2.04.9 Soils Resource Information

History of Soil Surveys at the West Elk Mine

During the summer of 1976, the soils of the initial West Elk Mine study area (Map 3) were mapped. Throughout the soil survey, mapping units were used to characterize the soils in the mine site area. These survey mapping units were combinations of Soil Families or selected Great Groups and Sub-groups according to the system of soil taxonomy used in the National Soil Program of the United States (USDA 1976).

Subsequent to the 1976 mapping, the Soil Conservation Service (now called the Natural Resources Conservation Service) mapped the soil on private, state, and BLM lands (SCS 1981) providing soil descriptions based on soil series, soil associations, and soil complexes. Then in 1993, the soils of the Gunnison National Forest within the permit area were mapped following criteria and descriptions contained in the Soil Conservation Service soil survey of the Paonia, Colorado area (SUDA-SCS, 1981). Any discrepancies in soil mapping units can be attributed to the change in soil classification nomenclature during the time between the mapping efforts.

The 1976 survey was a general reconnaissance of study area soils. The mapping units were broad in concept and the level of cartographic detail represented in the original mapping was designed with regard for the rough, mountainous topography of the survey area.

A baseline soils study was conducted in October 1995 for the Refuse Pile Expansion (RPE) area. Soil sampling was performed in accordance with Rules 2.04.9 and 4.06, and current recommended soil sampling methods. This report is included in Exhibit 70, Appendix M.

The current soil survey presents general mapping of soil series and associations based on aerial photography, vegetation types, and field reconnaissance. The maps provide a general overview of the soils in and adjacent to the permit area. Characteristics of soil series which occurred or may occur in the disturbed areas are discussed in detail below.

In 1980, a 1st Order soil survey was conducted on the affected area. The West Elk Mine site 1st Order soil survey was based on a 3rd Order survey of the Paonia area performed by the SCS in 1974. A representation of the SCS mapping of the West Elk Mine surface facilities area and the upper refuse disposal area is shown on Figure 15. It is most probable that the SCS delineation of mapping unit boundaries is based only on vegetation cover and gross topographic changes and does not reflect the intensive field checking that was performed during the 1st Order survey described below.

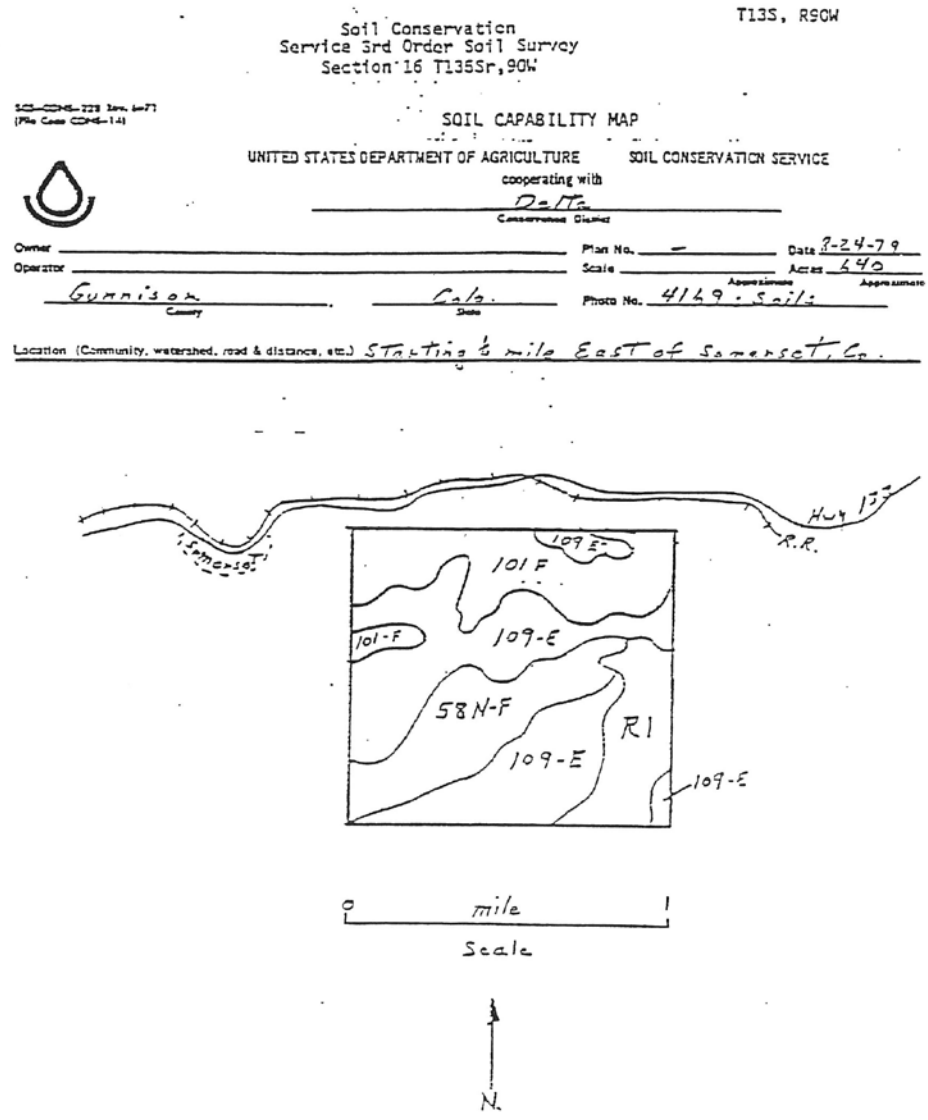

Figure 15 SCS Soil Mapping for Section 16, T13S, R90W

The West Elk Mine site soil survey map was prepared during a two-day field effort. During this period, the entire survey area was thoroughly traversed and transected to determine the location of mapping unit boundaries. Some 12 observation holes were augered to verify and determine the soil series present. In addition many surface horizon checks were made during the survey. Aerial photographs were used to prepare the soil survey map.

Although, included in the original soil surveys for the mine site, a more detailed baseline soil investigation of the Sylvester Gulch Facilities Area was completed in July and October of 1996. A more detailed soil investigation was needed as the original survey did not anticipate surface disturbance. This baseline soils investigation is provided in Exhibit 27A.

A current description of the soil series and associations within and adjacent to the permit area is found in Exhibit 27 through Exhibit 29.

Mapping Units

Twenty-three mapping units were identified in the West Elk Mine study area during the original 1976 soil survey. Characteristics of each unit are summarized in Exhibit 27. The distribution of current SCS and USFS mapping units is shown on Map 40. Table 21 addresses the suitability of the mapping units for reclamation. Due to changes in mapping unit description and nomenclature in the soil surveys from 1976 to 1994, cross-referencing and clarification was necessary. Table 22 identifies and correlates map units from the 1976, 1980 and current soil surveys.

Four of the SCS's mapping units occur in the disturbed surface areas. Mapping unit number 31 came before the current SCS mapping unit number 2 - Absarokee - Work loams; mapping unit number 6 came before the current SCS mapping unit number 13 - Beenom-Absarokee Association. Two of the original mapping units, numbers 27 and 400, also occur on the plant site in the S Section 9, T13S, R90W, but due to current mining activity on mapping unit number 27 and the rocky nature of mapping unit number 400, it is highly unlikely that any topsoil stripping will occur in these areas. Field verification of soils information will be conducted prior to construction. If areas of suitable seedbed material are encountered in mapping unit numbers 27 and 400, they will be stockpiled.

The SCS soil mapping units are described in Exhibit 28.

Soil Sampling and Analysis

1976 Soil Survey

Soil analyses were made by the Soil Survey Laboratory, Colorado State University, Fort Collins, Colorado on samples taken from the predominant soils in each of the mapping units during the 1976 soil survey. Only the most predominant and the most representative components of each unit were sampled. The samples taken were composite samples of all the soil horizons occurring in the upper 16 inches of the soil at the sample sites. Exceptions were soils of mapping unit numbers 1, 6, X6, and X38. Mapping unit numbers 1, 6, and X6 are predominately shallow soils. In these units the composite sample was from the surface to the top of the bedrock. Mapping unit number 38 is a deep forested soil and the composite sample was of the upper four feet. The samples represent an average of conditions within the zone of maximum rooting of the most important components of each mapping unit and are not specific for any one major soil horizon. Exhibit 26 presents the results of soil analyses conducted on the original 1976 mapping units for the West Elk Mine study area.

1980 Soil Survey

During the 1980 survey, soil samples were collected for analysis in those instances where substantial areas of soil were mapped or when there was a question as to the relative suitability of the mapping unit.

Soils were sampled and described by exposing the solum with a shovel and then sampling below this point with a bucket auger. Samples were collected by soil horizon to that depth at which soils appears suitable for topsoiling material. If this depth was questionable, samples were collected below the depth in question to determine the chemistry of this material. Soil sample locations are indicated on Map 41.

Samples were collected on August 20 and 21, 1980. Analysis was performed upon submittal to Energy laboratories, Billings, Montana on September 11, 1980, using procedures specified by the Wyoming Department of Environmental Quality. Exhibit 30 contains analytical results for those soils sampled on the survey area.

General Limitations for Use: Permit Area

A brief summary of some of the major soil limitations, or lack of them, follows:

Salinity and Sodium Concentration

No mappable field evidence of detrimental accumulations of sodium or other soluble salt within the normal root zones of plants high enough to affect the morphology of the soils was found. Localized evidence was found of some detrimental sodium concentration around small seeps in areas of mapping unit 5 located in Sections 8 and 17, Township 14S, Range 90W. This was confirmed by an analysis of one such area which showed the soil to have 52 percent exchangeable sodium (refer to Analysis Sample No. 179 in Exhibit 26); however, this applied to the very limited area around a few seeps. Since these observations and results are within the general area but are outside the mine area, it is unlikely that they will be involved in any direct mining or reclamation operation.

Calcium and Magnesium Carbonate Concentrations

Most of the soils of the study area do not have horizons of secondary carbonate accumulation. Units 16, 17, and 33 have such horizons but with the possible exception of unit 33, the genetic concentration of carbonate is small to moderate. Calcium carbonate equivalents in units 16 and 17 range from about 4 to 15 percent with an average estimated to about 8 percent.

Under normal circumstances the genetic concentration of carbonates occurs below the zone of maximum rooting and has little or no effect on the soil's fertility. Some depression in available phosphate might result if this material would constitute the bulk of the root zone through disturbance. If these materials were mixed with other soil materials, as would be the case if they were transported to other locations and used for new seedbeds, the concentration of carbonate would be diluted to the point where it would have little or no effect on fertility of common plants.

Table 21 Summary of the Suitability of West Elk Mine Soils as Seedbed Material

Mapping Unit	Good	Moderate	Poor
1			X
4	X		
5		X	
6		X	
X6		X	
16	X		
17		X	
18			X
20			X
X25	X		
26	X		
X26	X		
27	X		
30	X		
X30	X		
31		X	
X31		X	
X32			X
33			X
X38		X	

Texture

The high clay content of the soils of units 5, 31, X31, and X32 with their large shrink/swell ratios poses a serious limitation to their use. Unit X32 is particularly limited in this respect. It has the highest clay content and widest shrink/swell of any mapping unit in the survey.

The soils of units 5, 31, and X31 are considered marginally usable for revegetation. Seedbeds in these soils can be established with some difficulty but can be worked successfully only over a narrow range of soil moisture. They would require careful management if used for revegetation purposes. Unit X32 is considered unsatisfactory for seedbed material and would require very careful preparation if soils of this unit are to be revegetated, even in their undisturbed condition.

Table 22 Original and Current Soil Classification Designations, West Elk Mine Correlating 1976, 1980, 1993, and 1994 Mapping

Original* Map Unit	1980** Map Unit	Current Map Unit(s)	Agency Designation	Soil Classification	Soil Series or Association
1		226	SCS, USFS		Herm-Fughes-Kolob complex
		230	SCS, USFS	Haploborolls-Ustochrepts-Rock outcrop	
4		75	SCS	Torriorthents-Rock outcrop, sandstone	
5		Outside permit boundary	SCS		
6		13	SCS		Beenom-Absarokee association
		226	SCS,USFS		Herm-Fughes-Kolob complex
		250	SCS, USFS		Cerro-Herm complex
X6		222	SCS,USFS		Wetopa-Wesdy complex
		226	SCS,USFS		Herm-Fughes-Kolob complex
16		Outside permit boundary			
17		Outside permit boundary			
18		Outside permit boundary			
20		302	SCS,USFS	Cumulic Haploborolls	
X25		39	SCS		Fughes loam
		225	SCS,USFS		Herm-Fughes complex
26		229	SCS,USFS	Cryochrepts-Cryoborolls-Rubble	
X26		220	SCS,USFS		Taterheap-Papaspila complex
		229	SCS,USFS	Cryochrepts-Cryoborolls-Rubble	
27		17	SCS		Breece loam
30		229	SCS,USFS	Cryochrepts-Cryoborolls-Rubble	
X30		222	SCS,USFS		Wetopa-Wesdy complex
		226	SCS,USFS		Herm-Fughes-Kolob complex
31		39	SCS		Fughes loam
		226	SCS,USFS		Herm-Fughes-Kolob complex
X31		2	SCS		Absarokee-Work loam
X32		226	SCS,USFS		Herm-Fughes-Kolob complex
		240	SCS,USFS		Coberly-Falcon, dry complex
33		Outside permit boundary			
X38		220	SCS,USFS		Taterheap-Papaspila complex
200		75	SCS	Torriorthents-Rock outcrop, sandstone	

Table 22 (Continued) Original and Current Soil Classification Designations, West Elk Mine Correlating 1976, 1980, 1993, and 1994 Mapping

Original* Map Unit	1980** Map Unit	Current Map Unit(s)	Agency Designation	Soil Classification	Soil Series or Association
300		17	SCS		Breece loam
400		74	SCS	Torriorthents-Hoplargids complex	
	109E	2	SCS		Absarokee-Work loam
	101F	13	SCS		Beenom-Absarokee association
	58N-F	39	SCS		Fughes loam
	R1	75	SCS	Torriorthents-Rock outcrop, sandstone	
	200	2	SCS		Absarokee-Work loam
		221	SCS,USFS		Taterheap-Papaspila complex
		230	SCS,USFS	Haploborolls-Ustochrepts-Rock outcrop	
	400	Disturbed area			
		2	SCS		Absarokee-Work loam
		6	SCS		Beenom-Absarokee association
		13	SCS		Beenom-Absarokee association
		17	SCS		Breece loam
		31	SCS		Absarokee-Work Fughes loam
		38	SCS		Fughes loam
		39	SCS		Fughes loam
		41	SCS		Fughes-Curecanti stony loam
		67	SCS	Rock outcrop	
		74	SCS	Torriorthents-Haplargids complex	
		75	SCS	Torriorthents-Rock outcrop, sandstone	
		83	SCS		Work loam
		200	SCS	Rock outcrop, Torriorthents	
		202	USFS	Rock Outcrop	
		210	SCS,USFS	Torriorthents, cool-Rock outcrop	
		212	SCS,USFS		Hayrack-Muggins-Nutras complex
		220	SCS,USFS		Taterheap-Papaspila complex
		221	SCS,USFS		Taterheap-Papaspila complex
		222	SCS,USFS		Wetopa-Wesdy complex

Original* Map Unit	1980** Map Unit	Current Map Unit(s)	Agency Designation	Soil Classification	Soil Series or Association
		225	SCS, USFS		Herm-Fughes complex
		226	SCS,USFS		Herm-Fughes-Kolob Family complex
		227	SCS,USFS		Broad Canyon-Scout Family complex
		229	SCS,USFS	Cryochrepts-Cryoborolls-Rubble	
		230	SCS,USFS	Haploborolls-Ustochrepts-Rock outcrop	
		236	USFS		Shawa-Sandia Family-Kolob Family complex
		240	SCS,USFS		Fughes-Curecanti stony loam
		250	SCS,USFS		
		302	SCS,USFS	Cumulic Haploborolls	

* Original map designations from 1976 survey.
** Additional map units from 1980 survey.

Drainage

Most of the soils of the study area are well drained. Only units 20 and 27 have any limitations in this regard and both occur over very small acreage. Unit 20 in its natural state is poorly to somewhat poorly drained with water tables at or within two feet of the ground surface most of the year. Its degree of drainage is poor enough so that it influences the type of native vegetation. It is an important factor in regulating stream flow in the late summer months and as sources of water for wildlife.

Flood Hazard

Units 20, 26, X26, 27, and 300 are particularly susceptible to frequent overflow. Most of the other soils of the area may at times of heavy rainfall receive some runoff, but flood waters concentrate in areas of the units listed above making them particularly susceptible to flood damage.

Units 20, 26, and X26 occur on the floor and sides of small upland drains and smaller streams where excess water from surrounding slopes concentrates in periods of intense runoff. Units 27 and 300 occur on the floodplains of the North Fork of the Gunnison River. Though annual flooding of these areas no longer occurs due to upstream dams, some flood damage potential still exists.

Mass Movement

Some soils on steep slopes of the West Elk Mine study area are subject to some mass movement. However, these soils are not associated with the location of surface facility foundations. Such movement is difficult to predict, however, and usually is triggered by some changes in groundwater movement.

It should be emphasized that the following soil units have the potential for mass movement. Moreover, not all areas mapped as a given unit have the identical potential. Thus unit 31 on a five

percent slope may be very stable whereas the same unit on a 30 percent slope may have a considerable potential to slide.

From the standpoint of soil character alone, the soils of units 5, 17, 30, X30, 31, X31, and X32 have the greatest potential for mass movement. Units 30 and X30 have the lowest potential and have been listed primarily because in some landscapes they tend to be finer textured in the lower solum and C horizon than would be anticipated by their family classification which is based on a weighted average of the B2t horizon.

Soil Productivity

In their natural undisturbed state, most of the soils of the area are suitable for growing natural vegetation. Natural fertility decreases with depth in most soils of the area and is not adequate for vigorous growth in the lower solum and C horizons. Even though natural fertility seems to be adequate in the upper horizons of many soils, it is believed that some supplemental fertilization should be applied to all seedbeds to insure the best possible growth during early states of reclamation.

The soils of the area have moderate to strong grades of natural soil structure. The preservation of as much of the soils' original structure as is possible during the disturbance, transportation and redistribution of these earths is considered an important management goal in all of the soils and is extremely important in the use of some of the finer textured ones.

The productivity and capability of each mapping unit to support a variety of uses can be related directly to that soil's suitability as a topsoil material. Table 23 and the mapping unit descriptions provide such information for each unit.

Quantitative Soil Analysis

Table 23 is a breakdown of the soil occurring on the survey area and an assessment of their topsoiling suitability, stripping depth, and general limitations. Average topsoil stripping depths are based on the depth of material appearing suitable for topsoiling material when holes were augered during mapping.

Table 23 Summary of Topsoil Suitability and Availability on the West Elk Mine Affected Area

Mapping Unit	General Suitability	Average Depth of Topsoil (inches)	Soil Texture	Limiting Factors
Work (83)	Good	6	l-cl	Clay texture below 6”
Fughes (39)	Fair	20	cl-c	Clay texture below 20”
Beenom (13) –Absarokee	Fair	10	cl	Coarse fragments below 10’
Absarokee (2) –Work	Fair	30	cl-c	Clay texture lower part of solum
Torriorthents (75)	Poor-fair	Variable	scl	Rock fragments

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