percent, in native grass. When described the soil was dry in the surface layer and slightly moist below. (Colors are for dry soil unless otherwise stated)

A---0 to 4 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse granular structure; extremely hard, firm, moderately sticky and very plastic; common very fine, few fine roots throughout; few fine discontinuous pores; common trans-horizon cracks 0.5 to 1 cm wide; slightly effervescent; neutral (pH 7.2); abrupt smooth boundary. (1 to 5 inches thick)

AC-4 to 10 inches; light olive gray (5Y 6/2) parachannery silty clay, olive (5Y 5/3) moist; massive; extremely hard, very firm, very sticky and very plastic; few very fine roots; few very fine discontinuous pores; 20 percent weakly cemented angular claystone channers; common distinct to prominent, fine and medium spherical masses of salts; common trans-horizon cracks 0.5 to 1 cm wide; moderately effervescent; slightly alkaline (pH 7.5); clear smooth boundary.

C---10 to 28 inches; light olive gray (5Y 6/2) extremely parachannery silty clay, olive gray (5Y 5/2) moist; massive; very hard, firm, moderately sticky and very plastic; few very fine roots; 75 percent weakly cemented angular claystone channers; few faint fine and medium spherical and irregularly-shaped bodies of salts; slightly effervescent; slightly alkaline (pH 7.8), gradual smooth boundary. (Combined thickness of the C horizon is 3 to 18 inches)

Cr--28+ inches; gray (5Y 5/1) to pale olive (5Y 6/3) weakly to moderately cemented claystone of the Chadron formation of the White River group; stratification and vertical fracturing produces medium to coarse angular blocks; prominent strong brown (7.5YR 5/6) to reddish yellow (7.5YR 6/6) dry staining occurs on 5 to 10 percent of fragment surfaces; noneffervescent; strongly alkaline.

TYPE LOCATION: Waypoint 25, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS:

Depth to bedrock: 15 to 50 cm
Depth to carbonates: 0 to 25 cm
Clay (control section average): 35 to 70 percent
Surface fragments: 0 to 50 percent; fragments are typically angular chert and/or chalcedony, but may include semi-rounded and rounded rocks of mixed origin

A Horizon:
Hue: 7.5YR, 10YR, 2.5Y, or 5Y
Value: 5 to 7, 4 or 5 moist
Chroma: 1 to 4
Texture: L, SIL, SICL, CL, SIC, C
Sodium Adsorption Ratio: 8 to 15
Reaction: slightly alkaline to strongly alkaline

An AC horizon occurs in some pedons.

C Horizon:
Hue: 7.5YR, 10YR, 2.5Y, or 5Y
Value: 5 to 7, 4 to 6 moist
Chroma: 2 to 4
Texture: SICL, CL, SIC, C
Electrical conductivity: 1 to 8 mmhos
Sodium Adsorption Ratio: 13 to 30
Reaction: slightly alkaline to very strongly alkaline

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994):
According to WDEQ Guideline 1, marginal parameters were found from 0 to 28 inches for texture (Silty clay) and from 4 to 10 for saturation percentage. Moderate effervescence, as observed in the field, was found from 4 to 10 inches. Estimated salvage depth is 4 inches due to calcium carbonate accumulation, saturation percentage, and texture.

GEOGRAPHIC SETTING:
Parent Material: residuum derived from sodium-enriched claystone of the Chadron formation of the White River Group
Landform: badland pediments, uplands
Slopes: 1 to 45 percent
Elevation: 850 to 1,500 meters
Mean annual air temperature: 6 to 11 degrees C
Mean annual precipitation: 330 to 455 mm
Frost-free period: 130 to 160 days

VARIATION FROM TYPICAL SERIES:
- Lower SAR than typical for the series.

SAMDAY SERIES

The Samday series consists of well drained very shallow or shallow to bedrock soils formed in residuum, slope alluvium, and colluvial slopewash derived from clay shale. Samday soils occur on upland ridgetops, shoulders, and backslope positions of hills. This series is found both alone, and as part of the Samday-Rock outcrop complex.

SOIL MAPPING UNIT: Sm-RO

SOIL SAMPLE LOCATION: Waypoint 26

TYPICAL PEDON: Samday clay loam-rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 4 inches; light brownish gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; moderate coarse platy structure parting to weak fine granular; slightly hard, friable, moderately sticky and moderately plastic; neutral (pH 6.6); gradual wavy boundary. (2 to 6 inches thick)

C--4 to 13 inches; light brownish gray silty clay, coarse platy structure; hard, firm, very sticky and very plastic; moderately acid (pH 5.8); gradual wavy boundary.

Cr--13+ inches; gray acidic shale.

TYPE LOCATION: Waypoint 26, Weston County, Wyoming' refer to the map included in this report.

RANGE IN CHARACTERISTICS: Depth to bedrock and the paralithic contact ranges from 6 to 20 inches. Depth to carbonates is 0 to 6 inches. The control section is a clay, heavy clay loam, or silty clay with 35 to 50 percent clay. Coarse fragments range from 0 to 35 percent but are soft shale chips and break down with pretreatment. 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 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 52 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 4 mmhos throughout.

The A horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay loam, clay, silty clay loam or silty clay. Reaction is typically neutral through moderately alkaline but may be strongly alkaline due to disturbance.

The Bw horizon, when present, has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. The base of any Bw horizon is typically 10 inches or less or, if deeper, is not a diagnostic cambic horizon. Reaction is slightly alkaline through strongly alkaline.
Some pedons have an AB horizon.

The BC or BCky horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. Carbonates and gypsum appear to be autogenetic, but secondary accumulations are present in some pedons. Carbonates range from 4 to 10 percent. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Ustic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994):
According to WDEQ Guideline 1, marginal parameters were found from 0 to 6 inches for texture (Silty clay) and from 6 to 13 inches for texture (Clay). Estimated salvage depth is 4 inches due to marginal texture and presence of C horizon.

GEOGRAPHIC SETTING: Samday soils are on largely unstable upland ridgetops, shoulders, and backslopes of ridges and low hills. These soils formed in fine textured shale residuum, slope alluvium, and colluvial slopewash. Slopes are 0 to 45 percent. Elevation is 3,500 to 6,500 feet. Precipitation ranges from 10 to 17 inches with over half of the annual precipitation falling in each month of July, August, September, and October. The mean annual temperature ranges from 44 to 49 degrees F. The frost-free season is about 105 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Shallower than typical
- Lacked BCky horizon.
- Lower pH than typical in the C horizon.
- Paralithic material was composed of acidic shale.

SAMDAY SERIES

The Samday series consists of well drained very shallow or shallow to bedrock soils formed in residuum, slope alluvium, and colluvial slopewash derived from clay shale. Samday soils occur on upland ridgetops, shoulders, and backslope positions of hills. This series is found both alone, and as part of the Samday-Rock outcrop complex.

SOIL MAPPING UNIT: Sm-RO

SOIL SAMPLE LOCATION: Waypoint 29

TYPICAL PEDON: Samday clay loam-rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 2 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; moderate coarse platy structure parting to weak fine granular; slightly hard, friable, moderately sticky and moderately plastic; slightly acid (pH 6.2); gradual wavy boundary. (2 to 6 inches thick)

C--2 to 6 inches; light brownish gray silty clay, coarse platy structure; hard, firm, very sticky and very plastic; very strongly acid (pH 4.6); gradual wavy boundary.

Cr--6+ inches; gray acidic shale.

TYPE LOCATION: Waypoint 29, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: Depth to bedrock and the paralithic contact ranges from 6 to 20 inches. Depth to carbonates is 0 to 6 inches. The control section is a clay, heavy clay loam, or silty clay with 35 to 50 percent clay. Coarse fragments range from 0 to 35 percent but are soft shale chips and break down with pretreatment. 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 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 52 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 4 mmhos throughout.

The A horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay loam, clay, silty clay loam or silty clay. Reaction is typically neutral through moderately alkaline but may be strongly alkaline due to disturbance.

The Bw horizon, when present, has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. The base of any Bw horizon is typically 10 inches or less or, if deeper, is not a diagnostic cambic horizon. Reaction is slightly alkaline through strongly alkaline.
Some pedons have an AB horizon.

The BC or BCky horizon has hue of 5Y through 10YR, value of 4 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. Texture is clay, silty clay, silty clay loam, or clay loam. Carbonates and gypsum appear to be autogenetic, but secondary accumulations are present in some pedons. Carbonates range from 4 to 10 percent. Reaction is slightly alkaline through strongly alkaline.

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Ustic Torriorthents

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters were found from 2 to 12 inches for texture (Silty clay). Unsuitable parameters were found from 2 to 12 inches for pH. Estimated salvage depth is 2 inches due to pH and texture.

GEOGRAPHIC SETTING: Samday soils are on largely unstable upland ridgetops, shoulders, and backslopes of ridges and low hills. These soils formed in fine textured shale residuum, slope alluvium, and colluvial slopewash. Slopes are 0 to 45 percent. Elevation is 3,500 to 6,500 feet. Precipitation ranges from 10 to 17 inches with over half of the annual precipitation falling in each month of July, August, September, and October. The mean annual temperature ranges from 44 to 49 degrees F. The frost-free season is about 105 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Shallower than typical
- Lacked BCky horizon.
- Much lower pH than typical in the C horizon.
- Paralithic material was composed of acidic shale.

SAVAGETON SERIES

The Savageton series consists of moderately deep, well drained, slowly permeable soils. They formed in alluvium, colluvium, and residuum derived dominantly from shale on hills, ridges, fan remnants, fan piedmonts and fan aprons. Slopes range from 0 to 30 percent. The average annual precipitation is about 13 inches, and the average annual air temperature is about 45 degrees F. This series is part of the Bahl-Savageton complex.

SOIL MAPPING UNIT: Ba-Sv

SOIL SAMPLE LOCATION: Waypoint 4

TYPICAL PEDON: Savageton clay loam-in an area of native rangeland on an 8 percent east-facing slope. (Colors are for dry soil unless otherwise stated)

A---0 to 4 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common fine roots; slightly alkaline (pH 7.6); abrupt smooth boundary. (3 to 6 inches thick)

Bw---4 to 12 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate medium and coarse subangular blocky structure; very hard, firm, moderately sticky and moderately plastic; common fine roots; slightly effervescent, calcium carbonate disseminated; slightly alkaline (pH 7.7); clear smooth boundary. (7 to 26 inches thick)

Bk---12 to 20 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, moderately sticky and moderately plastic; few fine roots; strongly effervescent; common medium irregularly shaped, masses of calcium carbonate; slightly alkaline (pH 7.8); clear wavy boundary. (6 to 23 inches thick)

C---20-32 inches; light brownish gray (2.5Y 6/2) clay, grayish brown 2.5 Y 5/2) moist; platy; very hard, firm, moderately stick and moderately plastic; masses of calcium carbonate; slightly alkaline (pH 7.8); clear wavy boundary.

Cr---32+ inches*; platy, calcareous shale.

TYPE LOCATION: Waypoint 4, Weston County, Wyoming' refer to the map included in this report.

RANGE IN CHARACTERISTICS: Depth to the base of the cambic horizon ranges from 13 to 30 inches but is typically greater than 20 inches. Because of surface recharge, the soils are more commonly calcareous throughout; but depth to continuous zones of carbonate accumulation (or Bk horizon) is 15 to 30 inches in most pedons. Depth to bedrock ranges from 20 to 40 inches. 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. and is never moist in all parts for as long as 60 consecutive days when the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, but 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 52 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days. Textures for the entire profile and each horizon are clay loam, clay, silty clay or silty clay loam with 35 to 50 percent clay. Rock fragments range up to 5 percent.

The A horizon has hue of 2.5Y or 10YR, value of 4 to 7 dry, 3 to 5 moist, and chroma of 2 to 4. Reaction is neutral to moderately alkaline.
The Bw or cambic horizon has hue of 2.5Y or 10YR, value of 4 to 6 dry, 4 or 5 moist, and chroma of 2 to 4. Reaction is slightly alkaline to strongly alkaline. Dry consistence is hard or very hard.

The Bk or C horizon has hue of 2.5Y or 10YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. Reaction is moderately alkaline or strongly alkaline. Calcium carbonate equivalent averages 5 to 14 percent, but some discontinuous strata exceed 14 percent in some pedons. The measured ESP is less than 15 percent, but field tests show reactions over 8.6 in many pedons.

The Cr horizon is soft, massive clay shale which limits water intake and root growth. It forms a paralithic contact.

TAXONOMIC CLASS: Fine, smectitic, mesic Ustic Haplocambids

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994):
According to WDEQ Guideline 1, marginal parameters were found from 0 to 20 inches for texture (Silty clay), for texture (Clay) from 20 to 32 inches, and from 12 to 32 to SAR values. Strong effervescence, as observed in the field, was found from 12 to 20 inches. Estimated salvage depth is 12 inches due to calcium carbonate accumulation, texture, and SAR values.

GEOGRAPHIC SETTING: Savageton soils are on dissected fan piedmonts, fan aprons, ridges and rolling hills controlled by bedrock at moderate depths. Slopes are 0 to 30 percent. Elevations are 3,500 to 6,000 feet. The average annual precipitation is 13 inches with over half 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 average annual air temperature ranges from 45 to 51 degrees F. The frost-free season is about 105 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Lack of disseminated calcium carbonates typical within the A horizon.
- Lower pH values than typical for the Bk and C horizons.

SAVAGETON SERIES

The Savageton series consists of moderately deep, well drained, slowly permeable soils. They formed in alluvium, colluvium, and residuum derived dominantly from shale on hills, ridges, fan remnants, fan piedmonts and fan aprons. Slopes range from 0 to 30 percent. The average annual precipitation is about 13 inches, and the average annual air temperature is about 45 degrees F.

SOIL MAPPING UNIT: Ba-Sv

SOIL SAMPLE LOCATION: Waypoint 19

TYPICAL PEDON: Savageton clay loam-in an area of native rangeland on an 8 percent east-facing slope. (Colors are for dry soil unless otherwise stated)

A---0 to 4 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common fine roots; slightly acid (pH 6.3); abrupt smooth boundary. (3 to 6 inches thick)

Bw---4 to 13 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate medium and coarse subangular blocky structure; very hard, firm, moderately sticky and moderately plastic; common fine roots; neutral (pH 6.9); clear smooth boundary. (7 to 26 inches thick)

Bk--13 to 22 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, moderately sticky and moderately plastic; few fine roots; slightly effervescent; common medium irregularly shaped, masses of calcium carbonate; slightly alkaline (pH 7.4); clear wavy boundary. (6 to 23 inches thick)

Cr--22+ inches; platy, calcareous shale.

TYPE LOCATION: Waypoint 19, Weston County, Wyoming; refer to the map included in this report.

RANGE IN CHARACTERISTICS: Depth to the base of the cambic horizon ranges from 13 to 30 inches but is typically greater than 20 inches. Because of surface recharge, the soils are more commonly calcareous throughout; but depth to continuous zones of carbonate accumulation (or Bk horizon) is 15 to 30 inches in most pedons. Depth to bedrock ranges from 20 to 40 inches. 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. and is never moist in all parts for as long as 60 consecutive days when the soil temperature at a depth of 20 inches is 41 degrees F., which occurs about April 21-27, but 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 52 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days. Textures for the entire profile and each horizon are clay loam, clay, silty clay or silty clay loam with 35 to 50 percent clay. Rock fragments range up to 5 percent.

The A horizon has hue of 2.5Y or 10YR, value of 4 to 7 dry, 3 to 5 moist, and chroma of 2 to 4. Reaction is neutral to moderately alkaline.

The Bw or cambic horizon has hue of 2.5Y or 10YR, value of 4 to 6 dry, 4 or 5 moist, and chroma of 2 to 4. Reaction is slightly alkaline to strongly alkaline. Dry consistence is hard or very hard.

The Bk or C horizon has hue of 2.5Y or 10YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. Reaction is moderately alkaline or strongly alkaline. Calcium carbonate equivalent averages 5 to 14 percent, but some discontinuous strata exceed 14 percent in some pedons. The measured ESP is less than 15 percent, but field tests show reactions over 8.6 in many pedons.

The Cr horizon is soft, massive clay shale which limits water intake and root growth. It forms a paralithic contact.

TAXONOMIC CLASS: Fine, smectitic, mesic Ustic Haplocambids

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): According to WDEQ Guideline 1, marginal parameters for texture (silty clay) were found throughout the profile. Slight effervescence, as observed in the field, was found from 13 to 22 inches. Estimated salvage depth is 13 inches due to calcium carbonate accumulation and texture.

GEOGRAPHIC SETTING: Savageton soils are on dissected fan piedmonts, fan aprons, ridges and rolling hills controlled by bedrock at moderate depths. Slopes are 0 to 30 percent. Elevations are 3,500 to 6,000 feet. The average annual precipitation is 13 inches with over half 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 average annual air temperature ranges from 45 to 51 degrees F. The frost-free season is about 105 to 130 days.

VARIATION FROM TYPICAL SERIES:

- Slightly lower pH value than typical within the A, Bw, and Bk horizons.

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Addendum D-7-D Soil Laboratory Analysis

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LABORATORY ANALYTICAL REPORT
Prepared by Gillette, WY Branch

Client: Rare Element Resources Inc
Project: Upton Plant Site Soils
Workorder: G12100444

Report Date: 11/14/12
Date Received: 10/17/12

	Analysis	SAT	OM-WB	Coarse Fragments	Sand	Silt	Clay	Texture	pH-SatPst	COND	Ca-SatPst	Mg-SatPst	Na-SatPst	SAR-sat paste
	Units	wt%	%	%	%	%	%	%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	Client Sample ID	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
G12100444-001	RER Upton #4 0-4	58	2.3	< 2	4	48	48	SIC	7.6	0.6	1.35	0.53	4.62	4.8
G12100444-002	RER Upton #4 4-12	70	1.8	< 2	2	46	52	SIC	7.7	4.8	22.6	6.82	28.9	7.5
G12100444-003	RER Upton #4 12-20	68	1.6	< 2	2	48	50	SIC	7.8	5.9	21.6	9.75	41.9	10.6
G12100444-004	RER Upton #4 20-32	73	1.3	< 2	4	32	64	C	7.8	6.0	20.5	10.6	41.2	10.5
G12100444-005	RER Upton #8 0-5	54	2.0	< 2	12	48	40	SIC	7.3	0.7	2.02	0.73	3.83	3.3
G12100444-006	RER Upton #8 5-10	65	1.8	< 2	4	52	44	SIC	7.6	4.2	22.8	5.95	19.2	5.1
G12100444-007	RER Upton #8 10-30	74	1.5	< 2	8	44	48	SIC	7.8	8.9	20.5	20.5	65.0	14.4
G12100444-008	RER Upton #8 30-48	70	1.1	< 2	8	42	50	SIC	7.8	8.0	17.8	20.4	57.9	13.3
G12100444-009	RER Upton #10 0-10	70	3.4	< 2	4	48	48	SIC	6.1	0.6	1.20	0.76	3.17	3.2
G12100444-010	RER Upton #10 10-24	60	1.4	< 2	2	58	40	SIC	7.7	0.7	1.82	0.62	3.99	3.6
G12100444-011	RER Upton #10 24-36	61	1.0	< 2	8	56	36	SICL	7.6	3.6	20.6	7.41	13.9	3.7
G12100444-012	RER Upton #10 36-48	67	0.8	< 2	10	50	40	SIC	7.8	8.5	16.5	25.1	66.9	14.7
G12100444-013	RER Upton #11 0-12	79	3.0	< 2	4	48	48	SIC	7.3	2.0	3.07	1.90	13.3	8.5
G12100444-014	RER Upton #11 12-24	90	1.8	< 2	< 1	44	56	SIC	8.0	10.4	17.0	25.6	81.1	17.6
G12100444-015	RER Upton #11 24-36	67	1.3	< 2	< 1	60	40	SIC	7.4	7.0	18.4	21.4	46.9	10.5
G12100444-016	RER Upton #11 36-48	57	1.0	< 2	< 1	68	32	SICL	7.4	4.2	18.1	14.4	16.8	4.2
G12100444-017	RER Upton #13 0-6	75	3.1	< 2	2	48	50	SIC	7.2	0.6	1.32	0.70	3.12	3.1
G12100444-018	RER Upton #13 6-18	84	1.8	< 2	14	32	54	C	7.7	3.8	15.1	6.93	18.4	5.6
G12100444-019	RER Upton #14 0-5	55	2.9	< 2	6	60	34	SICL	6.2	0.7	2.45	1.72	2.55	1.8
G12100444-020	RER Upton #14 5-10	62	1.5	< 2	6	54	40	SIC	6.7	0.6	2.52	1.08	2.31	1.7
G12100444-021	RER Upton #14 10-30	72	1.2	< 2	6	50	44	SIC	7.6	7.1	17.2	19.1	42.9	10.1
G12100444-022	RER Upton #14 30-48	70	0.9	< 2	2	56	42	SIC	7.5	11.9	16.8	43.3	90.3	16.5
G12100444-023	RER Upton #17 0-4	54	1.7	< 2	4	52	44	SIC	6.9	0.6	2.50	1.37	1.56	1.1
G12100444-024	RER Upton #17 4-10	62	1.4	< 2	8	46	46	SIC	7.3	0.4	0.95	0.53	2.52	3.0
G12100444-025	RER Upton #17 10-24	72	1.5	< 2	14	44	42	SIC	7.3	5.5	16.7	11.4	34.1	9.7
G12100444-026	RER Upton #19 0-4	58	3.1	< 2	6	50	44	SIC	6.3	0.4	2.33	0.59	0.25	0.2
G12100444-027	RER Upton #19 4-13	65	1.6	< 2	6	46	48	SIC	6.9	2.3	23.4	2.68	0.54	0.1
G12100444-028	RER Upton #19 13-22	66	1.1	< 2	4	52	44	SIC	7.4	2.6	25.6	4.34	1.46	0.4
G12100444-030	RER Upton #22 0-8	52	1.9	< 2	26	40	34	CL	6.4	0.6	3.97	1.20	0.18	0.1
G12100444-031	RER Upton #22 8-18	46	1.2	< 2	32	40	28	CL	7.3	0.7	5.15	1.34	0.24	0.1
G12100444-032	RER Upton #22 18-36	48	0.7	4	32	36	32	CL	7.8	0.4	2.77	1.19	0.35	0.2
G12100444-033	RER Upton #22 36-48	46	0.3	3	34	40	26	L	8.1	0.6	2.01	2.09	1.30	0.9
G12100444-034	RER Upton #25 0-4	77	3.3	3	2	40	58	C	7.2	2.7	18.6	4.10	4.63	1.4
G12100444-035	RER Upton #25 4-10	77	1.7	< 2	< 1	40	60	C	7.5	2.9	23.4	4.09	6.51	1.8
G12100444-036	RER Upton #25 10-28	84	1.3	< 2	< 1	40	60	C	7.8	5.3	18.5	9.61	34.0	9.1
G12100444-037	RER Upton #26 0-6	68	3.1	< 2	4	40	56	C	6.6	1.4	11.7	1.96	0.70	0.3
G12100444-038	RER Upton #26 6-13	56	2.0	< 2	4	38	58	C	5.8	0.3	1.94	0.48	0.31	0.3
G12100444-039	RER Upton #29 0-2	48	4.3	< 2	6	58	36	SICL	6.2	0.6	4.19	0.85	0.19	0.1
G12100444-040	RER Upton #29 2-6	42	2.3	< 2	4	50	46	SIC	4.6	0.3	1.33	0.39	0.20	0.2
G12100444-041	RER Upton #29 6-12	45	1.7	< 2	< 1	54	46	SIC	4.3	0.3	1.16	0.33	0.25	0.3

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LABORATORY ANALYTICAL REPORT
Prepared by Gillette, WY Branch

Client: Rare Element Resources Inc
Project: Upton Plant Site Soils
Workorder: G12100444

Report Date: 11/14/12
Date Received: 10/17/12

	Analysis	B	Se
	Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Results	Results
G12100444-001	RER Upton #4 0-4	1.0	< 0.1
G12100444-002	RER Upton #4 4-12	1.7	< 0.1
G12100444-003	RER Upton #4 12-20	1.9	< 0.1
G12100444-004	RER Upton #4 20-32	2.1	< 0.1
G12100444-005	RER Upton #8 0-5	0.9	< 0.1
G12100444-006	RER Upton #8 5-10	1.6	< 0.1
G12100444-007	RER Upton #8 10-30	2.5	< 0.1
G12100444-008	RER Upton #8 30-48	1.8	< 0.1
G12100444-009	RER Upton #10 0-10	0.9	< 0.1
G12100444-010	RER Upton #10 10-24	0.9	< 0.1
G12100444-011	RER Upton #10 24-36	1.5	< 0.1
G12100444-012	RER Upton #10 36-48	2.3	< 0.1
G12100444-013	RER Upton #11 0-12	1.9	< 0.1
G12100444-014	RER Upton #11 12-24	2.2	< 0.1
G12100444-015	RER Upton #11 24-36	1.7	< 0.1
G12100444-016	RER Upton #11 36-48	1.5	< 0.1
G12100444-017	RER Upton #13 0-6	0.7	< 0.1
G12100444-018	RER Upton #13 6-18	1.5	< 0.1
G12100444-019	RER Upton #14 0-5	0.7	< 0.1
G12100444-020	RER Upton #14 5-10	0.8	< 0.1
G12100444-021	RER Upton #14 10-30	1.3	< 0.1
G12100444-022	RER Upton #14 30-48	1.3	< 0.1
G12100444-023	RER Upton #17 0-4	0.3	< 0.1
G12100444-024	RER Upton #17 4-10	0.8	< 0.1
G12100444-025	RER Upton #17 10-24	0.8	< 0.1
G12100444-026	RER Upton #19 0-4	0.3	< 0.1
G12100444-027	RER Upton #19 4-13	0.7	< 0.1
G12100444-028	RER Upton #19 13-22	1.3	< 0.1
G12100444-030	RER Upton #22 0-8	0.2	< 0.1
G12100444-031	RER Upton #22 8-18	0.2	< 0.1
G12100444-032	RER Upton #22 18-36	0.4	< 0.1
G12100444-033	RER Upton #22 36-48	0.9	< 0.1
G12100444-034	RER Upton #25 0-4	0.7	< 0.1
G12100444-035	RER Upton #25 4-10	0.9	< 0.1
G12100444-036	RER Upton #25 10-28	2.1	< 0.1
G12100444-037	RER Upton #26 0-6	0.7	< 0.1
G12100444-038	RER Upton #26 6-13	0.7	< 0.1
G12100444-039	RER Upton #29 0-2	0.5	< 0.1
G12100444-040	RER Upton #29 2-6	0.3	< 0.1
G12100444-041	RER Upton #29 6-12	0.5	< 0.1

Addendum D-7-E Prime Farmland Designation

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United States Department of Agriculture

NRCS

Natural Resources Conservation Service
Gillette Field Office
601 4J Court, Suite C
Gillette, WY 82716

Phone: (307) 682-8843 x3
Fax: (307) 682-3813
Website: http://www.wy.nrcs.usda.gov

Date: January 28, 2013

Cody Bank
BKS Environmental Associates
PO Box 3467
Gillette, WY 82717

Dear Mr. Bank:

The Natural Resources Conservation Service has reviewed the following list of legal descriptions that you submitted:

SW ¼ SW ¼ Section 27 T48N R65W
S ½ Section 28 T48N R65W
SE ¼ Section 29 T48N R65W
NE ¼ NE ¼ Section 32 T48N R65W
Section 33 T48N R65W
W ¼ Section 34 T48N R65W

None of the area described appears to be irrigated so there is no prime farm land or agricultural land of state wide importance contained within this legal description.

If you have any questions, or need to discuss this comment with us, please contact me at 307-682-8843 ext. 101.

Sincerely,

Timothy Kellogg
District Conservationist

Helping People Help the Land

An Equal Opportunity Provider and Employer

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Addendum D-7-F Photographs

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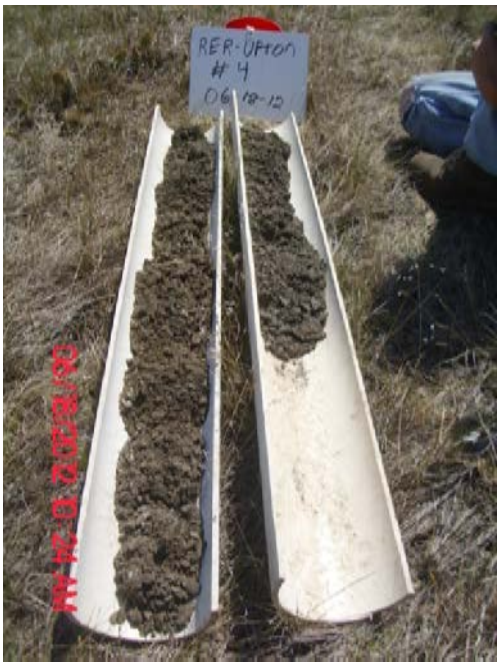
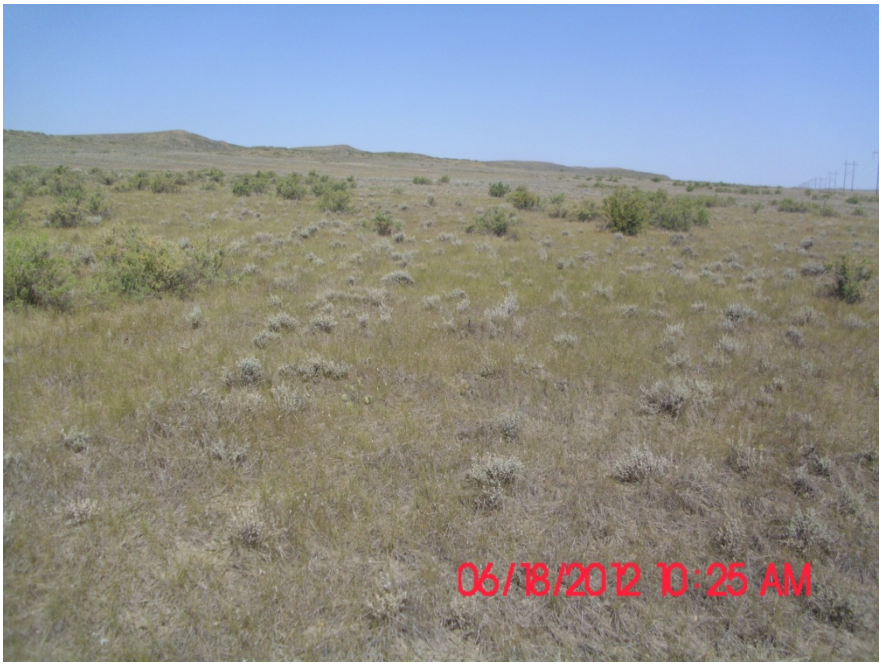
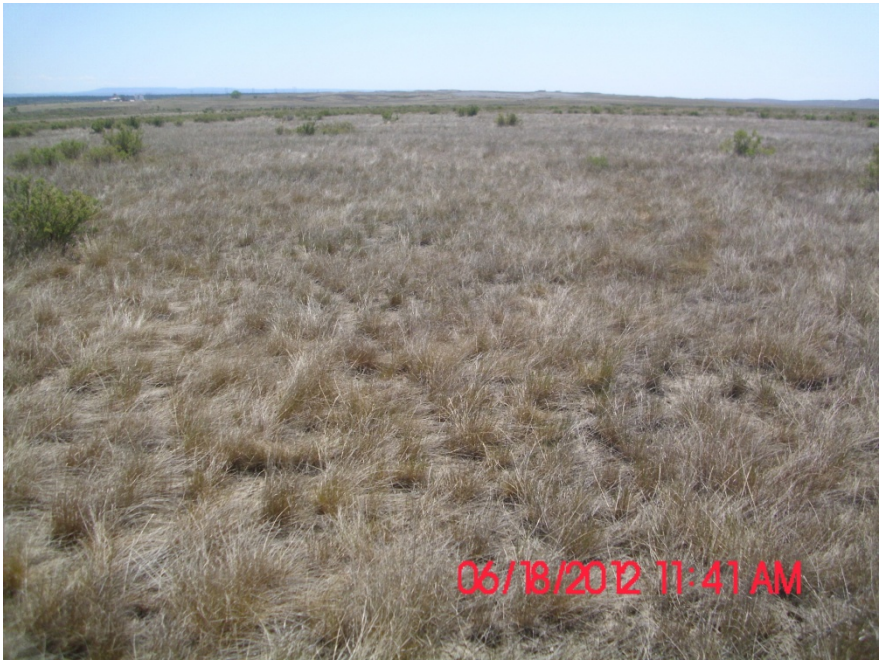


Picture 1 - Savageton - Profile

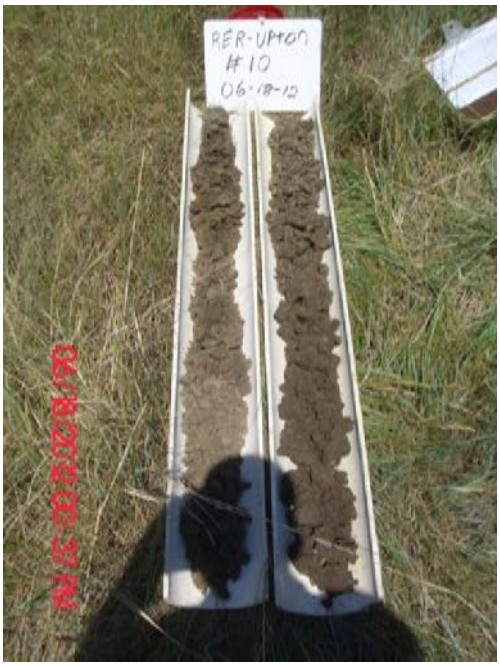


Picture 2 - Savageton - General

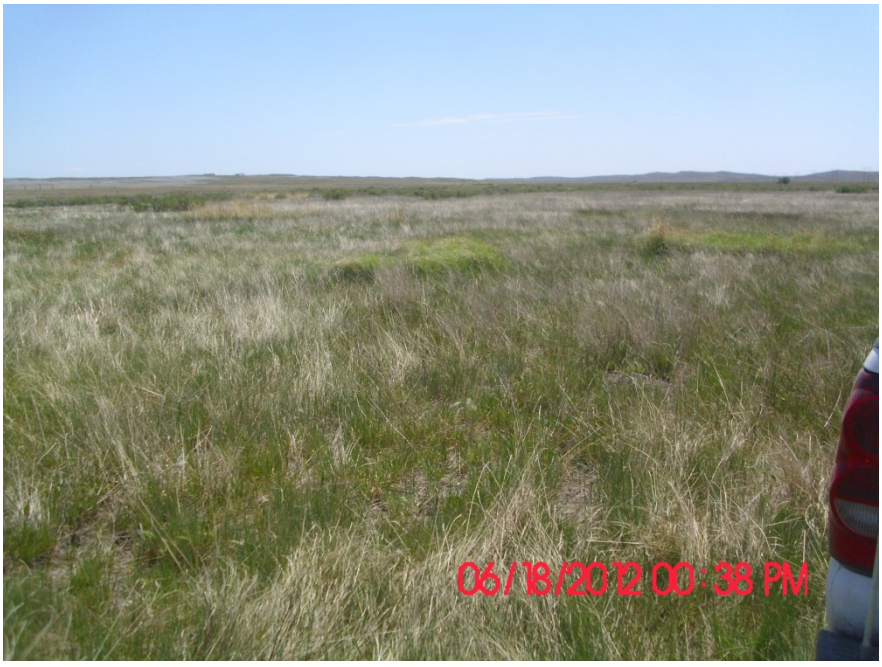
Picture 3 - Bahl - Profile



Picture 4 - Bahl - General

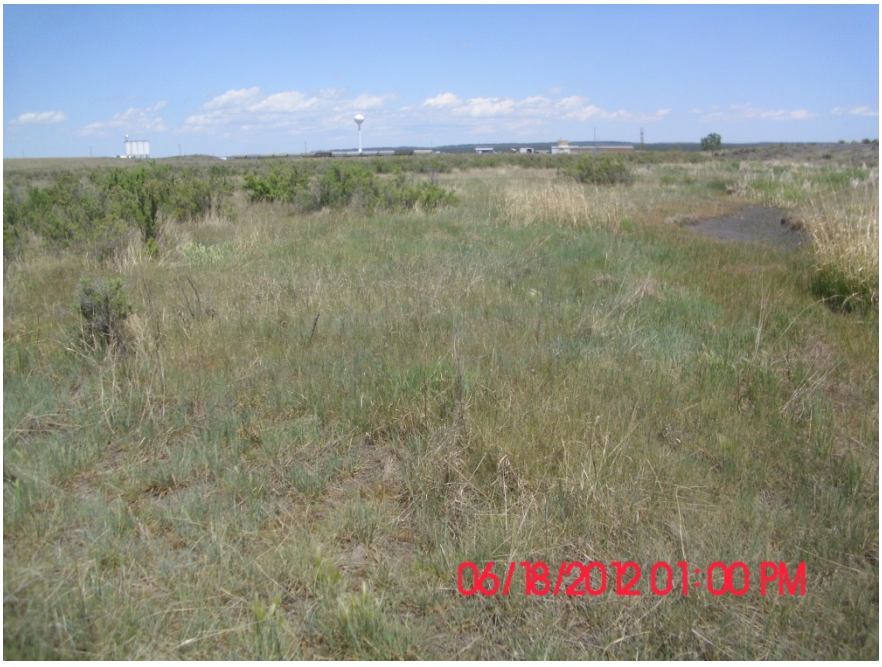


Picture 5 - Lohmiller - Profile

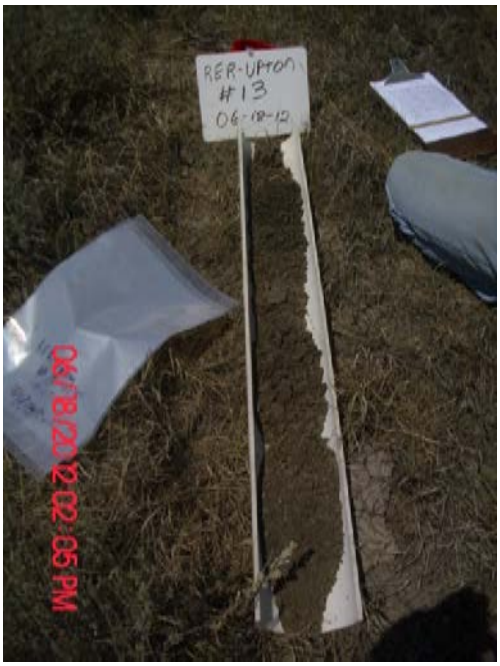


Picture 6 - Lohmiller - General

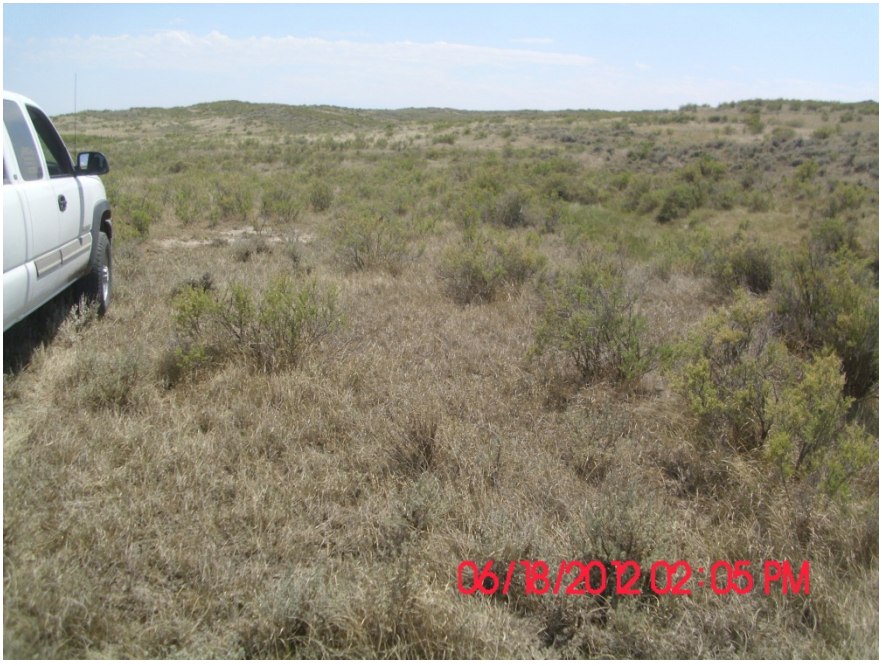
Picture 7 - Lohmiller - Profile



Picture 8 - Lohmiller - General

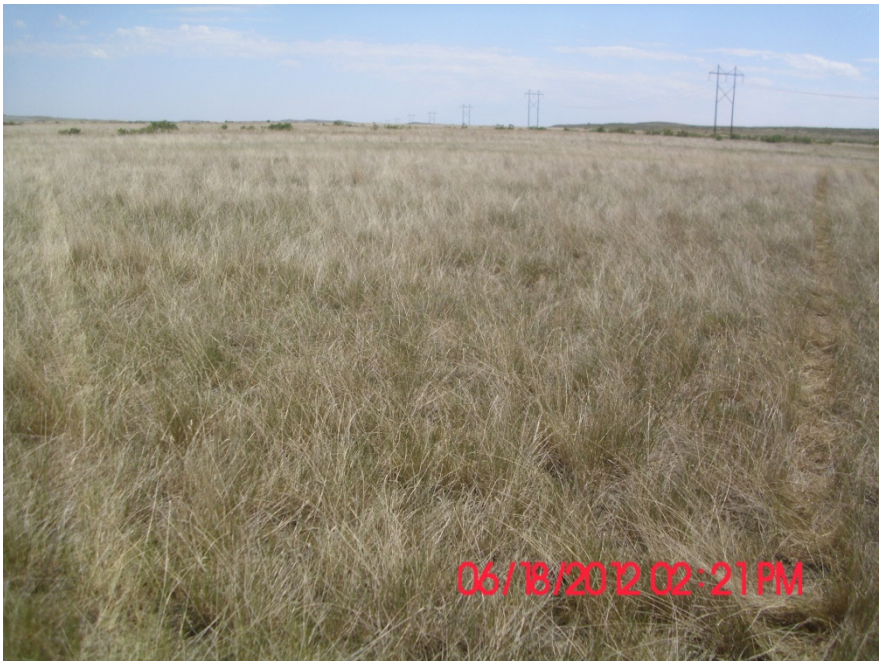


Picture 9 - Samday - Profile

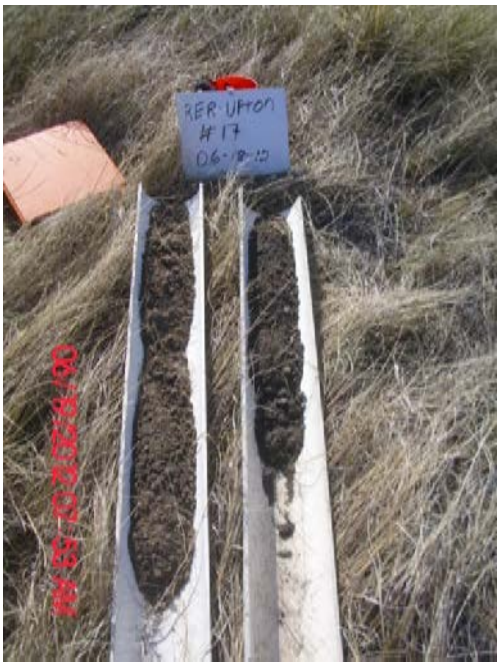


Picture 10 - Samday - General

Picture 11 - Bahl - Profile

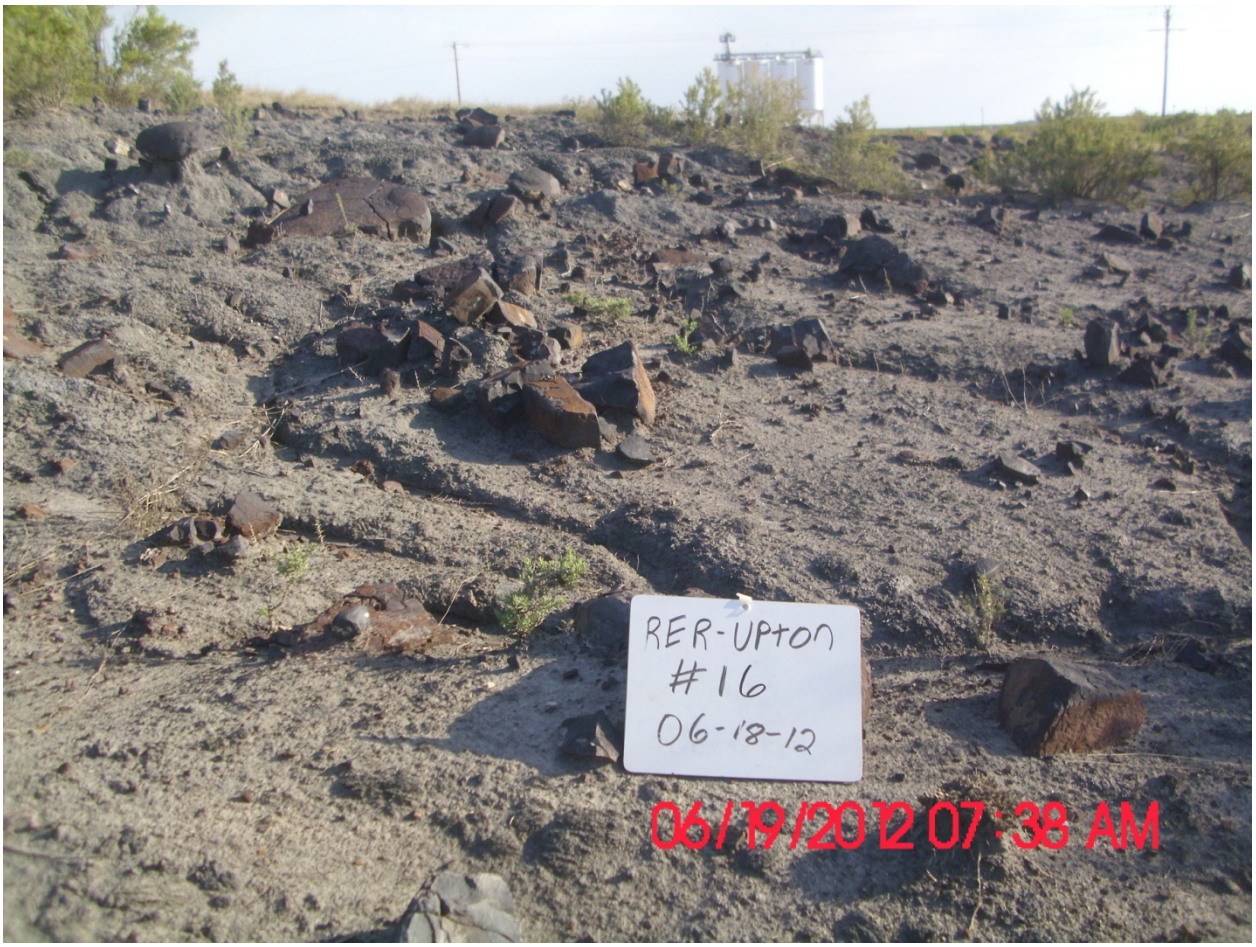


Picture 12 - Bahl - General

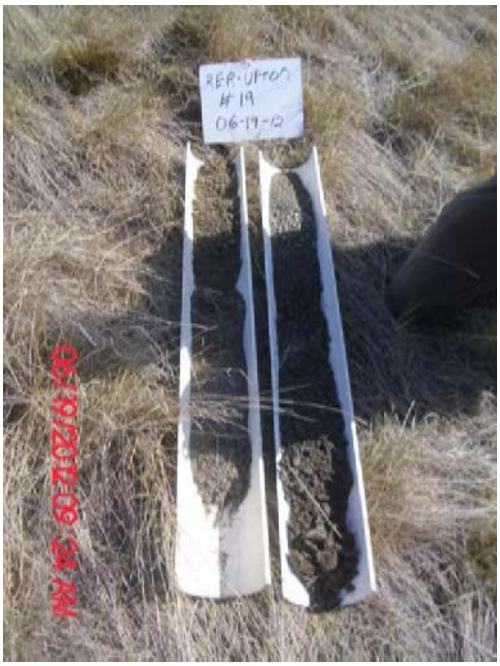


Picture 13 - Bentonite Pits-Reclaimed - Profile

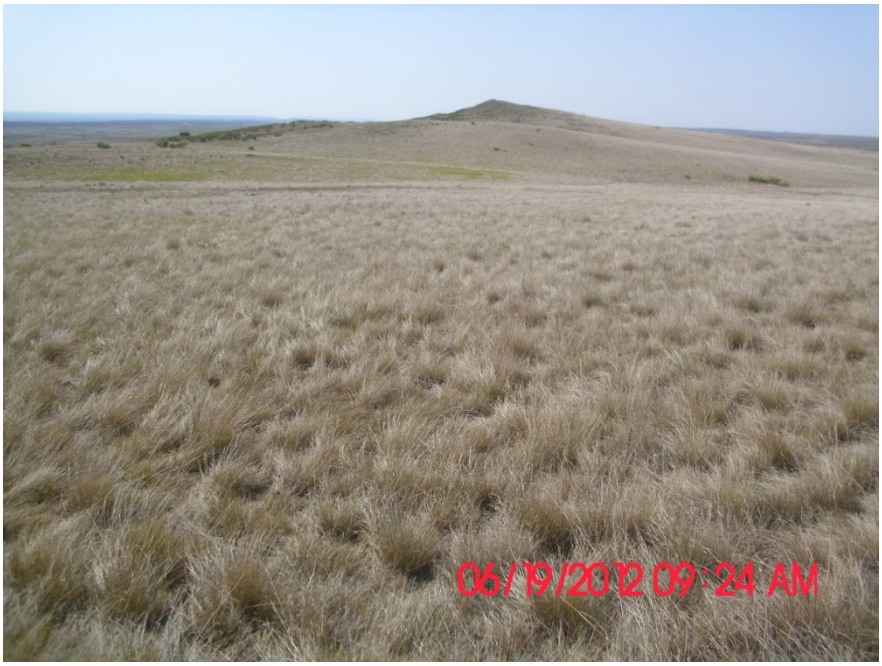
Picture 14 - Bentonite Pit-Reclaimed - General



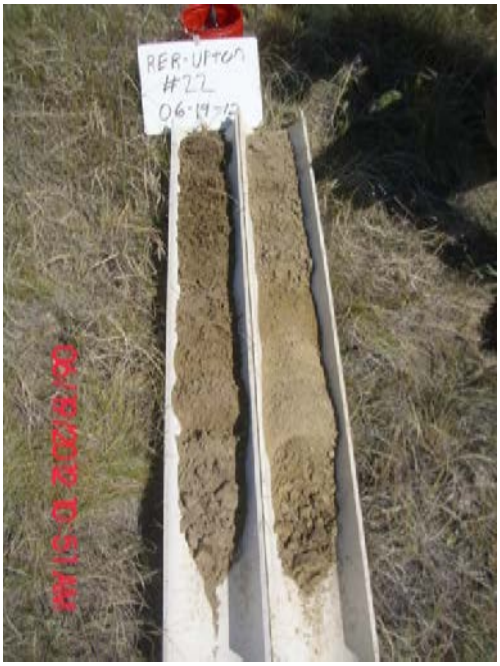
Picture 15 - Bentonite Pits-Reclaimed - General



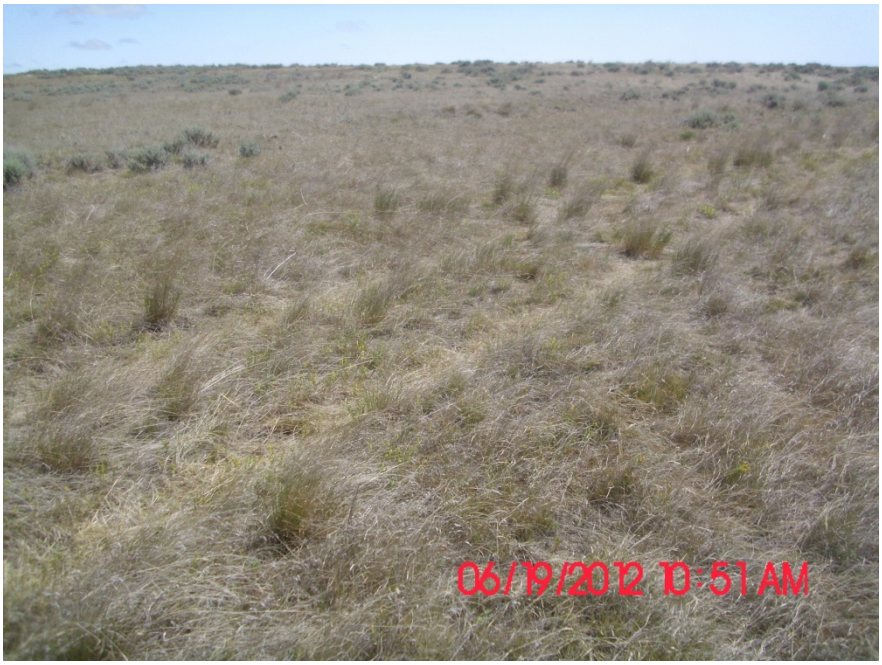
Picture 16 - Savageton - Profile



Picture 17 - Savageton - General

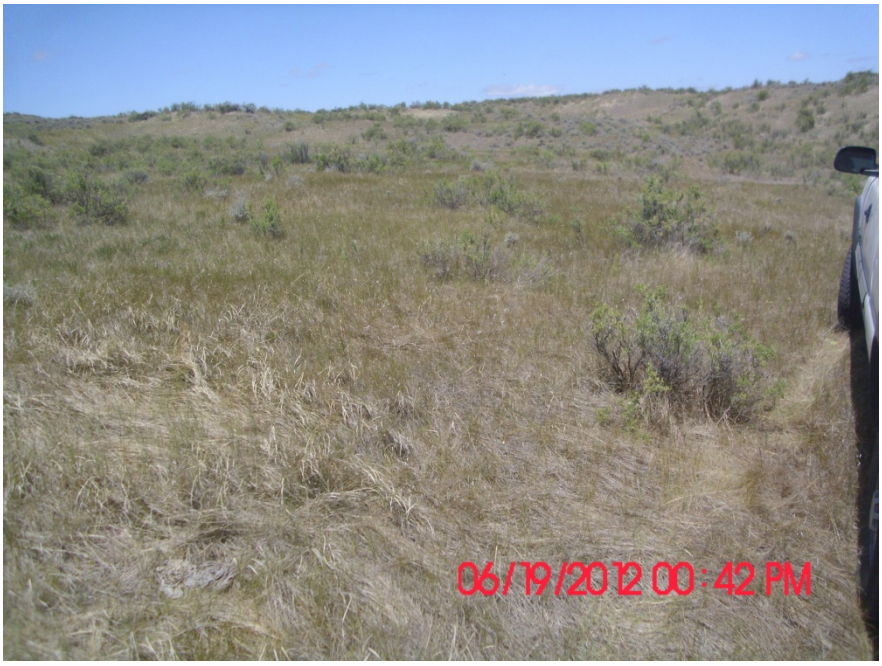


Picture 18 - Bahl - Profile

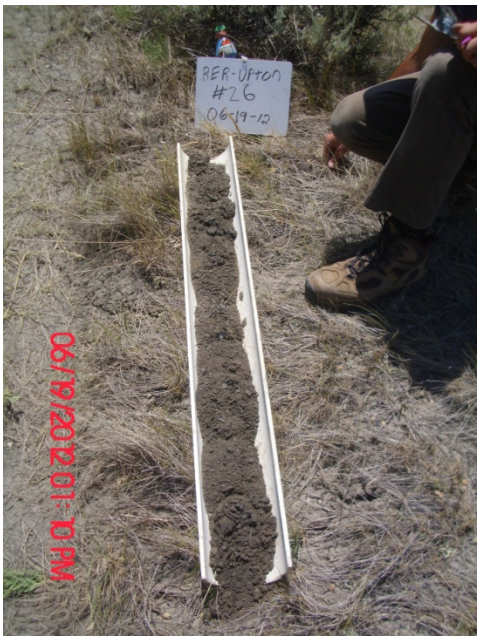


Picture 19 - Bahl - General

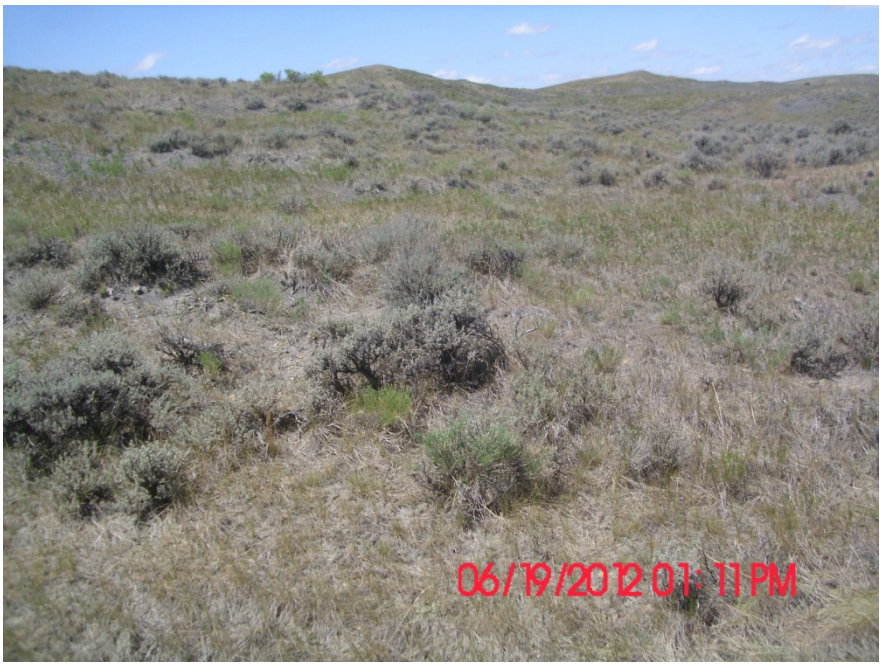
Picture 20 - Orella - Profile



Picture 21 - Orella - General

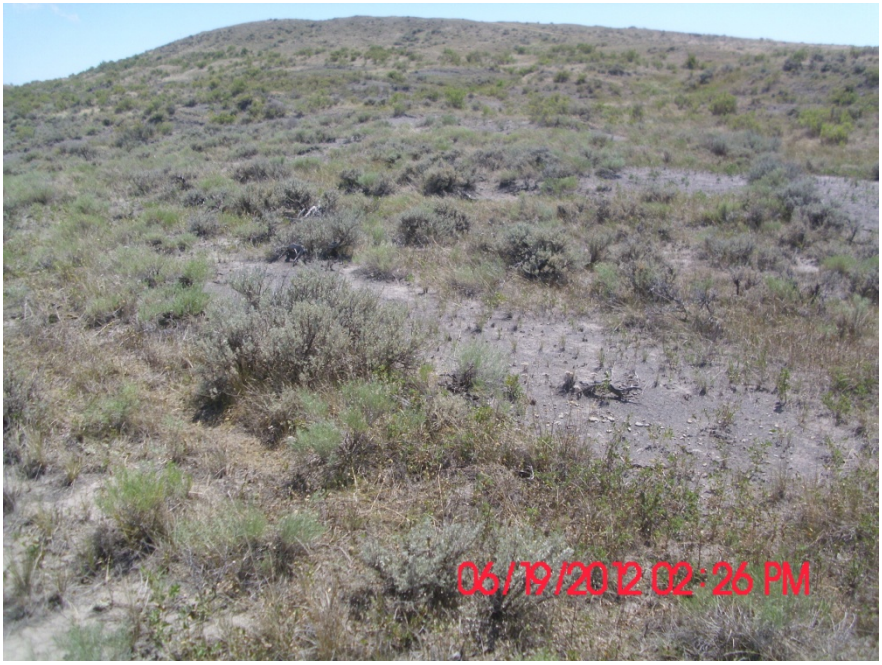


Picture 22 - Samday - Profile



Picture 23 - Samday - General

Picture 24 - Samday - Profile



Picture 25 - Samday – General

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Addendum D-7-G Map

Insert Oversize Map Here