SOIL SURVEY

Rev. 0 **Date: 01/29/09**

OF THE
ENVIRONMENTAL REPORT
IN SUPPORT OF THE APPLICATION FOR
LICENSE FOR SOURCE MATERIAL MILLING

PIÑON RIDGE URANIUM MILL
Montrose County, Colorado

Submitted to:

Radiation Management Unit
Colorado Department of Public Health and Environment

Prepared for:

Energy Fuels Resources
44 Union Blvd., Suite 600
Lakewood, Colorado 80228

Prepared by:

Kleinfelder
8300 Jefferson NE, Suite B
Albuquerque, NM 87113

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Prepared by: Kleinfelder
Albuquerque, New Mexico

Author: Louis Bridges by AK Kuhn
Louis Bridges, Principal Professional

Approved: Alan K. Kuhn
Alan K. Kuhn, Project Manager

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1.0 INTRODUCTION

Energy Fuels Resources Corporation (EFR) proposes to license, construct, and operate a conventional acid leach uranium and vanadium mill at the Piñon Ridge Mill site (the Site) in western Montrose County, Colorado. Site facilities will include an administration building, a 17-acre mill, tailing ponds totaling 90 acres, an 80-acre evaporation pond, a 5-acre ore storage pad, and an access road. The mill will process ore produced from mines within a reasonable truck-hauling distance. The mill will process up to 500 tons of ore per day but is designed to accommodate subsequent expanded production capacity of up to 1,000 tons per day. The expected operating life of the mill is 20 to 40 years.

The Piñon Ridge Mill is subject to regulation by the State of Colorado, and the mill license (Radioactive Source Material License) will be issued and administered by the Colorado Department of Public Health and Environment (CDPHE). The activities described in this document were performed as part of the baseline characterization required for the Environmental Report in accordance with Section 3.8.8, Part 3, 6 CCR 1007-1. This report presents the results of the soil survey conducted by Kleinfelder for EFR in support of the mill license application.

1.1 Site Location

The proposed Piñon Ridge Mill (Site) is located in the Paradox Valley at 16910 Highway 90, approximately 14 miles west of Naturita in Montrose County, Colorado. The Site's legal description is the Southwest ¼ of the Southeast ¼ of Section 5, all of Section 8, the North ¼ of Section 17, and the Southeast ¼ of the Northwest ¼ of Section 17, Township 46 North, Range 17 West, of the New Mexico Principal Base and Meridian. The Site is located on both the Davis Mesa Quadrangle (1994) and Bull Canyon Quadrangle (1994) 1:24,000 United States Geological Survey (USGS) topographic/geologic maps. The Site location with respect to major topographic features is shown in Figure 1.

1.2 Site Description

The Paradox Valley is formed by a collapsed salt anticline creating bluffs reaching 1,500 feet above the valley floor on both the north and south sides (Cater 1954). The Paradox Valley obtains its name from the anomaly that the Dolores River crosses perpendicular to the valley floor, although there is no river coursing through the valley (Cater, 1955b). The valley floor is approximately 5,300 feet above mean sea level (AMSL), while the bluffs reach to approximately 6,800 feet AMSL in the immediate area (Cater, 1955a). The Paradox Valley graben is on the crest of a salt-cored anticline near the Utah-Colorado border (Cater, 1954, 1955a, 1955b). Kelley (1955) refers to this region as the Paradox fold and fault belt. Formation of the salt-cored anticline is believed to be controlled by major subsurface faults that displace bedrock beneath the evaporitic Paradox Formation (Cater, 1970). The graben is a collapse feature that formed in response to salt migration and dissolution from beneath the area (Cater, 1954, 1955a, 1955b). Faults in this area are generally high-angle normal and downthrown towards the interior of the graben, although some faults are antithetic. More detailed description of the geology of the Site is contained in The Kleinfelder Geologic Report (Revised 01/22/09).

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2.0 PURPOSE AND SCOPE

As part of the mill licensing process, a soil survey is required by Section 5.3.3 of NUREG 1748, *Environmental Guidance for Licensing Actions with NMSS Programs* (NRC, 2003), to characterize geological environmental impacts, including soil compaction, soil erosion, subsidence, landslides, and disruption of natural drainage patterns prior to construction and permitting of the mill facility. The purpose of this survey was to characterize the soils at the Site and, in particular, determine whether or not hydric soils occur within the proposed area of construction. Hydric soils are those soils formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil horizon. Hydric soils are indicators of potential jurisdictional U.S. Army Corps of Engineers (USACE) water features.

Kleinfelder biologists collected field data to compare with information from the Natural Resources Conservation Service (NRCS) Web Soil Survey (USDA, 2008) and soils data in concurrence with the USACE jurisdictional "waters of the U.S." (WoUS) (USACE, 2006). The purpose of the data collection was to properly and efficiently characterize the baseline conditions (pre-development conditions) of the Site for inclusion in the Environmental Report in accordance with CDPHE and Federal guidance (NRC, 2003).

Field investigations were conducted in accordance with applicable Kleinfelder standard operating procedures (SOP), Quality Procedures (QP), and the work plan.

3.0 METHODS

3.1 USDA Web Soils Data

A database search was completed using the NRCS Web Soil Survey (USDA, 2008; accessed August 20, 2008). The Web Soil Survey provides soil data and information produced by the National Cooperative Soil Survey and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

A review of the literature (USDA, 2008) indicated that the soils at the Site are classified as Barx, Vananda, Begay, Mikim, Gypsiorthids, and Paradox (Figure 2). The USDA (2008) and USACE (2006) literature did not identify hydric soils as being present at the Site.

3.2 Field Methodology

Soils at sample plots within the potential wetlands were evaluated by digging 12-inch soil pits (Figure 3). Soils sample locations were selected based on drainage features located on the Site and areas of potential ponding or inundation. Ponded or inundated areas were identified as areas where earthen berms were previously constructed to retain seasonal surface water flows related to storm events or snowmelt. Soils along the drainage features (Figure 1) were also evaluated to determine whether hydric soils were present.

Methods used to determine if hydric soils were located on the Site were in accordance with the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (USACE, 2006). All drainage features, ponded and inundated areas were observed and evaluated for soil types and characterized based on USACE WoUS Final Wetland Delineation guidance (Meyer, 2008). The sample points (SP) were dug to the depth needed to document a

hydric indicator, or to confirm the absence of hydric indicators (USACE, 2006). Soils were compared to the Munsell® Soil Color Charts (MacBeth, 2000) to evaluate the color, hue, and chroma of representative soils. Soils were also observed for oxygen reduction reactions (redox) features associated with anaerobic conditions. Redox features were also characterized by their size, distinction, and frequency of occurrence.

4.0 RESULTS

4.1 USDA Web Soils Data

The Site soils are listed by the NRCS Web Soil Survey (USDA, 2008) as Barx, Vananda, Begay, Mikim, and Paradox (Figure 2). The majority of the soils (71.6 percent) are classified as fine sandy loam (USDA, 2008). The soils are derived from alluvium from the surrounding sandstone and shale bluffs to the north and south of the valley. Soils within the Site were observed to be well drained. The water capacity is variable between the different soil types (USDA, 2008). The water table is more than 80 inches below the ground surface (bgs) (USDA, 2008). The soil profiles at the Site were observed to have little or no soil horizon differentiation in the upper 24 inches. Rock outcropping accounts for 4.3 percent of the Site, located in the southwest corner. According to NRCS, none of the soils within the study area are classified as hydric (USDA, 2008).

4.1.1 Barx Series

The Barx series consists of very deep, well-drained soils that form in alluvium and reworked eolian material derived from sandstone. Barx soils are on alluvial fans, terraces, hills, and mesas. Slopes range from 0 to 15 percent. The Barx series typically occurs between 4,400 to 7,800 feet AMSL. Mean annual precipitation is between 8 and 14 inches and the mean annual temperature is between 45° and 55° Fahrenheit (F). These soils form under a frost-free period of 100 to 175 days a year (USDA, 2008).

4.1.2 Vananda Series

Typically, Vananda series soils have fragile, massive, vesicular, clear silt-coated surface crust and have indistinct gradation below this crust in grayish-brown grading to olive gray slightly calcareous clay (USDA, 2008). The continuous surface crust is 1/8 to 1/2 inch thick under sparse grass cover. The climate is cool semiarid with mean annual temperature of 45 to 47° F, mean summer temperature more than 60° F, and mean winter temperature between 18 and 28° F. Mean annual precipitation is from 10 to 14 inches (USDA, 2008).

4.1.3 Begay Series

Usually occurring at elevations between 4,700 to 7,400 feet AMSL, the Begay series consists of very deep, well-drained, moderately to rapidly permeable soils that form in eolian deposits and alluvium derived mainly from sandstone. Begay soils are on structural benches, broad mesas, and fan remnants, and have slopes of 0 to 30 percent (USDA, 2008). The average annual precipitation is between 8 and 14 inches, and the mean annual air temperature is between 44° and 55° F (USDA, 2008).

4.1.4 Mikim Series

The Mikim series consists of very deep, well-drained soils that form in alluvium derived from sandstone and shale. Mikim soils are on alluvial fans and in drainage ways and valleys. Slopes

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range from 0 to 15 percent. Mean annual precipitation is between 10 and 13 inches and the mean annual temperature is between 50° and 52° F (USDA, 2008).

This series of soils is found between the elevations of 5,400 and 6,200 feet AMSL. These soils are used primarily for range; however, they are used as dryland or irrigated cropland in some locations (USDA, 2008).

4.1.5 Paradox Series

The Paradox series consists of deep, well-drained soils that form in alluvium derived from red sandstone and shale. Paradox soils are on nearly level to gently sloping broad alluvial fans and old alluvial valley floors. Slopes are from 1 to 25 percent. The mean annual precipitation is about 11 inches and the mean annual temperature is between 44° and 49° F (USDA, 2008).

Paradox soils are in a climatic setting that receives the annual precipitation uniformly distributed throughout the year with over 50 percent coming as snow. Elevations are 4,900 to 5,200 feet AMSL. These soils are utilized as rangeland and irrigated cropland (USDA, 2008).

4.1.6 Gypsiorthids Series

The Gypsiorthids soils consist of deep, well drained soils that form on valley floors and terraces. These soils consist of residium weathered from gypsum. Gypsiorthids soils are found on slopes that range from three to 25 percent. The mean annual precipitation ranges from 10 to 12 inches and the mean annual temperature is between 46° and 49°F (USDA, 2008).

Gypsiorthids soils are in a climatic setting that receives the annual precipitation uniformly distributed throughout the year with over 50 percent coming as snow. Elevations are 4,900 to 6,600 feet AMSL. These soils are utilized as rangeland (USDA, 2008).

4.2 Field Observations

The soils observed in the northern portion of the Site tended to be sandy loam to fine sandy loam with typical hues in the 5YR range (MacBeth, 2000). Kleinfelder water resources professionals observed that water from rain and snow melt events takes some time to infiltrate past the first few inches. The soil appeared to be dry under approximately six inches of saturated soil during the winter and spring surveys.

Drainage features across the Site were characterized as discontinuous ephemeral streams (Meyer, 2008). In addition, the six USDA soil series identified by the NRCS Web Soil Survey (Barx, Vananda, Begay, Mikim, Paradox and Gypsiorthids) were recognized at the Site (Figure 2).

Biological soil crusts, also known as cryptogamic, microbiotic, cryptobiotic, and microphytic crusts (Belnap and Lange, 2001), were observed sporadically at the Site. Biological soil crusts were observed to cover less than five percent of the area, with the highest concentrations located under big sage (*Artemisia tridentata*). Biological soil crusts are made up primarily of cyanobacteria (formerly blue-green algae), green and brown algae, microfungi, mosses, liverworts, and lichens (Rosentreter et al., 2007). The organisms on the soil increase soil stability, contribute carbon to the underlying soil, convert atmospheric nitrogen into bio-available nitrogen, and retain water (Belnap and Lange, 2001).

The locations of the two soil sample points are shown in Figure 3. Sample Point 1 (SP1) is an atypical soil profile of the site. The presence of organic material is indicative of above normal soil moisture. The soil profile consisted of the top 4 inches of clay loam with approximately 10 percent organic material (Attachment A, Photograph 1). The color of the top 4 inches was dark brown (7.5YR3/4) (MacBeth, 2000). From 4 to 12 inches bgs, the profile changed to a sandy loam with a yellowish-red color (5YR4/6) (MacBeth, 2000). The soil profile did not exhibit hydric characteristics under the guidelines within the Pocket Guide to Hydric Soil Field Indicators (WTI, 2006).

Sample Point (SP2) was a typical soil profile for the Site. The soil profile consisted of the top 2 inches of loam with plates of clay that restrict water infiltration (strictures), and flake off at the touch (Attachment A, Photograph 2). The color of the top 2 inches was brown (7.5YR4/4) (MacBeth, 2000). From 2 to 12 inches bgs, the profile changed to a sandy loam with a yellowish-red color (5YR4/6) (MacBeth, 2000). The soil profile did not exhibit hydric characteristics under the guidelines within the Pocket Guide to Hydric Soil Field Indicators (WTI, 2006).

5.0 CONCLUSIONS

The soils identified during the field observations at the Site are consistent with the USDA and NRCS Web Soil Survey (USDA, 2008) literature review. The listed USDA soil series observed at the Site included the Barx, Vananda, Begay, Mikim, and Paradox. Additionally, no hydric soils were observed or identified within the ponded areas or within or near any of the Site's drainage features. Biological soil crust-like structures were observed under the big sage habitat. Biological soil crusts were observed to make up less than five percent of the ground cover on the Site.

6.0 LIMITATIONS

Kleinfelder prepared this report in accordance with generally accepted standards of care that exist in Montrose County, Colorado at this time. This report may be used only by Energy Fuels Resources Corporation and only for the purposes stated. All information gathered by Kleinfelder is considered confidential and will be released only upon written authorization by Energy Fuels Resources Corporation or as required by law. Non-compliance with these requirements by Energy Fuels Resources Corporation or anyone else, unless specifically agreed to in advance by Kleinfelder in writing, will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and Energy Fuels Resources Corporation agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

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