

**APPENDIX D7:  
SOIL ASSESSMENT**

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**LIST OF ABBREVIATIONS AND ACRONYMS**

AMSL	Above mean sea level
ISR	In Situ Recovery
NRCS	Natural Resources Conservation Service
TRC	TRC Environmental Corporation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WDEQ/LQD	Wyoming Department of Environmental Quality, Land Quality Division

### **D7.1.0 INTRODUCTION**

The purpose of this report is to provide a detailed inventory of premine soil characteristics within the project area in accordance with Wyoming Department of Environmental Quality, Land Quality Division (WDEQ/LQD) Guideline No. 1 (1994). The soils information presented in this appendix was collected in accordance with a Soils Baseline Study Plan for the Nichols Ranch ISR Project approved by WDEQ/LQD and TRC Environmental Corporation (TRC) in August 2006. The information in this appendix includes an inventory of soil types (soil map units) and soil series based on the Order 3 soil survey, a base map delineating the soil types, physical and chemical characteristics of the topsoil for potential disturbance areas, and estimated depths of salvageable topsoil from the potential disturbance areas for future reclamation purposes.

The Nichols Ranch ISR Project area is located in southwest Campbell County and southeast Johnson County approximately 46 mi southwest of Gillette, Wyoming. The project area includes two noncontiguous areas designated as the Nichols Ranch Unit and the Hank Unit. The Nichols Ranch ISR Project area includes a total of 3,370.53 acres; 1,120 acres within the Nichols Ranch Unit and 2,250.53 acres within the Hank Unit.

The project area is located within the 10- to 14-inch Northern Plains zone of northeastern Wyoming (Natural Resources Conservation Service [NRCS] 1988). Elevations range from 5,055 to 5,209 ft above mean sea level (AMSL) in the Hank Unit and from 4,670 to 4,900 ft AMSL in the Nichols Ranch Unit. Annual precipitation varies from 10 to 14 inches, with approximately 35-41% falling during the normal growing season. Growth of native cool-season plants begins about April 1 and continues to about July 1. Growth of native warm-season plants begins about May 15 and continues to about August 15 (NRCS 1988). According to Wyoming Gap data, two primary vegetation types occur in the project area; sagebrush shrubland and mixed grassland (Wyoming Gap Analysis 2000).

## **D7.2.0 METHODOLOGY**

### **D7.2.1 LITERATURE REVIEW**

The soils in the southern portions of Johnson and Campbell Counties were studied and mapped to an Order 3 scale by the NRCS in 1975 and 1991 respectively (NRCS 1975; 1991). Soils information for Southern Campbell County is available both electronically and in hard copy. However, soils information for Johnson County is only available in hard copy. The NRCS has also centralized dissemination of typical soil series descriptions and this information is available on the Internet at [www.nrcs.usda.gov](http://www.nrcs.usda.gov).

### **D7.2.2 PROJECT PARTICIPANTS**

BKS Environmental Associates, Inc. of Gillette, Wyoming, performed the soil survey fieldwork and compiled a draft report. Energy Laboratories, Inc. of Casper, Wyoming, analyzed the soil samples, and TRC of Laramie, Wyoming, provided project direction and editing and quality assurance on the soils assessment report.

### **D7.2.3 SOIL SURVEY**

All soils within the project area (including lands to be disturbed and all lands to be left undisturbed) were mapped to an Order 2 level. The soil maps for the project area were prepared in accordance with the techniques and procedures presented in the National Cooperative Soil Survey (U.S. Department of Agriculture [USDA] 1993), and all portions of this project adhered to procedures presented in WDEQ/LQD Guideline No. 1 (1994).

### **D7.2.4 SOIL SAMPLING**

Because the proposed project involves the in situ recovery of uranium resources, WDEQ/LQD agreed that soil samples would only be collected from the disturbance areas associated with the two proposed plant areas (one in the Nichols Ranch Unit and one in the Hank Unit). The number

and location of samples are representative of the soil series that will be affected by the plant areas in the Nichols Ranch Unit and the Hank Unit.

Soil 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. Although numerous holes were augered for series and map unit verification, only the field locations of profiles selected for laboratory analysis are plotted on the soils map included with this report (see Exhibits D7-1 and D7-2). At least two quarts of sampled soil material were placed in clean, labeled, polyethylene plastic bags and kept cool to limit chemical changes. Due to the timing of the sample collection (i.e., December 2006), ambient air temperatures were not considered excessive and did not threaten the integrity of the samples or corresponding sample results. Samples were kept out of direct sunlight and transported promptly to Energy Laboratories for preparation and analysis.

#### **D7.2.5 LABORATORY ANALYSIS**

Following collection, the samples were prepared for chemical analysis and sample splits were collected and stored for possible future use. Laboratory analyses comply with the methodologies outlined in WDEQ/LQD Guideline No. 1 (1994).

### **D7.3.0 RESULTS AND DISCUSSION**

#### **D7.3.1 SOIL SURVEY - GENERAL**

Topography of the area includes gently rolling hills and ridges, as well as steep terrain near North Middle Butte and eroded areas associated with Dry Willow Creek. The soils occurring in the Hank Unit and Nichols Ranch Unit are generally fine textured throughout with patches of sandy loam on upland areas and fine-textured soils occurring near or in drainages. The project area contains deep soils on lower toeslopes and flat areas near drainages with shallow and moderately deep soils located on upland ridges and shoulder slopes.

#### **D7.3.2 SOIL MAPPING UNIT INTERPRETATION**

The soil survey was conducted during the summer/fall of 2006 and covered the entire project area. All soils within the project area (including lands to be disturbed and all lands to be left undisturbed) were mapped to an Order 2 level. U.S. Geological Survey (USGS) topographic maps and aerial photos were projected to a scale of 1 inch = 500 ft and were used as the base map for the soil mapping effort. The results of the Order 2 soil mapping effort are presented as Exhibits D7-1 and D7-2. Both maps comply with the requirements of WDEQ/LQD Guideline No. 6 (2003). Soil map unit acreages within the project area, the Nichols Ranch Unit, and the Hank Unit are presented in Tables D7-1, D7-2, and D7-3, respectively.

Descriptions of mapping units and soil series are presented in Addendums D7A and D7B, respectively. Mapping unit and soil series descriptions presented in this appendix are consistent with the National Cooperative Soil Survey, and mapping unit descriptions are specific to the project area.

Table D7-1 Soil Map Units Within the Nichols Ranch ISR Project Area.

Soil Map Unit	Soil Map Unit Name	Project Area (Acres)	Percent (%)
102	Arvada, thick surface-Arvada Slickspots complex, 0-6 percent slopes	40.3	1.2
109	Bidman loam, 0-6 percent slopes	8.6	0.2
111-1	Bidman loam, 0-6 percent slopes	78.8	3.0
111-2	Parmleed loam, 0-6 percent slopes	26.2	0.8
121-1	Cushman loam, 0-6 percent slopes	36.3	1.1
121-2	Cambria loam, 0-6 percent slopes	40.2	1.2
124	Cushman-Shingle loams, 0-6 percent slopes	9.6	0.3
124-1	Cushman loam, 6-15 percent slopes	20.0	0.6
124-2	Shingle loam, 6-15 percent slopes	12.0	0.3
126-1	Cushman loam, 0-6 percent slopes	9.7	0.3
126-2	Theedle loam, 0-6 percent slopes	26.2	0.8
127-1	Cushman loam, 6-15 percent slopes	3.2	0.1
127-2	Theedle loam, 6-15 percent slopes	82.2	2.4
146-1	Forkwood loam, 0-6 percent slopes	124.8	3.6
146-2	Cushman loam, 0-6 percent slopes	130.3	3.8
147-1	Forkwood loam, 6-15 percent slopes	66.7	1.9
147-2	Cushman loam, 6-15 percent slopes	24.6	0.7
148-2	Ulm loam, 0-6 percent slopes	10.3	0.3
152	Haverdad-Clarkelen complex, 0-4 percent slopes	94.3	2.7
157-1	Hiland fine sandy loam, 0-6 percent slopes	140.0	4.1
157-2	Bowbac fine sandy loam, 0-6 percent slopes	89.9	2.6
158	Hiland-Bowbac fine sandy loams, 6-15 percent slopes	14.1	0.4
158-1	Hiland fine sandy loam, 6-15 percent slopes	48.8	1.4
158-2	Bowbac fine sandy loam, 6-15 percent slopes	88.2	2.6
170-1	Tullock loamy sands, 6-30 percent slopes	94.1	2.7
170-2	Tullock loamy sands, 6-30 percent slopes	129.2	3.7
171	Keeline-Tullock-Niobrara, dry complex, 3-30 percent slopes	21.4	0.6
180	Maysdorf-Pugsley sandy loams, 6-15 percent slopes	11.0	0.3
180-2	Pugsley sandy loams, 6-15 percent slopes	8.6	0.2
194	Pugsley-Decolney sandy loams, 6-15 percent slopes	32.1	0.9
194-1	Pugsley sandy loams, 6-15 percent slopes	44.2	1.3
194-2	Decolney sandy loams, 6-15 percent slopes	3.6	0.1

Table D7-1 (Continued)

Soil Map Unit	Soil Map Unit Name	Project Area (Acres)	Percent (%)
206	Samday-Shingle-Badland complex, 10-45 percent slopes	202.53	7.0
208-1	Savaeton clay loam, 0-6 percent slopes	10.4	0.3
208-2	Silhouette clay loam, 0-6 percent slopes	26.8	0.8
211-1	Shingle loam, 3-30 percent slopes	4.8	0.1
211-2	Worf loam, 3-30 percent slopes	15.5	0.4
213-1	Terro sandy loam, 6-30 percent slopes	24.5	0.7
213-2	Taluce sandy loam, 6-30 percent slopes	4.1	0.1
216-1	Theedle loam, 3-30 percent slopes	27.6	0.8
216-2	Kishona loam, 3-30 percent slopes	272.4	7.9
216-3	Shingle loam, 3-30 percent slopes	30.4	0.9
217-1	Theedle loam, 3-30 percent slopes	156.4	4.5
217-2	Shingle loam, 3-30 percent slopes	143.3	5.7
227	Ulm-clay loam, 0-6 percent slopes	129.3	3.7
233	Ustic Torriorthents, gullied	392.5	11.4
HH	Haverson-Glenberg association	30.1	0.9
HK	Haverson-Glenberg association, saline	4.5	0.1
LO	Limon-Cadoma association, 0-10 percent slopes	27.7	0.8
MP-1	Maysdorf association, 6-15 percent slopes	24.7	0.7
MP-2	Pugsley association, 6-15 percent slopes	88.7	2.6
MR-1	Maysdorf association, 6-15 percent slopes	8.9	0.3
MR-2	Schooner association, 6-15 percent slopes	51.1	1.5
PXD-1	Pugsley complex, hilly, 6-15 percent slopes	19.4	0.6
PXD-2	Southfork complex, hilly, 6-15 percent slopes	20.8	0.6
STa-2	Arvada (Absted) complex, 0-3 percent slopes	11.1	0.3
STe-1	Stoneham association, 0-3 percent slopes	12.7	0.4
STe-2	Forkwood (Fort Collins) association, 0-3 percent slopes	22.7	0.7
Total Acres		3,370.53	100.0

Table D7-2 Soil Map Units Within the Nichols Ranch Unit.

Soil Map Unit	Soil Map Unit Name	Acres
102	Arvada, thick surface-Arvada Slickspots complex, 0-6 percent slopes	40.3
121-1	Cushman loam, 0-6 percent slopes	6.9
124	Cushman-Shingle loams, 0-6 percent slopes	9.5
124-1	Cushman loam, 6-15 percent slopes	20.0
124-2	Shingle loam, 6-15 percent slopes	12.0
127-1	Cushman loam, 6-15 percent slopes	23.9
127-2	Theedle loam, 6-15 percent slopes	61.6
146-2	Cushman loam, 0-6 percent slopes	10.2
152	Haverdad-Clarkelen complex, 0-4 percent slopes	94.1
170-2	Keeline loamy sands, 6-30 percent slopes	11.6
171	Keeline-Tulloch-Niobrara, dry complex, 3-30 percent slopes	21.4
180	Maysdorf-Pugsley sandy loams, 6-15 percent slopes	11.0
180-2	Pugsley sandy loams, 6-15 percent slopes	8.6
194-1	Pugsley sandy loams, 6-15 percent slopes	76.4
194-2	Decolney sandy loams, 6-15 percent slopes	3.6
208-1	Savageton clay loam, 0-6 percent slopes	10.4
208-2	Silhouette clay loam, 0-6 percent slopes	26.8
211-1	Shingle loam, 3-30 percent slopes	4.8
211-2	Worf loam, 3-30 percent slopes	15.5
216-1	Theedle loam, 3-30 percent slopes	27.6
216-2	Kishona loam, 3-30 percent slopes	46.1
216-3	Shingle loam, 3-30 percent slopes	30.6
217-1	Theedle loam, 3-30 percent slopes	36.5
217-2	Shingle loam, 3-30 percent slopes	143.3
233	Ustic Torriorthents, gullied	44.2
HH	Haverson-Glenberg association	30.2
HK	Haverson-Glenberg association, saline	4.7
LO	Limon-Cadoma association, 0-10 percent slopes	27.8
MP-1	Maysdorf association, 6-15 percent slopes	24.7
MP-2	Pugsley association, 6-15 percent slopes	88.9
MR-1	Maysdorf association, 6-15 percent slopes	8.9
MR-2	Schooner association, 6-15 percent slopes	51.2
PXD-1	Pugsley complex, hilly, 6-15 percent slopes	19.4
PXD-2	Southfork complex, hilly, 6-15 percent slopes	20.8
STa-2	Arvada (Absted) complex, 0-3 percent slopes	11.1
STe-1	Stoneham association, 0-3 percent slopes	12.7
STe-2	Forkwood (Fort Collins) association, 0-3 percent slopes	22.7
Total Acres		1,120

Table D7-3 Soil Map Units Within the Hank Unit.

Map Unit ID	Name of Soil Map Unit	Acres
109	Bidman loam, 0-6 percent slopes	8.6
111-1	Bidman loam, 0-6 percent slopes	78.8
111-2	Parmleed loam, 0-6 percent slopes	26.2
121-1	Cushman loam, 0-6 percent slopes	29.2
121-2	Cambria loam, 0-6 percent slopes	40.2
126-1	Cushman loam, 0-6 percent slopes	9.7
126-2	Theedle loam, 0-6 percent slopes	26.2
146-1	Forkwood loam, 0-6 percent slopes	124.8
146-2	Cushman loam, 0-6 percent slopes	119.9
147-1	Forkwood loam, 6-15 percent slopes	66.7
147-2	Cushman loam, 6-15 percent slopes	24.6
148-2	Ulm loam, 0-6 percent slopes	10.3
157-1	Hiland fine sandy loam, 0-6 percent slopes	140.0
157-2	Bowbac fine sandy loam, 0-6 percent slopes	89.9
158	Hiland-Bowbac fine sandy loams, 6-15 percent slopes	14.1
158-1	Hiland fine sandy loam, 6-15 percent slopes	48.8
158-2	Bowbac fine sandy loam, 6-15 percent slopes	76.3
170-1	Keeline loamy sands, 6-30 percent slopes	94.1
170-2	Tulloch loamy sands, 6-30 percent slopes	129.2
206	Samday-Shingle-Badland complex, 10-45 percent slopes	202.53
213-1	Terro sandy loam, 6-30 percent slopes	24.5
213-2	Taluce sandy loam, 6-30 percent slopes	4.1
216-2	Kishona loam, 3-30 percent slopes	226.2
217-1	Theedle loam, 3-30 percent slopes	119.9
217-2	Shingle loam, 3-30 percent slopes	38.3
227	Ulm-clay loam, 0-6 percent slopes	129.3
233	Ustic Torriorthents, gullied	348.0
----- Total Acres		2,250.53

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In accordance with NRCS recommendations, the following soil series have been renamed and the new names have been included in this Appendix:

- Absted loam has been changed to Arvada (thick surface) loam,
- Fort Collins loam has been changed to Forkwood loam,
- Olney sandy loam has been changed to Hiland sandy loam,
- Tassel sandy loam has been changed to Taluce sandy loam,
- Terry sandy loam has been changed to Terro sandy loam,
- Stoneham loam has been changed to Cambria loam, and
- Thedalund loam has been changed to Theedle loam.

### **D7.3.3 ANALYTICAL RESULTS**

Since only a small portion of the project area will be disturbed by the ISR project, WDEQ/LQD directed that a representative number of samples be collected from the two plant site areas (one plant site is located in each unit). To provide siting flexibility of each plant, a 5-acre area (this is larger than the size of the actual plant disturbance) was designated and soil samples were collected. Based on this approach, a total of seven sample sites were designated for the plant sites located within the Nichols Ranch ISR Project area (four within the Nichols Ranch Unit and three within the Hank Unit) (refer to Table D7-4). The sample locations are illustrated in Exhibits D7-1 and D7-2, and the number and location of samples were representative of the mapping unit that will be affected. Energy Laboratories, Inc. analyzed all samples in accordance with WDEQ/LQD Guideline No. 1 (1994) and the results are presented in Addendum D7C. Laboratory soil texture analyses did not include percent fine sands; however, field observations of fine sands within individual profiles, as well as sample site topographic position, were used in conjunction with laboratory analytical results to determine series designation.

### **D7.3.4 EVALUATION OF SOIL SUITABILITY AS A PLANT GROWTH MEDIUM**

General information about the topsoil samples collected from the two proposed plant sites is presented in Table D7-2. Total depths for all samples ranged from 57-60 inches and were

Table D7-2 General Soil Sample Information.<sup>1</sup>

Sample Site ID	Soil Unit	No. of sample intervals	Total Sample Depth (inches)
<b>Nichols Ranch Unit Sample</b>			
NNW	216-2	5	0 - 57
NNE	216-2	6	0 - 60
Nnorth	Ste-2	6	0 - 60
Nmiddle	Ste-2	6	0 - 60
<b>Hank Unit Samples</b>			
HNE	216-2	5	0 - 60
HNW	121-1	6	0 - 60
HSE	216-2	7	0 - 57

<sup>1</sup> Refer to Exhibits D7-1 and D7-2 for sample locations and Addendum D7C for a copy of the analytical results.

collected based on the appropriate soil profile. Based on the physical and analytical results presented in Addendum D7C, there are no factors that will limit the suitability of topsoil as a plant growth medium. All laboratory values were compared to Table I-2 of WDEQ/LQD Guideline No. 2 (1994) and the results were determined to be within the suitable range, except for marginal soil texture for four soil profiles from three samples collected in the Hank Unit. These four soil profiles were determined to have clay soil textures (refer to Addendum D7C).

### **D7.3.5 PRIME FARMLAND ASSESSMENT**

Based on a reconnaissance survey conducted by NRCS, no prime farmland was identified within the Nichols Ranch ISR Project area (refer to Addendum D7D).

#### **D7.4.0 REFERENCES**

- Natural Resource Conservation Service. 1993. Soil survey of Campbell County, Wyoming, southern portion. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, D.C. 39 pp. + append.
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- Wyoming Gap Analysis. 2000. A geographic analysis of biodiversity. Prepared in cooperation with the Wyoming Cooperative Fish and Wildlife Research Unit and University of Wyoming, Laramie. 109 pp.