APPENDIX 7-39

EROSION CALCULATION METHODOLOGY, BLIND CANYON WATERSHED

7-39.1.0 INTRODUCTION

The study referenced in Section 7.42.2 is designed to aid in determining the effects of retreat-mining produced subsidence on overlying watersheds. Specifically, this study investigates the effects of subsidence on erosion within the overlying Blind Canyon watershed. The portion of the Blind Canyon watershed investigated is State Section 36 in T15S-R6E, which is contained within the Manti-La Sal National Forest. Modeling of the pre- and post-mining erosion rates has been completed and appears in Appendices 7-27 through 7-37. Appendix 7-38 calculates Blind Canyon channel erosion and the potential cumulative erosion of the drainage in Section 36. This appendix presents the methodology used in determining the pre- and post-mining erosion rates and sediment production. Genwal Coal has committed to funding and partaking in a U.S.F.S. Intermountain Research Station Study (Appendices 7-25 and 7-26) to conduct a study to monitor the actual effects of mining in Utah State Section 36. Due to the inability to perform sediment control measures within the Blind Canyon drainage for fear of influencing the U.S.F.S. Intermountain Research Project, Genwal Coal has committed to provide the Manti-La Sal National Forest with ten thousand dollars to perform sediment control measures at other sites within the Manti-La Sal National Forest that the Forest Service has determined would be aided by the implementation of sediment control measures. This sediment control enhancement procedure would control an equal or greater amount of sediment that could theoretically be delivered to the Manti La-Sal National Forest from Utah State Section 36.

This U.S.F.S. Intermountain Research Station's investigation serves as part of a continuing study of the effects of subsidence on overlying watersheds. The Research Station will conduct hydrologic investigations of the Blind Canyon watershed prior to, during, and following subsidence. Studies conducted by the Research Station will be aided by subsidence monitoring, and water quality/quantity data collection conducted by Genwal Coal Company. In addition, to assess effects of subsidence on erosion, Genwal Coal Company has performed pre- and will conduct post-subsidence erosion calculations for Section 36 for ten years starting in 1992.

Erosion magnitudes were obtained using United States Forest Service erosion loss calculations (Tew, 1973), and a computer model (SEDROUTE) obtained from the Manti-La Sal National Forest (Kelly, 1976). Discussions with Dennis Kelly as well as a SEDROUTE user's guide, and examples of how Dennis Kelly has used SEDROUTE in other sites proved invaluable in applying SEDROUTE. In general, SEDROUTE takes soil loss data and calculates the amount of sediment yield within a watershed. Inputs into erosion calculations include, land types (and their respective curve numbers), vegetation types, and soil types (inherent soil erodibilities). Many of these integral data inputs into the erosion calculations were provided by personnel from the Manti-La Sal National Forest. The variability of scales, and the large scales of the data obtained from the Manti-La Sal National Forest necessitated rescaling the above-mentioned data to a scale with which representative land types could be delineated. As a result, composite land types for the Blind Canyon watershed were delineated. The mapped Manti-La Sal National Forest land types, vegetation, and soil data served as the base upon which the composite land types were delineated. Plates 7-8 and 7-10 show the Manti-La Sal Forest vegetation, soil, and land type boundaries, as well as the composite land type boundaries. Eight composite land types, numbered one through eight were delineated within Section 36.

SEDROUTE erosion calculations were added to worst-case erosion conditions that could occur in the Blind Canyon stream drainage. A pre- and post-mining profile of the Blind Canyon drainage appear in Plate 7-11. Calculations of stream bed erosion that may occur are found in Appendix 7-38.

7-39.2.0 EROSION CALCULATION METHODOLOGY

Tew (1973) provides soil loss rates via a nomograph beginning with inherent soil erodibility, and progressing through rainfall factor, percent slope, percent ground cover, and percent crown cover, to yield a soil loss rate in inches per year for each land type. The soil loss rate for each land type is then inputted into SEDROUTE, to yield an annual sediment yield rate in acre-feet.

An integral step in calculating projected magnitudes of erosion that may occur as a result of subsidence is to determine the magnitude of subsidence, and the resultant change in slope of the overlying composite land types. To determine subsidence magnitudes, TerraTek Research Company was contracted by Genwal to determine subsidence magnitudes in the Blind Canyon Watershed. Modeling was conducted using a Boundary Element Model (BEM), Finite Element Model (FEM), as well as comparisons with actual subsidence magnitudes that have occurred and previously been quantified at Genwal Coal Company's Crandall Canyon Mine, and the neighboring Deer Creek Mine (TerraTek, 1993). The TerraTek subsidence modeling results appear in Appendix 7-40. Due to the liberal nature of the subsidence magnitude results produced by the FEM (TerraTek, 1993), the FEM subsidence results were used to assess subsidence magnitudes. Subsidence transects and the magnitudes of subsidence appear on Plate 7-9.

7-39.2.1 Soil Loss Determination

7-39.2.1.1 Inherent Soil Erodibility

Inherent soil erodibilities for each composite land type were obtained by calculating a weighted average soil erodibility. Soil erodibilities were obtained from the soil data provided by the Manti-La Sal National Forest. Manti-La Sal National Forest soil data appears in Appendix 7-27. Soil erodibility calculations appear in Appendix 7-28.

7-39.2.1.2 Rainfall Factor

The rainfall factor for the entire area encompassing the Blind Canyon Watershed is 0.045 (Tew, 1973).

7-39.2.1.3 Percent Slope

Both pre- and post-subsidence percent slopes for each composite land type were determined. Subsidence magnitudes (see Appendix 7-40 and Plate 7-9) were used to determine the post-mining percent slope of each composite land type. Land slopes were obtained for each composite land type using method seven as outlined by the Water Resources Bulletin (Chang et al, 1989). Pre- and post-mining percent slope calculations for each composite land type are found in Appendix 7-29

7-39.2.1.4 Percent Ground and Crown Cover

Weighted averages of both percent ground and crown cover were calculated from vegetation date provided by the Manti-La Sal National Forest (Appendix 7-30). Weighted averages for the composite land types were calculated for both percent ground and percent crown cover. Appendix 7-31 contains weighted percent ground and crown cover calculations.

7-39.2.1.5 Soil Loss Nomograph

Nomographs (Tew, 1973) of inherent soil erodibility, rainfall factor, percent slope, percent ground, and crown cover, yielding soil loss rates (inches/year), were plotted for each composite land type. The pre- and post-mining nomographs appear in Appendices 7-32 and 7-33, respectively. A table summarizing and comparing the pre- and post-mining soil loss calculations appear at the end of Appendix 7-33.

7-39.2.2 SEDROUTE

Weighted average runoff curve numbers for each composite land type were calculated using the curve numbers of the Manti-La Sal National Forest land types. Manti-La Sal National Forest land types appear in Appendix 7-34 and on Plate 7-8. The runoff curve numbers associated with each Manti-La Sal National Forest land type were provided by the Forest Service. Calculations of the weighted runoff curve numbers for the composite land types appear in Appendix 7-35.

7-39.2.2.1 Stream Channel Density

Stream channel density, defined as the stream channel length (miles) divided by the area (square miles) of each composite land type were calculated. Calculations of stream channel density are found in Appendix 7-36. Plate 7-10 shows the drainages in each land type.

7-39.2.2.2 SEDROUTE Calculations

For each of the eight composite land types the following data were entered into the SEDROUTE program: land type number, area (acres), runoff curve number, erosion rate (IN), percent slope, and stream channel density (MI/SQ MI). SEDROUTE then calculated annual erosion (AC FT), pollution hazard index, delivery coefficient (%), sediment yield rate (IN/YR), and annual sediment yield rate (AC/YR).

Appendix 7-37 contains pre- and post-mining SEDROUTE outputs. The difference in pre- and post-mining SEDROUTE outputs is 0.006 AC-FT.

2-39.2.3 STREAM BED EROSION CALCULATIONS

A pre- and post-mining profile of the Blind Canyon drainage appear in Plate 7-11. Worst case calculations of stream bed erosion that may occur are found in Appendix 7-38. The vertical amount of subsidence is used to obtain the vertical amount of erosion that may occur in the drainage channel. Channel width and side slopes equal to those currently present are used as the conditions present after mining. The volume of material within the potential downcut drainage is calculated. This calculation is reduced by the amount of gravel material present in the downcut volume of soil that is coarser than gravel (Soil Taxonomy, 1975). The estimate of the percent of coarse material was obtained from the Manti-La Sal soil surveys of the area to be subsided. In calculating the amount of material too coarse to be transported, worst-case values of the Manti-La Sal Forest Service data was used. No downcutting and hence erosion is calculated in channel reaches where the stream is flowing directly on bedrock (Plate 7-11) (personal communication, Dennis Kelly).

7-39.2.4 DISCUSSION

As discussed in Appendix 7-40 and shown on Plate 7-9, the maximum subsidence occurs where the overburden is greatest. Consequently the magnitude of subsidence over the ridges (maximum 40.3 inches) is greater than that at the lower stream drainage elevations (minimum 16 inches). In general the south-slope of Blind Canyon is somewhat flattened, while the north-slope remains unaltered. As a result, the percent slopes of the vast majority of the composite land types remains constant or decreases.

The percent slope of the land types is the only parameter that changes as a result of retreat produced subsidence in the calculation of soil loss (Appendix 7-29). Of the eight composite land types, the percent slopes remained constant in four, decreased in three, and increased in only one. The three land types that exhibit a decrease in percent slope, experience minor reductions. Land type eight experiences an increase of 5.9%. This increase in the percent slope of land type eight can be partially attributed to the absence of a subsidence modeling transect in the western third of section 36, where the overburden and expected subsidence magnitude is expected to be greatest.

Comparison of the pre-and post-mining SEDROUTE erosion calculations for the Blind Canyon Watershed reveal an increase in annual sediment yield of only 0.006 acre-feet. Worst-case stream channel erosion is 0.44 acre-feet of sediment, yielding a total of 0.446 acre-feet of potentially erodible material that could result from retreat mining of State Section 36. As a worst-case estimate, the amount of material that could enter the Manti-La Sal National Forest Service lands from State Section 36, the entire volume is assumed to be transported down the drainage onto Forest Service land. Genwal commits to providing the Manti-La Sal National Forest with ten thousand dollars to mitigate this or a greater volume of sediment.