CHAPTER 22

MINESOIL RECONSTRUCTION

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CHAPTER 22

MINESOIL RECONSTRUCTION

Introduction

This chapter outlines Peabody Western Coal Company's (PWCC) plan for reconstructing mined-land soils and spoil at Black Mesa and Kayenta mines. The plan addresses those reclamation activities that are conducted following the completion of backfilling and grading (Chapter 21) and prior to revegetation (Chapter 23). The objective of the plan is to reconstruct a plant growth medium that is capable of supporting the postmining land uses. The plan objective is achieved by ensuring a minimum of four feet of suitable plant growth material, which includes twelve inches of soil (except for 1- steep slope, cultural planting, key habitat, and main drainage channel reclamation areas where supplemental surface plant growth media or residual soils may be used in the 0 to 1 foot increment to establish certain substrate-specific species, create wildlife habitat, and provide erosionally stable landscapes; 2- pre-permanent program facilities and reclamation areas where six inches of soil replacement were approved by Permit AZ-0001; and 3- N-11 reclamation area where 8 to 9 inches of soil are available for replacement), exists on the surface of graded lands prior to the commencement of revegetation activities. The plan presents an account of the plant growth material requirements based upon current and projected disturbance acreages, and plant growth material availability based on stockpiled material, soil depth mapping, and near-surface overburden assessments. The plan also describes the procedural aspects of removal, storage, and redistribution of soil materials and soil supplements, and testing of spoil material.

For the purpose of this presentation, soil material is defined as suitable topsoil and subsoil proved up in the soil resources studies (Chapter 8). Supplemental material is defined as suitable overburden and spoil. Supplemental surface plant growth medium is defined as suitable overburden and spoil utilized to establish the 0 to 1 foot increment of special reclamation areas including cultural plantings, key habitats, main drainage channels, and steep slopes. Supplemental surface plant growth medium includes native soils, many of which are classified as residual with a high coarse fragment content (e.g., red rock suitable overburden material that is oxidized, fractured, and weathered (scoria)). Toxic- and potentially toxic-forming materials are defined as spoil which could adversely affect plant growth or contribute to toxic levels of elements or compounds in above ground plant parts.

Toxic-forming and potentially toxic-forming materials were identified in the overburden assessment (Chapter 8). Because of the existence of multiple coal seams and non-uniform parting thickness, extreme variability in the lateral and vertical extent of unsuitable overburden strata, and economic considerations, routine special handling of these materials is not feasible. Therefore, PWCC maintains a mined-land soil reconstruction plan that involves handling soil material and suitable supplements rather than potentially toxic or toxic-forming materials. The intent is to identify areas of graded spoil that exhibit unsuitable characteristics and bury them with adequate amounts of the best available suitable materials.

Over the past 15 years, PWCC has developed a site-specific soil, spoil, and overburden sampling program to accurately maintain a dynamic inventory of plant growth material requirements and availability. This program is based upon the sampling of graded spoil to determine how much topsoil, residual soil, supplemental material, or supplemental surface plant growth medium will be needed prior to revegetation. The suitability and approximate volume of available soil material (in storage and in-place) is known. The suitability and estimated volumes of suitable supplements, including residual soils is also known. Overburden and spoil piles are occasionally sampled to further delineate the volumes and locations of supplements. This sampling program allows PWCC to track the availability of both soil material and supplemental material on an ongoing basis. The program enables PWCC to determine the amount of material needed prior to revegetation via the graded spoil sampling plan, and where to obtain the material.

PWCC removes and stores available soil material in sufficient quantities needed to cover all disturbances (with exception of special reclamation areas, the N-11 mining area, and interim program disturbance areas) with twelve inches of soil. After grading is completed for a given unit of grading advance, a graded spoil sampling program is used to identify the volume of soil, soil supplements, supplemental surface plant growth medium, or residual soil needed in the area to bury unsuitable spoils. Soil and soil supplements (if needed) are then salvaged and redistributed on the basis of the graded spoil sampling results. The collection of ongoing sampling data to identify both unsuitable graded spoils and suitable soil supplements enables PWCC to maintain a dynamic inventory of available (in stockpile and in-place) and required plant growth material. These inventories are updated and balanced no less than once annually. In this manner, an adequate inventory of suitable plant growth media is maintained to meet reclamation requirements prior to revegetation.

Plant Growth Media Requirements and Availability

This section presents an estimate of the volume of plant growth material that is required and available for reclamation. The accounts consider both the current and future requirements and availability because the Black Mesa mining complex has been in operation for several years. Soil and supplemental material availability is considered first, followed by the requirements.

Soil in Stockpiles. Tables 3 thru 9 presented later in this chapter, list the total estimated volume of soil material in stockpile as of January 1, 2002. The storage volumes are sub-totaled by each active mining area and individual stockpile in the Reclamation Status and Monitoring Report submitted to OSMRE annually. Terra-Matrix Montgomery Watson used cross-sectional area survey techniques in August 1997 to determine soil volumes for stockpiles. Subsequently, volume changes have been updated using scraper load count information. The estimated volume of material in storage as of January 1, 2002 is 6,651 acre-feet. Stockpile locations are shown on the Mine Plan Map, Drawing 85210.

Near-Surface Overburden. An assessment of the near-surface overburden is performed to identify suitable material in each active mining area and future development areas should it be needed as soil material supplements. This assessment is performed using the physical and chemical analysis results on the shallow and deep overburden cores drilled in each mining area (see Appendix B, Volume 12). Table 1 presents the results of the assessment of near-surface overburden that meets the limits for suitable supplemental material. Suitability criteria, presented later in Table 11 of this chapter, are used for the near-surface overburden assessments. Table 2 presents the estimated volumes of suitable near-surface overburden available in each mining area for reclamation. The volumes represent sources of soil supplements that can be used to bury unsuitable graded spoils. The volumes were derived from the average depth data given in Table 2, and the acreages of the mining blocks and coal resource areas in each mining area, delineated on Drawing 85210, Mine Plan Map, remaining to be excavated as of December 15, 2003.

Projected Soil Salvage. Projected soil salvage areas and volumes for the remaining life-of-mine by mine area are determined as follows. Individual soil map units (Drawings 85305A and [illegible]) to be disturbed by mining activities are digitized and placed into an ArcInfo GIS database to determine the total affected area. The projected soil disturbance

TABLE 1

Evaluation of Near-Surface Overburden for

Suitable Soil Supplements

Mining Area	Core Number[1]	Depth of Suitable Material ft[2]	Criterion Out of Range[3,4]
J-7	23154-C	11.0	Clay>45%
	23156-C	11.6	Lost Sample
	23158-C*	4.0	Lost Sample
	Average	8.9	
J-19	24407-C*	29.3	ABP<-5
	24418-C	22.0	Coal
	24419-C*	111.5	Coal
	24420-C*	54.3	SAR>20
	24423-C	0.0	Clay>45%
	26275-C	8.0	ABP<-5
	26276-C	24.0	Clay>45%
	26277-C*	20.0	None
	26287-C	14.0	pH<5.5
	26371-C	2.0	Clay>45%
	26372-C	18.0	pH<5.5
	26373-C	20.0	pH<5.5
	26374-C	18.0	Coal
	26469-C	10.0	Clay>45%
	26483-C	2.0	pH<5.5
	26484-C	4.0	pH<5.5
	26485-C	30.0	None
	26486-C	10.0	Lost Sample
	26487-C	28.0	pH<5.5
	26488-C	2.0	ABP<-5
	26489-C	0.0	ABP<-5
	26495-C	30.0	None
	26496-C	10.0	Clay>45%
	Average	20.3	
J-21	24405-C*	0.0	Clay>45%
	24412-C*	19.9	pH<5.5
	24413-C	9.5	pH<5.5
	24415-C*	18.6	pH<5.5
	24416-C*	14.8	Coal

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TABLE 1 (Continued)

Evaluation of Near-Surface Overburden for

Suitable Soil Supplements

Mining Area	Core Number[1]	Depth of Suitable Material ft[2]	Criterion Out of Range[3,4]
J-21	24417-C*	10.4	pH<5.5
	26280-C*	12.0	pH<5.5
	26286-C	20.0	Clay>45%
	26288-C	4.0	pH<5.5
	26289-C	0.0	Clay>45%
	26377-C*	20.0	pH<5.5
	26384-C*	4.0	Clay>45%
	26385-C*	14.0	pH<5.5
	26386-C	14.0	Clay>45%
	26387-C	22.0	SAR>20
	26388-C*	8.0	Clay>45%
	26493-C	30.0	None
	26494-C	8.0	Clay>45%
	26497-C	8.0	Clay>45%
	Average	12.5	
N-6	23166-C*	0.0	Clay>45%
	24093-C*	6.9	pH<5.5
	24094-C*	29.6	pH<5.5
	24095-C*	14.8	pH<5.5
	24099-C	0.0	Clay>45%
	24400-C*	21.4	Coal
	24401-C	28.0	Ses>0.26ppm
	24402-C	0.0	Clay>45%
	Average	12.6	
N-11	26272-C	0.0	pH<5.5
	26364-C*	28.8	pH<5.5
	26463-C*	42.7	Coal
	Average	23.8	

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TABLE 1 (Continued)

Evaluation of Near-Surface Overburden for

Suitable Soil Supplements

Mining Area	Core Number[1]	Depth of Suitable Material ft[2]	Criterion Out of Range[3,4]
N-9	30355EO	30.2	Coal
	30356EO	12.9	pH<5.5
	30357EO	26.2	Coal
	30358EO	72.4	ABP<-5
	Average	35.4	
N-99	30351EO	75.0	pH<5.5
	30352EO	26.1	pH<5.5
	30353EO	56.0	ABP<-5
	30368EO	56.5	ABP<-5
	30369EO	40.0	pH<5.5
	30370EO	56.4	Coal
	30381EO	24.8	pH<5.5
	Average	47.8	

(1) For sample site location, see Drawings 85613 and 85613A, Volume 23.

(2) Asterisked cores are cores where topsoil materials will be salvaged and the probable depths of salvage have been subtracted from the determination.

(3) For overburden analyses, see Appendix B, Volume 12.

(4) Diagnostic criteria and limits for suitable material are based upon maximum threshold limits presented in Table 11 later in this chapter.

TABLE 2

Volumes of Suitable Overburden

Available in the Mining Areas for Reclamation[1]

Mining Area	Mining Disturbance (Acres)	Mean Depth of Suitable Material (ft)	Volume of Suitable Material (ac-ft)
J-7	118	8.9	1,050
J-19	1,991	20.3	40,417
J-21	1,919	12.5	23,988
N-6	612	12.6	7,711
N-9	1,279	35.4	45,277
N-11	82	23.8	1,952
N-99	2,648	47.8	126,574
Total	8,649	28.6	246,969

(1) Mean depths of suitable material are from Table 1. The mining disturbance area for each pit is delineated on Drawing 85210, Mine Plan Map.

boundaries for the life-of-mine area are determined by referencing the Jurisdictional Permit and Affected Lands Map (Drawing 85360). Projected soil volumes are determined by multiplying each affected soil map unit area by the respective mean salvage thickness. The soil salvage thickness, shown on Drawings 85305B and 85305C, are based upon the results of the Order 1 and 2 soil survey presented in Chapter 8. The quantity of soil available for salvage in each pit area is presented in Tables 3 through 10 of this chapter. About 13,961 acre-feet of soil remain to be salvaged (projected soil volume) as of January 1, 2002 in the life-of-mine active mining disturbance areas. About 6,492 acre-feet of soil is available for salvage in the life-of-mine N-9 and N-99 development areas.

Existing Disturbance Areas. The post-law disturbance area, as of January 1, 2002, for the entire Black Mesa mining complex by mining area is presented in Tables 3 thru 9 of this chapter. This acreage represents the current plant growth material liability area for the leasehold. These liability areas include the existing disturbance area surrounding the active pits, non-permanent roads, and facilities. An additional 969 acres at the Black Mesa and Kayenta Mines are under sediment ponds. This acreage is not included in the total soil material liability area because the ponds will be reclaimed and surface-dressed using site-specific materials or retained to compliment the postmine land use (see Chapter 23). The existing dam embankment material, upstream alluvium, and trapped sediments (if they meet the soil suitability criteria) will be used as surface dressing to reclaim the sediment ponds. An additional 363 acres are under existing soil storage piles located on native ground. This acreage is not included in the total liability area because the original ground surface will be re-exposed upon removal of the stockpiles. Lastly, certain proposed permanent roads (278 acres) will not receive any soil because they will be retained for access to residences and grazing lands.

Based upon the redistribution depth requirements in Permits AZ-0002A and AZ-0001D, post July 1990 disturbances at the N-14 and J-16 mining areas, and all disturbances at the J-19 and J-21 mining areas (excluding special reclamation areas) must be covered with a minimum of one foot of plant growth material. A 8- to 9-inch minimum-average replacement thickness of soil is proposed for the N-11 mining area. Based upon the redistribution depth requirement in Permit AZ-0001, all remaining disturbances must be covered with a minimum of 0.5 feet of material. The minimum volume of soil material required for reclamation over the entire liability area is 4,818 acre-feet and there are 6,651 acre-feet of soil stockpiled as of January 2002 (Tables 3 thru 9). Thus, sufficient soil material exists in stockpile to meet all reclamation requirements, as of January 2002, on

TABLE 3

Soil Salvage Volume and Supplemental Plant Growth
Material Disturbance Planning Summaries for the
Black Mesa Mine J-7 Disturbance Area
(As of January 1, 2002)

Disturbance Area Near Existing Pit = 322 acres

The disturbed area includes the advance grubbed and soil removed area, active pit, last two spoil piles, gradable area, ramps, and final graded land. The soil stockpiles (37 acres) and ponds (168 acres) are not included.

Road Disturbance Area = 167 acres

Includes haul roads and the J-7/J-27 Black Mesa roads, but does not include 36 acres of permanent roads (see Drawing 85445).

Facility Disturbance Area = 150 acres

Includes Black Mesa office, shop, and warehouse areas and coal storage areas.

Existing Soil Volume = 502 acre-feet

The volume stored in stockpiles as of January 1, 2002.

Projected Disturbance Area = 104 acres

Projected Soil Volume = 66 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities.

Supplemental Plant Growth Material Volume = 1,050 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Permitted Scoria Pit Area = 304 acres

Includes two separate areas, as shown on Drawing 85360. Disturbed lands will be reclaimed using soil or supplemental plant growth media salvaged from these areas.

Mean Soil Replacement Thickness = 0.76* feet

(568 acre-feet/743 acres)

*The minimum-average replacement thickness of soil at J-7 will be 9 inches. Pursuant to Permit AZ-0001, soil replacement thickness on interim disturbance areas is required to be 0.5 feet or greater.

Soil Required to Reclaim Current Disturbance Area = 320 acre-feet

((322 + 167 + 150) acres X 0.5 feet)

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TABLE 4

Soil Salvage Volume and Supplemental Plant Growth
Material Planning Summaries for the
Kayenta Mine J-16 Disturbance Area
(As of January 1, 2002)

Disturbance Area Near Existing Pit = 1 acre

The disturbed area includes final graded land, but does not include 87 acres of ponds and 11 acres of soil stockpiles.

Road Disturbance Area = 72 acres

Includes haul roads and the adjacent J-16 Kayenta roads, but does not include 18 acres of permanent roads (see Drawing 85445).

Facility Disturbance Area = 34 acres

Includes bucket barn area.

Existing Soil Volume = 105 acre-feet

The volume stored in stockpiles as of January 1, 2002

Projected Disturbance Area = 0 acres

Projected Soil Volume = 0 acre-feet

No additional soil map units will be disturbed by future mining-related activities.

Supplemental Plant Growth Material Volume = 0 acre-feet

If supplemental material is required based on graded spoil analysis, it will be hauled from nearby graded land or an adjacent mine area.

Mean Soil Replacement Thickness = 0.98* feet

(105 acre-feet/107 acres)

* Pursuant to Permit AZ-0001, soil replacement thickness on interim disturbance areas is required to be 0.5 feet or greater.

Soil Required to Reclaim Current Disturbance Area = 105 acre-feet

(1 + 72 + 34 acres X 0.98 feet)

TABLE 5

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the Kayenta Mine

J-19 Disturbance Area (Includes J-19-West)

(As of January 1, 2002)

Disturbance Area Near Existing Pit = 873 acres

The disturbed area includes the advance soil removed area, active pit, last two spoil piles, gradable area, ramps, and final graded land. The soil stockpiles (96 acres) and ponds (166 acres) are not included.

Road Disturbance Area = 194 acres

Includes haul roads, the J-19 Kayenta Mine roads, and 50% of the N-1, N-2, N-7, and N-8 Kayenta Mine roads, but does not include 50 acres of permanent roads (see Drawing 85445).

Facility Disturbance Area = 96 acres

Includes J-28 office, shop, warehouse complex, and 50% of the N-1 and N-7/8 conveyor sections.

Existing Soil Volume = 1,950 acre-feet

The volume stored in stockpiles as January 1, 2002

Projected Disturbance Area = 2,330 acres

Includes entire life-of-mine area.

Projected Soil Volume = 5,541 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities over the life-of-mine.

Supplemental Plant Growth Material Volume = 40,417 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Permitted Scoria Pit Area = 0 acres

No scoria pits are planned outside of the projected pit disturbance area.

Mean Soil Replacement Thickness = 2.02 feet

(7,065 acre-feet/3,493 acres) Replacement thickness has been adjusted for 426 acre-feet of soil that will be exported to the N-14 reclamation area. An excess of 3,572 acre-feet of soil, based on the 1-foot replacement thickness required by Permit AZ-0001D, is available for use as supplemental material.

Soil Required to Reclaim Current Disturbance Area = 1,163 acre-feet

((873 + 194 + 96) acres X 1.0 feet)

TABLE 6

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the

Kayenta Mine J-21 Disturbance Area

(As of January 1, 2002)

Disturbance Area Near Existing Pit The disturbed area includes the advance grubbed and soil removed area, active pit, last two spoil piles, gradable area, ramps, and final graded land. The soil stockpiles (154 acres) and ponds (197 acres) are not included.	=	898 acres
Road Disturbance Area Includes haul roads, the J-21 and J-28 Kayenta Mine roads, and 50% of the N-1, N-2, N-7 and N-8 Kayenta Mine roads but does not include 76 acres of permanent roads (see Drawing 85445).	=	294 acres
Facility Disturbance Area Includes J-21 explosive storage, J-28 coal handling facilities, and 50% of the N-1 and N-7/8 conveyor sections.	=	402 acres
Existing Soil Volume The volume stored in stockpiles as of January 1, 2002	=	2,983 acre-feet
Projected Disturbance Area Includes entire life-of-mine area.	=	2,437 acres
Projected Soil Volume Includes only those soil map units that will be disturbed by mining-related activities over the life-of-mine.	=	7,086 acre-feet
Supplemental Plant Growth Material Volume Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.	=	23,988 acre-feet
Permitted Scoria Pit Area Includes one area as shown on Drawing 85360. Disturbed lands will be reclaimed using soil or supplemental plant growth media salvaged from this area.	=	117 acres
Mean Soil Replacement Thickness (10,069 acre-feet/4,031 acres) An excess of 6,038 acre-feet of soil based on the 1.0 foot replacement thickness required by Permit AZ-0001D, is available for use as supplemental material.	=	2.50 feet
Soil Required to Reclaim Current Disturbance Area ((898 + 294 + 402) acres X 1.0 feet)	=	1,594 acre-feet

TABLE 7

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the

Black Mesa Mine N-6 Disturbance Area

(As of January 1, 2002)

Disturbance Area Near Existing Pit = 874 acres

The disturbed area includes the advance grubbed and soil removed area, active pit, last two spoil piles, gradable area, ramps, and final graded land. The soil stockpiles (33 acres) and ponds (204 acres) are not included.

Road Disturbance Area = 222 acres

Includes haul roads and the J-3/N-6 Black Mesa roads, but does not include 48 acres of permanent roads (see Drawing 85445).

Facility Disturbance Area = 235 acres

Includes Black Mesa Central warehouse, office, and HRC areas, truck storage, explosive storage, J-3 airport, public coal yard, trailer park, and reclamation office.

Existing Soil Volume = 622 acre-feet

The volume stored in stockpiles as of January 1, 2002.

Projected Disturbance Area = 426 acres

Projected Soil Volume = 1,174 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities.

Supplemental Plant Growth Material Volume = 7,711 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Permitted Scoria Pit Area = 140 acres

Includes two separate areas, as shown on Drawing 85360. Disturbed lands will be reclaimed using soil or supplemental plant growth media salvaged from these areas.

Mean Soil Replacement Thickness = 1.02* feet

(1,796 acre-feet/1,757 acres)

*Pursuant to Permit AZ-0001, soil replacement thickness on interim disturbance areas is required to be 0.5 feet or greater.

Soil Required to Reclaim Current Disturbance Area = 655 acre-feet

((874 + 222 + 235) acres X 0.5 feet)

TABLE 8

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the

Kayenta Mine N-11 Disturbance Area

(As of January 1, 2002)

Disturbance Area Near Existing Pit = 511 acres

The disturbed area includes the advance grubbed and soil removed area, active pit, last two spoil piles, gradable area, ramps, and final graded land. The soil stockpiles (32 acres) and ponds (58 acres) are not included.

Road Disturbance Area = 58 acres

Includes haul roads and the N-11 Kayenta roads, but does not include 15 acres of permanent roads (see Drawing 85445).

Facility Disturbance Area = 158 acres

Includes N-11 coal storage area, adjacent conveyors, and CDK yard.

Existing Soil Volume = 489 acre-feet

The volume stored in stockpiles as of January 1, 2002

Projected Disturbance Area = 8 acres

Includes entire life-of-mine area.

Projected Soil Volume = 94 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities over the life-of-mine.

Supplemental Plant Growth Material Volume = 1,952 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Permitted Scoria Pit Area = 53 acres

Includes the area as shown on Drawing 85360. Disturbed lands will be reclaimed using soil or supplemental plant growth media salvaged from this area.

Mean Soil Replacement Thickness = 0.79* feet

(583 acre-feet/735 acres)

*The minimum-average replacement thickness of soil at N-11 will be 9 inches.

Soil Required to Reclaim Current Disturbance Area = 545 acre-feet

((511 + 58 + 158) acres X 0.75 feet)

TABLE 9

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the

Kayenta Mine N-14 Disturbance Area

(As of January 1, 2002)

Disturbance Area Near Existing Pit The disturbed area includes final graded land, but does not include 89 acres of ponds.	=	49 acres
Road Disturbance Area Includes haul roads and adjacent N-14 Kayenta roads, but does not include 35 acres of permanent roads (see Drawing 85445).	=	135 acres
Facility Disturbance Area Includes N-14 explosive storage, lab parking area, and adjacent conveyor areas.	=	242 acres
Existing Soil Volume The volume stored in stockpiles as of January 1, 2002	=	0 acre-feet
Projected Disturbance Area	=	0 acres
Projected Soil Volume No additional soil map units will be disturbed by future mining-related activities.	=	0 acre-feet
Supplemental Plant Growth Material Volume If material is required based on graded spoil analysis, it will be hauled from nearby graded land or an adjacent mine area.	=	0 acre-feet
Permitted Scoria Pit Area Includes three areas, as shown on Drawing 85360. Disturbed lands will be reclaimed using soil or supplemental plant growth media salvaged from these areas.	=	54 acres
Mean Soil Replacement Thickness (0 acre-feet/426 acres) *The maximum projected deficit of 426 acre-feet of soil will be transported from existing J-19 soil storage stockpiles. The actual quantity of soil transported will be less than 426 acre-feet since 1) many conveyor and haulroad sideslopes have already been topsoiled, and 2) pursuant to Permit AZ-0001, soil replacement thickness on interim disturbance areas is required to be 0.5 feet or greater.	=	0.00* feet
Soil Required to Reclaim Current Disturbance Area ((49 + 135 + 242) acres X 1.0 feet	=	426 acre-feet

TABLE 10

Soil Salvage Volume and Supplemental Plant Growth

Material Planning Summaries for the

Kayenta Mine N-9 and N-99 Disturbance Areas

(As of January 28, 2005)

N-9 Disturbance Area

Projected Disturbance Area (Through 2011) = 2,165 acres

Includes entire life-of-mine area including pits, roads, and facilities.

Projected Soil Volume (Through 2011) = 3,299 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities over the life-of-mine.

Supplemental Plant Growth Material Volume = 45,277 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Mean Soil Replacement Thickness (Through 2011) = 1.52 feet

(3,299 acre-feet/2,165 acres) An excess of 1,134 acre-feet of soil, based on the 1.0-foot replacement thickness required by Permit AZ-0001D, is available for use as supplemental material.

N-99 Disturbance Area

Projected Disturbance Area (Through 2011) = 2,375 acres

Includes entire life-of-mine area including pits, roads, and facilities.

Projected Soil Volume (Through 2011) = 3,193 acre-feet

Includes only those soil map units that will be disturbed by mining-related activities over the life-of-mine.

Supplemental Plant Growth Material Volume = 126,574 acre-feet

Supplemental material available for special handling or reclamation of additional facilities based on graded spoil analyses as listed in Table 2.

Mean Soil Replacement Thickness (Through 2011) = 1.34 feet

(3,193 acre-feet/2,375 acres) An excess of 818 acre-feet of soil, based on the 1.0-foot replacement thickness required by Permit AZ-0001D, is available for use as supplemental material.

the leasehold. Excess soil will be used as supplemental material for covering and burying unsuitable spoil.

Projected Disturbance Areas. Tables 3 through 10 present projected disturbance area statistics for the life-of-mine Mine Plan. Approximately 9,845 acres are expected to be disturbed and 20,453 acre feet of soil are projected to be salvaged. This total includes: (1) land to be disturbed for the first time as a result of the life-of-mine Mine Plan; (2) lands disturbed as a result of existing Mine Plans (redisturbance); and (3) pre-December 16, 1977 land disturbance that will be redisturbed. By dividing the total volume of soil to be salvaged by the projected disturbance area, it can be seen that 2.1 feet of soil is available for future reclamation purposes on the leasehold. When the volumes of suitable soil supplements are considered (Table 2), it can be seen that a sufficient amount of suitable plant growth media is available to reconstruct mined-land soils that meet the objectives of the minesoil reconstruction plan.

Plant Growth Material Summaries by Pit Area. Tables 3 through 10 present soil and supplemental plant growth material planning summaries for each respective mining area. The tables present: (1) volume of soil material in storage; (2) the projected soil salvage areas and soil volume for the remaining areas to be disturbed; (3) existing disturbance areas, including roads and facilities, requiring soil replacement; (4) excess soil available for use as supplemental material; (5) mean soil replacement thickness values; and (6) supplemental plant growth material volumes (from Table 2). The information given in the tables demonstrates that adequate plant growth materials are available, and will be salvaged and replaced to achieve reconstructed minesoil productivity consistent with the postmining land uses in each disturbance area.

The soil and supplemental plant growth material planning summaries (Tables 3 thru 9) for the active mining areas indicate an excess of about 9,610 acre-feet of soil is available for special handling and use for supplemental material. The J-7, N-6, N-11, N-14, and J-16 areas have little to no available excess soil available for use as supplemental material. In contrast, the J-19 and J-21 areas have 3,500 to 6,000 acre-feet of soil available for use as supplemental material. This excess soil will be used with supplemental suitable overburden material (Table 2) to cover unsuitable spoil with a minimum of four feet of suitable plant growth medium. All facilities will be reclaimed according to the provisions of the minesoil reconstruction and revegetation plans outlined in this and the succeeding chapter. The location of these facilities may be found on Drawing 85360 (Volume 20).

The soil and supplemental plant growth material planning summaries for the future life-of-mine N-9 and N-99 development areas (Table 10) indicates an excess of only about 1,134 and 818 acre-feet of soil is available for special handling and use for supplemental material in these respective areas. Therefor little excess soil is available for use as supplemental material. This minor amount of excess soil will be used with supplemental suitable overburden material (Table 2) to cover unsuitable spoil with a minimum of four feet of suitable plant growth medium.

The projected soil replacement volumes and replacement thickness listed in Tables 3 through 10 will vary depending upon the amount and availability of plant growth material needed to bury unsuitable graded spoils. In all cases except the existing N-11 mining area or other interim disturbance areas, a minimum-average of twelve inches of soil will be redistributed on the reclaimed spoils unless specific substrates are being reconstructed for shrub and tree establishment, wildlife habitat, or reduced erosion potential (see Steep Slope, Cultural Planting, Key Habitat, and Main Drainage Channel discussion presented in the "Special Purpose Reclamation Areas" section of this chapter). Insufficient soil is available at N-11 to meet the minimum-average twelve-inch thickness. The minimum-average replacement thickness of soil at N-11 will be 8 to 9 inches while all interim disturbance areas will receive 0.5 feet or more of soil as required by Permit AZ-0001.

It appears from Tables 3 thru 9 that an excess 9,610 acre-feet of soil will remain in stockpile after reclamation of all projected mining disturbances. However, the graded spoil sampling program is used to identify the actual volumes of soil, supplemental material, supplemental surface plant growth media, and residual soils needed to meet redistribution requirements. A dynamic inventory is maintained of available and required plant growth material. Logically, as mining approaches completion in a given area, the inventory of stockpiled soil is adjusted to ensure that little or no excess material remains in stockpile. Should excess soil remain in stockpile after mining is completed in a given area, the excess will, after OSM approval, remain in place and the perimeter of the stockpile will be blended with the adjacent final reclamation to achieve an approximately uniform, stable thickness consistent with the approved postmining land use, contours, and surface-water drainage system.

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The maximum uniform depth of soil that could potentially be redistributed at each mining area varies from slightly less than a foot to over two feet. PWCC intends to bury unsuitable spoils with a minimum of four feet of suitable plant growth material. The available soil in each mining area is not sufficient to cover the liability areas if the very conservative assumption is made that all graded spoils are unsuitable at the surface. Suitable supplements and residual soils will be used to augment the soil material.

Highwall and Spoil Sampling Plan

Considerable supplemental plant growth material has been identified ahead of the highwall in each mining area as inventoried in Tables 1 and 2. Should any of this overburden material be needed for reclamation, it will be sampled to determine suitability for redistribution on graded spoil prior to handling unless the quality has been established from previous sampling activity.

In-place overburden will be sampled using a core drill. The drilling and sampling methods and procedures will follow those used to obtain overburden impact cores or chip samples (Chapter 4). Suitability criteria and analysis procedures will be the same as those used to sample graded spoils (see Material Redistribution Plan section of this chapter). Dozers, trucks and front-end loaders/shovels, or scrapers will handle in-place overburden used as a source of supplemental material.

Spoil piles and rough graded spoil to be used as a source of supplemental material will also be sampled prior to moving materials. Suitable material may be used in situations where the graded spoil to be buried is in close proximity to the suitable borrow area. Dozers, trucks and front-end loaders/shovels, or scrapers will be used to move spoil identified as suitable. Suitability criteria and analysis procedures will be the same as those used to sample graded spoils. Records from highwall and spoil sampling will be kept on file at the mine site.

Material Salvage Plans

Site Clearing Procedures. Prior to soil removal, dozers or other suitable equipment, clear the area of large vegetation material consisting primarily of pinyon and juniper trees. The vegetation debris removed in the clearing process is placed at locations that will not interfere with mining operations. Local residents utilize a majority of the woody material for firewood. The remainder is either piled at the edges of mining areas to provide cover and nesting habitat for wildlife, or buried during the mining operations so as not to cause a stability hazard. Clearing activities are conducted throughout the year. Maximum clearing distances are given in Attachment 22-1.

<u>Soil Removal Procedures</u>. Soil is removed a maximum of 1,500 feet in advance of mining operations in each pit for sagebrush-grassland habitat and 2,000 feet for pinyon-juniper woodland when suitable material is occasionally encountered (see Attachment 22-1 for justification). Other mine support facilities such as, but not limited to, sediment ponds, soil stockpiles, powerlines, substation sites, access roads, storage yards, environmental monitoring sites, and deadhead routes located in the mine plan areas that may require site clearing and/or soil removal activities isolated from the main advance disturbance areas are not considered part of the specifications in Attachment 22-1. These isolated activities are permitted and limited to Category I or II disturbance areas shown on the Bonding Map, Drawing No. 89800. However, advance soil removal distances may be less at times in each pit due to ground conditions, equipment availability, operating room constraints, and material requirements. Soil is normally removed from March to November or in other months if mining conditions warrant and weather conditions permit.

Once the soil investigation and site clearing are complete, the soil scientist reviews the depositional and areal extent of the soil that is to be removed with foremen and reclamation personnel who will be supervising the soil removal operation. The foreman and reclamation supervisors are qualified and trained to evaluate various field observation tests, including soil color, rooting depth, sand and clay content, rock fragment content, and weathered bedrock. In areas where extensive material exists, the soil scientist, foreman, and/or reclamation personnel observes the soil removal operation on a frequent basis to assure that material is recovered without being contaminated by extraneous soil materials. In areas with thin depositions of soil or where soil recovery may be complicated or difficult, the soil scientist, foreman, and/or reclamation personnel may stake depths of soil to be recovered based on site-specific conditions and their professional judgment, or continuously monitor the soil removal operation.

Once the planning, instruction, and pre-removal investigations are completed, the soil is removed by scrapers or other earthmoving equipment and redistributed or transported to a soil storage area. In final pit highwall reduction and first pit boxcut spoil areas, at pond construction sites, along pioneering road corridors, at terrace or downdrain sites, along ramp/road final reclamation parcels, and for interfacing/blending final graded areas with topsoiled parcels, soil removed by dozers and/or graders will be pushed outside the soil disturbance area and stored temporarily (less than one year) in furrows. These furrow areas are not depicted on Drawing 85210. This soil will either be respread over adjacent final graded slopes or will be transported to an approved stockpile site. The soil removal operation is continually checked and supervised by reclamation personnel to assure complete removal of all required soil, and to prevent contamination of that soil by any soils that would not be considered suitable.

<u>Overburden Removal Procedures</u>. Overburden that will be used as soil supplements, and therefore has been delineated based upon sampling, is removed in much the same manner as soil. Soil supplements may be handled throughout the year. Once the planning, instruction, and pre-removal investigations are complete, the overburden is drilled and blasted or ripped, depending on its degree of induration or lifted undisturbed if non-indurated, and moved to the redistribution site. Soil supplements are typically not stockpiled; however, if the need arises, such stockpiles will be designated and shown on the Mine Plan Map, Drawing 85210. The removal and redistribution processes are supervised by reclamation personnel.

Suitable rough-graded spoil and spoil piles that will be used as soil supplements are moved using dozers, trucks and front-end loaders/shovels, or scrapers. The equipment to be used is determined by the amount of material and distance the material must be moved. Spoil may be handled throughout the year.

<u>Proof of Salvage</u>. Proof of salvage activities are used to document the volume of soil and soil supplements salvaged for reclamation.

The soil survey and soil depth maps are utilized to determine areas where suitable soil exists. The results of the highwall sampling plan are used to determine areas where suitable supplemental material exists. The salvage depths and actual yardage removed (based on equipment load counts) are usually recorded. The soil scientist and/or qualified reclamation personnel periodically observe and occasionally record salvage depths of cut banks and soil islands on topographic base maps or photographs. As the materials are being removed, a generic photo is sometimes taken to show the profile and depth of the soil being removed. The records thus obtained are cross-referenced to the soil depth maps and sampling data. The photographic record, and the volume and location information is prepared by or under the supervision of qualified reclamation personnel. Records are kept on file for inspection and reference at the mine site.

Soil Stockpiling Plans

Soil stockpile sites for each mining area are shown on Drawing 85210. Proposed piles for each pit area have been assigned a "pit area-XX" or "pit area-LP" designation on Drawing 85210. Identification numbers will be assigned sequentially by the field reclamation supervisor or soil scientist as the piles are constructed.

Soil stockpile locations are selected collectively by the reclamation, operations, engineering, and environmental groups. The criteria used in the selection process are:

1. Stockpiles must be located in areas that will not interfere with the mining operation;
2. Stockpiles are placed within the lease, permit, and projected disturbance boundaries;
3. Stockpiles are located as close as possible to salvage and redistribution sites; and
4. Stockpiles are located in stable areas where wind and water erosion, and contamination are minimized.

If it is necessary to move a stockpile without redistributing the stored materials on graded spoils, regulatory authorities are contacted for approval prior to disturbance of the stockpiles.

Soil stockpiles will at times be located on final graded spoil to:

1. Keep the stockpiles as close as possible to the salvage and redistribution areas;
2. Keep the piles out of future coal recovery areas;
3. Prevent the piles from being relocated; and
4. Minimize projected disturbance areas.

Soil stockpiles that are or will be located on final graded spoil are identified and shown on Drawing 85210. Stockpiles will be located in stable areas and the spoil will be graded according to the Surface Stabilization Plan criteria in Chapter 26. The spoil at the stockpile sites will be sampled for suitability using methods described in the Graded Spoil Sampling Plan section of this chapter.

Stockpile sites located on final graded spoil will be reclaimed using methods described in the Material Redistribution Plans section of this chapter. Soil will not be mixed with spoil during reclamation because an abrupt smooth boundary occurs at the interface between these materials. The soil/spoil interface is easily identified by an abrupt color change, texture or grain size difference, change in consistency, and/or the presence of coal, scoria, sandstone, or shale chips in the spoil medium. Sufficient soil will remain in the stockpile during reclamation to blend the site with the surrounding soiled areas, and to adequately cover spoil as described in the Material Redistribution Plans section of this chapter.

Stockpile dimensions, slopes, and volumes vary based upon total salvage volumes, the configuration of the stockpile location site, equipment ingress and egress routes, and proximity to access roads. Within these constraints, PWCC typically constructs stockpiles that are oblong in shape with a rounded cross section. Short and long axis side slopes are typically restricted to a maximum 4:1 slope. The long axes of the stockpiles are oriented with prevailing wind patterns to minimize wind erosion when possible within terrain restrictions. The profiles of the stockpiles are kept as low as possible within the slope and volume constraints.

Pursuant to 30 CFR 816.22(c)(2)(iii), topsoil stockpiles will be protected from wind and water erosion using effective conservation practices including either or a combination of vegetation establishment, ripping or tillage to create surface roughness, mulching, berms, ditches, sediment traps, and alternate barriers such as hay bales and silt fence. Wind and water erosion is minimized by surface roughness and/or establishing a vegetation cover on the stockpiles (Chapter 23). Stockpiles, including linear piles that will remain in place less than one year will be ripped or otherwise have the surface roughened to protect the soil against wind and water erosion. Stockpiles that will remain in place for more than one year are seeded with the soil stockpile stabilization mix. This mix is comprised of quick establishing perennial species. The stockpiles are then mulched at a rate [illegible] tons per acre to provide stabilization in the interim between seeding and plant cover establishment.

Berms, ditches, and/or sediment traps will be constructed and maintained around the perimeter of the stockpile, when necessary, to minimize the loss of stockpiled material resulting from surface water runoff on the stockpile and from adjacent terrain. These berms, ditches, sediment traps, and/or alternate barriers will be constructed or placed to retain the material at the stockpile site or to divert water away from the stockpile. Berms, ditches, and/or sediment traps will be constructed from material located near the stockpile site and may consist of soil, weathered overburden, and/or spoil. Small temporary earthen ditches and berms or an alternate barrier such as hay bales or a geotextile fabric such as silt fence will be used. The typical ditch would be a minimum of one foot deep with asymmetrical side slopes of 1:1 (H:V) and 2:1. Small temporary berms would also be typified by the above ditch dimensions. The lowest practicable longitudinal grades will be maintained. Locations exhibiting a low interception potential for incoming surface water runoff are chosen for soil stockpiles.

The berms, ditches, sediment traps, and/or alternate barriers will typically only be constructed and maintained where stockpiles are located on steep slopes, where vegetation establishment is delayed, where runoff from the pile is not routed through a sediment pond, or where runoff will displace soil to a potential contamination or loss area (pit, ramp, haul roads, etc.). Berms, ditches, sediment traps, and/or alternative barriers will often not be used or maintained around the perimeter of those stockpiles where the vegetation cover has been adequately established or on short duration, low profile, narrow linear piles located between final graded spoil and recently topsoiled areas. This latter type of soil stockpile is very short-term, meaning it will be respread over the final graded spoil during the next favorable seeding season. The footprint of this type of stockpile is not static, but will progress forward in unison with the existing pit. Therefore, the exact centerpoint location may not always be depicted on the Mine Plan Map, Drawing 85210. Wind and water erosion will be minimized by the shape, location, surface roughness, and life expectancy of this pile. Additionally, displaced soil, if any, will be deposited either on final graded spoil or recently topsoiled areas, thereby preventing any soil loss or contamination. Berms, ditches, sediment traps, and/or alternative barriers will be constructed around linear piles and the piles will be seeded and mulched when these piles are retained linger than one year.

Final protection measures for soil stockpiles include fencing and sign placement. When necessary, soil stockpiles are fenced to limit disturbance of the stockpiled material, protect the vegetation, and prevent compaction and contamination. Identification sign(s) (see Chapter 25) are placed in a prominent location(s) around the stockpiles.

protect the vegetation, and prevent compaction and contamination. Identification sign(s) (see Chapter 25) are placed in a prominent location(s) around the stockpiles. Mine personnel are instructed that soil stockpiles are not to be disturbed or contaminated. The signs serve as continuing reminders to personnel that stockpile areas are to be preserved and not disturbed.

Material Redistribution Plans

Graded Spoil Sampling and Analysis Plans. Following the completion of grading within logical reclamation units and often prior to redistribution of soil and supplemental material, the graded spoil in all mining areas is sampled to identify the extent and nature of unsuitable materials. The spoil is sampled using a grid pattern with 330-foot centers. At each sample point on the grid, spoil samples are collected to a minimum depth of three feet. Representative samples are collected by or under the supervision of the soil scientist at the 0 to 1 and 1 to 3 foot intervals using conventional sampling techniques. The qualified field sampler also inspects the surface-spoil between grid points. If a significant change in the spoil characteristics is found between grid points, additional sample sites are located accordingly.

The parameters and criteria used to evaluate spoil suitability are given in Table 11 and Figure 1. The parameters and criteria are based upon the characteristics of the overburden found in the sampling program (Chapter 8) and spoil quality as identified by postmine soil-spoil pedon data and final graded spoil data (PCC, 1988; PCC, 1992; and PWCC, 1993-2010). The list represents those characteristics of the Black Mesa overburden and spoil that are likely to be deleterious to plant growth. Analyses will be performed in the field, at the mining complex, or at an independent soil lab. Field, laboratory, and quality control procedures are presented in Table 12.

The following special criteria are applicable for boron and SAR evaluations. The hot-water-soluble boron (HWS-B) analysis will only be included in the analytical suite for future soil and overburden baseline assessments where there is no existing HWS-B data, spoil collected from the N10 reclamation area, and future reclamation areas where problem levels of HWS-B have been identified in the overburden. Problem levels of HWS-B shall be defined by mixing criteria established by Dollhopf et al. (1978). HWS-B will be included on the parameter list for spoil whenever unsuitable HWS-B levels comprise more than 5 percent of the associated premine overburden section. In all instances, HWS-B will only

TABLE 11

Maximum Threshold Limits for Evaluating

Recently Graded Spoil at the Black Mesa Mining Complex[1]

Parameter	Major Root Zone (Subsoil-Spoil) 0 to 1 feet	Minor Root Zone (Substratum-Spoil) 1 to 3 feet
pH (sat.paste)	>8.8	>9.0
	<5.5	<4.5
EC(mmhos/cm)	>12.0	>12.0
SAR		
<20% clay	>25	>40[2]
20-35% clay	>20	>35[2]
>35% clay	>16	>25[2]
Texture		
Clay %	>45	>45
Rock Fragments %[3]		
>2 mm(by volume)	>65	>75
>3 inch (by volume)	>35	>40
Calcium Carbonate Equivalent %[3]	>30	>30
Acid-based potential[4] (ABP)	<0 if pH<6.0 <-5 if pH>6.0	<-5
Boron, ppm[5]	>10	>10

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TABLE 11 (Continued)

Maximum Threshold Limits for Evaluating

Recently Graded Spoil at the Black Mesa Mining Complex[1]

(1) Parameters and maximum threshold limits are based on OSMRE (1998) and site-specific justification documents that PWCC submitted to OSMRE in September 1998, November 1998, January 1999, February 1999, January 2000, and August 2001.

(2) Suitable maximum SAR values for the minor root zone substratum spoil must be in the slight to no reduction zone of the infiltration hazard classes adapted from Ayers and Westcott (1989) as shown in Figure 1.

(3) These suitability criteria are used only for the 0 to 1 and 1 to 3 foot increments of special reclamation areas including steep slopes, key habitats, cultural plantings, and main drainage channels where supplemental surface plant growth media are used.

(4) Units are tons calcium carbonate equivalent per 1000 tons of material. Suitability levels based upon correspondence from OSMRE (August 6, 1987). The acid potential must be calculated from pyritic sulfur as specified in the New Mexico guidelines.

(5) The hot water soluble boron analysis will only be included in the analytical suite for future soil and overburden baseline assessment where there is no existing HWS-B data, spoil collected from the N10 reclamation area, and future reclamation areas where problem levels of HWS-B have been identified in the overburden. In all instances, HWS-B will only be determined for very dark gray to black carbonaceous shale and black weathered coal strata.

Figure 1. Saturated paste electrical conductivity (EC) and SAR relationships for 1989-1998 recent spoil samples from the BMMC. Infiltration hazard classes adapted from Ayers and Westcott (1989).

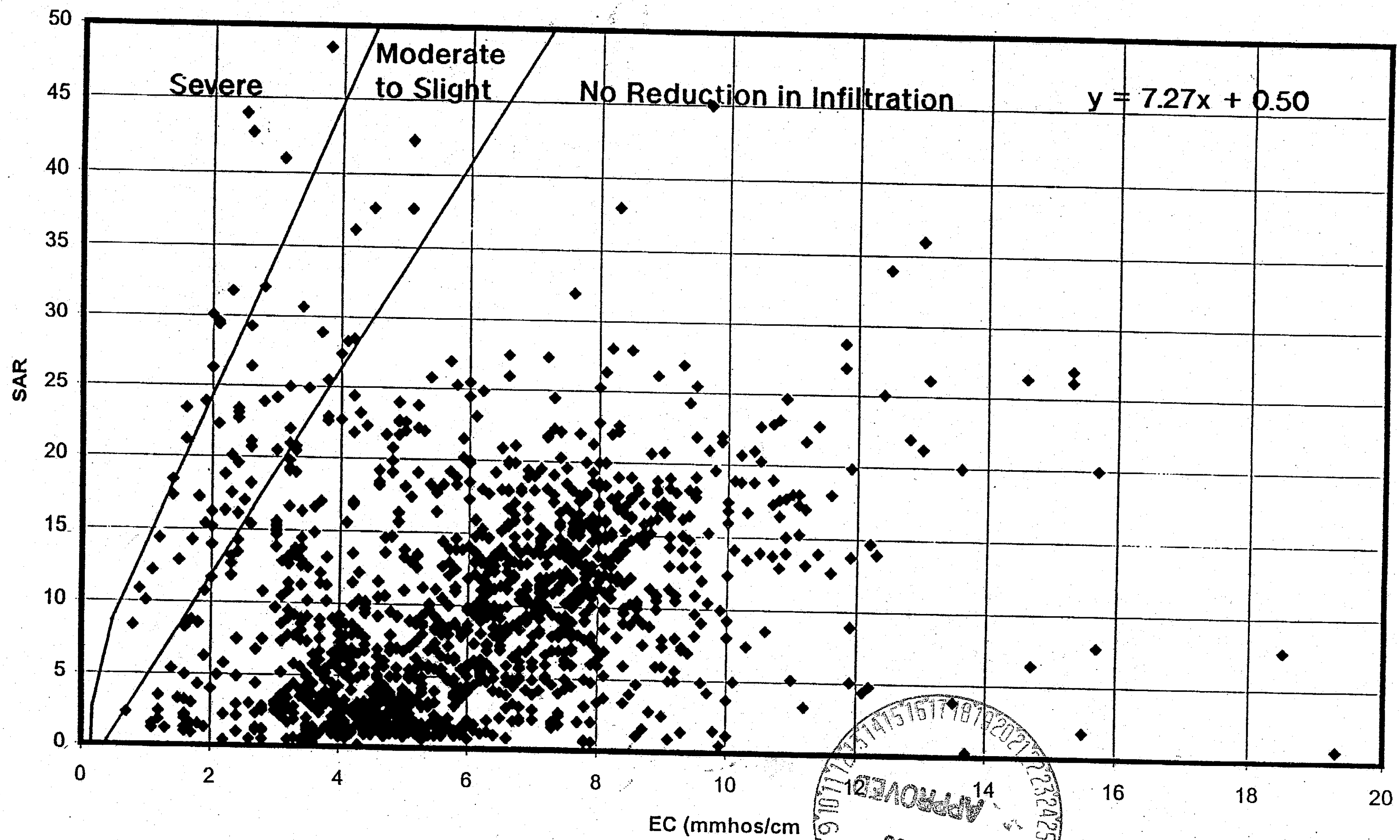

TABLE 12

Parameter, Procedure, and Reference List for Evaluating Postmine Soil and Spoil Samples(1)

Parameter-Units	Procedure-Reference
Preparation of saturated paste and extract	USDA (1969), Methods 2 & 3a, pp.84 & 88.
pH (determination using saturated paste)	USDA (1969), Method 21a, p. 102.
Conductivity of saturation extract in mmhos/cm at 25°C	Sandoval and Power (1978), Method 1, pp. 22-24.
Calcium content in the saturation extract in meq/l	Sandoval and Power (1978), Method 2, pp. 24-26.
Magnesium content in the saturation extract in meq/l.	Same as Calcium
Sodium content in the saturation extract in meq/l	Same as Calcium
SAR	USDA (1969), p. 26
Particle size analysis in % sand, silt & clay	Black (1965), Method 43-5,p 562-566.
Textural classification	USDA (1951), p. 209
Acid Potential. Sulfur fractionation in % (determined when ABP is less than 0)	Sobek et al. (1978), Method 3.2.6, p. 60-62. 60 mesh sieve. Acid potential must be calculated from pyritic sulfur as recommended by Sobek et al. (1987), New Mexico MMD (1987) and OSMRE (1988a).
Neutralization potential in tons $CaCO^3$ per acre furrow slice.	Sobek et al. (1978), Method 3.2.3, p. 47-50. 60 mesh sieve.

TABLE 12 (Continued)

Parameter, Procedure, and Reference List for Evaluating Postmine Soil and Spoil Samples[1]

Parameter-Units	Procedure-Reference
Acid base potential (ABP) in tons $CaCO^3$ per acre furrow slice	Smith et al. (1974), p. 48-49. 60 mesh sieve.
Visual Features (Field test)	Source rock in spoil materials will be visually assessed for the presence and abundance of pyrite, sulfur, gypsum, carbonaceous material, coal fines, etc.
Calcium Carbonate Equivalent[2] (%)	USDA (1969). Method 27a, p. 197
Rock Fragments[2] (% by Volume)	Arbitrary grid and/or transect traverses as recommended by SCS (1971). Method 2.7, p. 2.7-1.
Boron[3], ppm (Soluble)	Black (1965), Method 75.4. EPA 600, Method 200.7 ICP.

(1) PWCC will also adhere to the following quality assurance and quality control program recommended by OSMRE, 1988b:

The quality assurance and control program will include:

A. Personnel qualifications.
B. Detailed collection, storage, and sample preparation procedures.
C. Laboratory procedures and modifications thereof used by the laboratory with statistical data justifying such modifications.

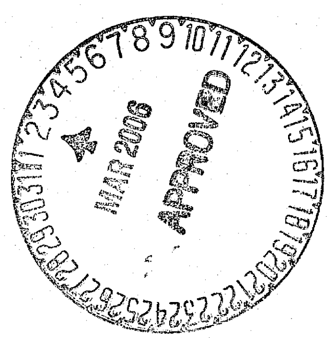

TABLE 12 (Continued)

Parameter, Procedure, and Reference List for Evaluating

Postmine Soil and Spoil Samples[1]

D. Laboratory equipment with modes of operation, reaction times, response times, recorder speeds, etc.

E. Quality control data will include:

a. Standard reference materials;

b. Duplicate sample results reported with data;

c. Referee sample data; and

d. Laboratory quality control data, including statistical variability for parameters requested, detection limits, sensitivity values, and concentration ranges of optimum detection.

(2) Analysis completed only for the 0 to 1 and 1 to 3 foot increments of special reclamation areas including steep slopes, key habitats, cultural plantings, and main drainage channels.

(3) The hot water soluble boron analysis will only be included in the analytical suite for future soil and overburden baseline assessment where there is no existing HWS-B data, spoil collected from the N10 reclamation area, and future reclamation areas where problem levels of HWS-B have been identified in the overburden. In all instances, HWS-B will only be determined for very dark gray to black carbonaceous shale and black weathered coal strata.

be determined for very dark gray to black carbonaceous shale and black weathered coal strata. HWS-B levels in overburden throughout the BMMC are closely correlated to lithology. Suitable maximum SAR values for the minor root zone substratum spoil must be in the slight to no reduction zone of the infiltration hazard class adapted from Ayers and Wescott (1989) as shown in Figure 1.

The criteria in Table 11 will be used to assess suitability of the graded spoils and supplemental surface plant growth media. If one or more parameters fall within the unsuitable range at a given grid point, additional sampling may be conducted at the midpoint between the four surrounding sample sites on the grid. The same sampling procedures used on the grid will be followed. Sampling will continue in this manner (one midpoint sample surrounding the unsuitable gridded sample site) until the real extent of unsuitable material in the reclamation unit is determined. A reduced analysis list, comprised of parameters that fall within the unsuitable range, will often be used at these phase 2 inter-sample sites that were selectively placed between 330-foot grid locations to verify spoil suitability. Unsuitable areas will be staked at the next adjacent suitable sample site to identify the problem area and provide an adequate margin between unsuitable and suitable material.

On graded spoils that are determined to be suitable in all respects, twelve inches of soil will be redistributed except the existing N-11 mining area, interim disturbance and reclamation areas, and special reclamation areas requiring substrate-specific species. A topdressing of soil will often not be applied in special reclamation areas including key habitats, steep slopes, cultural plantings, or main drainage channels where the supplemental surface plant growth media are determined to be suitable in all respects. This will result in a minimum of four feet of suitable plant growth media for revegetation.

The thickness of suitable material that will be redistributed on areas determined to have unsuitable spoil characteristics will be based upon the depth at which unsuitable materials were encountered. For example, if sampling identified a five-acre area that has unsuitable characteristics in the 1 to 3 foot sample increment, the entire area will be covered with a minimum of three feet of suitable material. If an area is encountered where the depth to unsuitable material is variable and it is impractical because of size to stake subareas for suitable material redistribution, the entire area will be covered with that quantity of suitable material required by the shallowest unsuitable interval encountered in the final graded spoil. It is not necessary to resample the redistributed supplements to verify suitability prior to redistribution of soil materials because the material was sampled and determined to be suitable prior to salvage.

Graded spoils that are determined to be unsuitable will be covered with soil or a combination of suitable overburden, supplemental surface plant growth media (in special reclamation areas including key habitats, steep slopes, cultural plantings, and main drainage channels), and soil. The relative amounts of each kind of material that will be used will be determined based on haulage distance, the need for rehandling or special handling, topographic position, postmine land use, substrate-specific specie requirements, and the availability of materials. In most situations, PWCC expects to use suitable supplemental material for burial followed by an application of twelve inches of soil. In situations where supplemental material is not available, soil will be used. The potentially available volume of supplemental material is addressed elsewhere in this plan. In every case except the existing N-11 mining area, and interim disturbance/reclamation areas, a minimum-average of twelve inches of soil material will be used as a surface treatment unless residual soils and supplemental surface plant growth media are being utilized in key habitats, cultural plantings, and steep slopes, and a minimum total depth of 4 feet of suitable material will be redistributed for revegetation. Suitable supplemental material will be used to reconstruct the subsoil when available. Insufficient soil is available at N-11 to meet the minimum twelve-inch average depth. An approximate average of 8 to 9 inches of soil will be redistributed in this mining area. The interim disturbance/reclamation areas will receive 0.5 feet of soil or more as required by Permit AZ-0001.

PWCC will maintain records of the sampling results for each logical reclamation unit. Soil and topsoil supplement redistribution depth requirements will be mapped using 1" = 400' aerial photography following the completion of sampling. These records will be kept on file at the mine site and will be submitted with each annual reclamation report.

Special Purpose Reclamation Areas. PWCC uses supplemental surface plant growth media (suitable overburden and spoil) and residual soils to establish certain substrate-specific species, create wildlife habitat, and provide erosionally stable landscapes. These steep slope, cultural planting, key habitat, and main drainage reclamation areas are reconstructed to support the postmining land uses of rangeland grazing, wildlife habitat, and cultural plants. Suitable overburden and residual soils are used to create these landscapes because these materials are inherently stable, have low erodibility potential, promote deep root growth and water/air movement, and reduce competition from shallow-rooted herbaceous vegetation. These special purpose areas provide the potential for structural diversity and increased plant community diversity within the reclaimed landscape. Justification for utilizing supplemental surface plant growth media and residual soils within steep slope, key habitat, cultural planting, and main drainage channel reclamation areas is presented in Attachment 22-2.

Soil testing and amendment applications for steep slope, key habitat, cultural planting, and main drainage channel reclamation areas will be implemented on an as-needed basis. Revegetation success monitoring and revegetation trials will be utilized within these reclamation areas as described in Chapter 23. Soil and spoil samples will be collected at representative revegetation soil sample sites located in these special purpose reclamation areas to correlate revegetation data (including forage quality) with soil chemical and physical characteristics and to verify the acceptability of using supplemental soil materials in these areas. The list of soil and spoil analyses will, at a minimum, include all parameters listed in Table 11.

<u>Mine Support Facilities.</u> The existing and proposed mine support facilities for the Black Mesa leasehold included steep slope reclamation areas. For temporary mine support facilities affected land areas, due to the composition of the underlying bedrock material in excavation areas, the slope aspect, steepness of slope, or low potential for revegetation success, etc., the reclamation and surface stabilization efforts may be hindered if existing soil and subsoil reserves are utilized (see "Steep Slope" section in Attachment 22-2). Therefore, suitable overburden or a minimum depth of six inches of non-toxic, non-acidic rock mulch cover on the side slopes or backslopes in lieu of soil and revegetation may be utilized for temporary surface stabilization.

In addition, as an alternative, and based on suitable site conditions, the soil scientist or other competent professionals may still approve soil redistribution and revegetation in lieu of temporary revegetation and surface stabilization techniques for this type of site.

Once the support facility is no longer required to support mining, the facilities area will be reclaimed in accordance with the approved reclamation plan, utilizing permanent revegetation or surface stabilization techniques.

Redistribution Procedures. Plant growth media are redistributed utilizing scrapers, dozers, front-end loaders, shovels or loaders and end-dumps, and miscellaneous support equipment; for example, road graders, water trucks, and farm tractors. Scrapers, sometimes assisted by dozers, are used primarily to load and haul soil or supplements to the areas where redistribution is to occur. PWCC direct hauls plant growth materials as often as possible.

Soil and supplements are redistributed only on graded spoils that have been prepared for redistribution. Surface preparation of final-graded spoil is carried out to minimize the potential for slippage of replaced soil and is performed during final backfilling and grading or after soil redistribution. The procedure is completed using surface mechanical manipulation techniques including deep ripping and chisel plowing. The increased adhesion created at the interface between the respective materials by these surface treatments minimizes slippage of the redistributed soil. Redistribution is performed whenever weather and soil moisture conditions permit. To the greatest extent possible, materials are removed and replaced in a single operation.

Plant growth material is redistributed from soil storage piles, from soil material removal areas, and supplemental sources (highwalls, spoil piles, and rough-graded spoil). Uniform redistribution of soil materials is accomplished by unloading scrapers when they are traveling at constant speed. Supplemental materials are unloaded from scrapers or end-dumps in a similar manner to scrapers, or are dumped and graded depending upon slope conditions and the extent of the area being covered. Excessive compaction is minimized by setting up circulation patterns for scrapers or other equipment that minimize or prevent travel over redistribution materials.

Soil will not be replaced on certain downdrain alignments and all main reclamation channels (including the 15-foot apron on each side of the main channels). Suitable overburden material will be utilized as a surface plant root growth medium (soil supplement) for reclamation of main drainage channels. The rationale for this approach is to conserve that amount of soil material that would otherwise wash down the water conveyance channels to the sediment ponds below reclaimed areas. Also, the spoil has a high rock fragment content that will aid in armour-coating the channels. If the location of a downdrain is known prior to soil redistribution activities, soil will not be placed in the downdrain unless site-specific conditions indicate that portions of the downdrain would be stable. Should the location of a downdrain or terrace be defined after soil replacement, the soil will be removed in the immediate vicinity of the terrace or downdrain. The minimum width along the downdrain alignment that will not be soiled is approximately 45 feet. This is based on a minimum estimated primary channel bottom width of 15 feet with an additional 15 feet of width each side of the primary downdrain channel. In this manner, soil material loss will be minimized. Soil will be replaced on terrace cut- and fill-slopes once construction has been completed.

Surface Stabilization and Erosion Control

Several procedures are used to minimize the potential for erosion on redistributed soil surfaces. Slope gradients are kept to a minimum within the confines of grading to approximate original contours and topographic manipulation is practiced to reduce overland flow velocities and runoff volumes. Also, reestablishment of surface drainage systems, where necessary, are incorporated into the grading plans. These estimated postmine topography procedures are described in the surface stability and drainage reestablishment plan (Chapter 26) and shown on the annual Surface Stabilization Report maps and on Drawing 85352.

Surface stabilization and erosion control are also enhanced by mechanical surface manipulations. Surface mechanical manipulation may include chisel plowing, ripping, contour furrowing, contour ditching, slope tracking, land imprinting, pitting, or other methods of surface roughening to reduce surface runoff, increase infiltration, reduce surface erosion, and enhance the establishment of vegetative cover. Deep ripping and contour furrowing are the primary methods to be used on the leasehold. Generally, these mechanical manipulation methods are applied after rough grading of the spoil material and soil redistribution are completed. These mechanical manipulation practices have been developed largely for semi-arid and arid lands where water and soil conservation is critical. On mined lands in this region, several complementary treatments may be necessary to offset scant soil moisture supplies resulting from (1) erratic and low rainfall (nine to ten inches of average annual precipitation), (2) high evapotranspiration, and (3) high runoff rates. Equipment commonly used are modified

Once the support facility is no longer required to support mining, the facilities area will be reclaimed in accordance with the approved reclamation plan, utilizing permanent revegetation or surface stabilization techniques.

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Deep ripping or chisel plowing are mechanical treatment measures used to shatter compacted layers and provide better mixing or contact at the soil-spoil interface. The purpose of these treatments is to loosen and mix subsoil, improve root penetration and aeration, and increase infiltration and subsurface water storage. Chisel plowing or ripping is used to treat the top one to three feet of soil. Chisel plowing does not provide as great a depth benefit as ripping; however, because more chisel shanks are carried and the shank spacing is closer, a greater proportion of surface material is affected in the approximate one foot effective operating depth of the chisel implement. Chisel plowing is also an effective tool for mulch incorporation and reducing annual weed growth. Though chisel plowing can provide positive benefits, it is felt that deep ripping will provide a greater range of effectiveness. Thus, ripping will be the primary method used, while chisel plowing will only be used as a backup method in case of equipment breakdown or other logistical problems.

Upon completion of final grading and replacement of soil, contour ripping with multi-ripper shanks spaced 3 to 5 feet apart will be carried out to depths ranging from one to three feet. Ripping will typically extend through the replaced soil across the soil-spoil interface and into the upper spoil. Replaced drainages, key habitat, cultural planting, and steep slope reclamation areas where soil is not respread, will be included in the areas ripped. The drainages will be ripped perpendicular to their channel length, increasing the roughness coefficient of the channel and the opportunity for additional infiltration and less runoff. Deep ripping breaks or shatters compacted layers that tend to inhibit root development and restrict the zone from which plants can extract soil water and nutrients. Branson et al. (1966) found that ripping rangeland with large rippers that created lasting furrows increased forage production by 160 percent. Studies conducted by Dortignac and Hickey (1963) and Hickey and Dortignac (1964) determined that ripping on a rangeland research area in New Mexico reduced runoff by as much as 96 percent and erosion by 85 percent the first year after treatment. Three years following the initial treatment, runoff still was 85 percent less than the control with 31 percent less erosion. While the effects of ripping on reclaimed lands at Black Mesa may vary from the above because of site and climatic differences, the above studies indicate the potential

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benefits of these practices. The increased plant growth and vigor resulting from the practice will also provide additional erosion and land use benefits.

The ripping operation can be expected to cause a certain amount of blending of soil and spoil. It may also expose a certain amount of coarse material at the surface. This will not interfere with the revegetation process and will benefit the reclaimed landscape by creating additional microhabitat, increasing the potential for runoff detention storage, reducing evaporative surface areas, and reducing the kinetic energy of falling raindrops.

For schematics of ripping implements and land surface patterns, see Chapter 26. In addition to standard farm subsoilers, construction equipment with large single-shank or multi-shank rippers may be used to loosen the soil.

Contour furrowing and ditching are mechanical manipulations that roughen the soil surface, creating small trenches and grooves parallel to the slope contour. Contour furrowing and ditching are used on topsoiled areas to reduce runoff and soil erosion and enhance the establishment of vegetative cover. Of the two, contour furrowing will be the primary method used on reclaimed lands on the Black Mesa leasehold.

Following soil or supplemental surface plant growth media replacement and ripping, the reclaimed lands will be contour furrowed using a modified offset disk. The modified disk is a large off-set type disk with the standard front disk gang retained and the rear gang modified to include a 36-inch diameter disk spaced every 36 inches. This creates furrows on the reclaimed landscape that are 9 to 14 inches deep with 36-inch spacings. The front unmodified disk gang aids in seedbed preparation.

Contour furrowing is a standard range improvement practice used to control runoff, reduce erosion, and retain water on slopes for increased plant growth and forage production (Valentine 1971). For reclaimed lands, contour furrows increase surface roughness and provide for catchment and retention of runoff. This reduction in runoff translates into reduced erosion, increased infiltration, and increased plant available water. Simons, et al. (1983) stated contour furrows can increase infiltration up to 10 fold and decrease runoff by as much as 84 percent. Typically, contour furrows are 8 to 12 inches deep and are spaced 7 to 20 feet apart, with the furrows dammed every 4 to 20 feet (WET, Inc. 1986). Contour furrowing has been and continues to be practiced at the Black Mesa and

Kayenta Mines. Furrows are not dammed; however, the furrow spacing of only 36 inches is less than half the lower interval spacing of 7 feet as described above. Thus, the contributing area for each furrow is relatively small. Furrows need not be dammed periodically if they are placed on the contour (Valentine 1971). Quality control procedures will insure that furrowing is done on the contour whenever practicable.

The discussions presented above for ripping and contour furrowing are to provide an indication of the immediate potential benefits of these practices when applied to the reclaimed areas. Dixon (1975), in his discussion of the air-interface concept for infiltration, showed that a micro-rough, macro-porous interface (on the surface of the landscape) will improve control of runoff, reduce flash flooding, erosion, sedimentation, and nonpoint source pollution, improve control of soil water and ground water recharge, and reduce plant water stress with resultant increased growth rates. He further showed that a rough open surface has the characteristics necessary to allow for a highly functional exchange of water and air across the soil surface that results in high infiltration rates. A number of authors (Scholl 1985, Schuman et al., 1987, Aldon et al., 1980) have shown that surface manipulations, as described above, measurably benefit the establishment, development, and sustained growth of vegetation in reclaimed areas. Thus, the development and maintenance of an effective and permanent vegetative cover is the means by which erosional and landform stability will be maintained over the long term.

Slope tracking and land imprinting are surface manipulation practices used in arid areas that form microfurrows or microbasins in the soil to reduce runoff, increase infiltration, and pond water for increased plant growth. Slope tracking and land imprinting creates firm seedbeds and microsites beneficial to seedling germination and establishment. This type of surface manipulation roughens the surface with wedges or other geometric impression patterns that are approximately four inches deep, depending on soil compaction, soil texture, soil moisture, and weight of the implement. Slope tracking with a dozer usually creates lightly swollen depressions. Vegetation that is present at the time of the operation is crushed and spread on the surface as a mulch. The microbasins have been found to perform successfully in concentrating small amounts of rainfall on arid lands though the length of time for effectiveness of the operation is reduced when operating in coarse textured soils. In addition to farm implements (cultipackers), track construction equipment or sheeps-foot roller equipment can also be used to form the imprint pattern. Specialized imprinting equipment such as the Dixon Land Imprinter are also available. These specialized types of imprinters are based on large drum rollers with angle iron welded to the surface to create geometric patterns. The Dixon Land Imprinter was developed to provide the type of surface discussed by Dixon (1975) in his air-earth interface concept. The furrows can collect up to 2 inches of rainfall and rough, rocky terrain with slopes up to 45 percent can be treated (Larson, 1980).

Pitting, a valuable water conservation and erosion control measure in arid and semi-arid regions, is a mechanical treatment that creates small basins or pits. This 1930's era practice is done with modified disk pitters, drum or rotary pitters, and modified listers. The most practical pitting equipment to be considered for use at Black Mesa is modified disk plows. The primary modification involves the mounting of eccentric disks, deeply-notched, or cutaway disks to create the pits. The pits created are three to five feet long with a four to eight-inch depth and an eight to twelve-inch width (Valentine, 1971). The pits reduce runoff, concentrate water for increased infiltration, and provide favorable microsites for vegetation establishment and development. While pitting provides positive benefits to plant establishment and development on seeded ranges, pits may only last three to five years in the semi-arid Southwest (Barnes et al., 1958), especially if coarse textured soils are encountered.

As stated earlier, the primary surface mechanical manipulations to be employed at the Black Mesa and Kayenta Mines are deep ripping and contour furrowing. Chisel plowing may be used in lieu of ripping where conditions allow and pitting may be used as an alternative to contour furrowing. Land imprinting and slope tracking are to be used in specialty situations such as rill and gully repair or areas of steep slope reclamation.

Traffic on redistributed soil surfaces will be kept to a minimum. Revegetation treatments such as seeding, mulching, and fertilization will be conducted on the contour to maintain furrow integrity and to reduce the potential for formation of surface imprints that could conduct downslope water flow. All slopes are mulched or cover cropped. The methods and application rates are described in Chapter 23. Finally, the Revegetation Plan (Chapter 23) is designed to achieve revegetation in a contemporaneous manner, using plant species with high utility for stabilizing the soil surface from erosion.

Plan Modification

The graded spoil sampling grid, sampling depths, and sampling methods described herein will be evaluated and modified from time to time based on the site-specific data collected. The amount of suitable soil that is salvaged will also be adjusted in accordance with the sampling results and the amounts and availability of suitable supplemental material. Any changes in the plan as outlined above will be submitted to the regulatory authority for approval prior to implementation.

Nutrients and Soil Amendments

Soil testing and amendment applications are addressed in the Fertilization section of Chapter 23. PWCC does not add fertilizer amendments to reclaimed areas as normal practice. Special reclamation areas have received nutrient and microbial supplements.

Approximate Original Contour

None of the components of this plant growth media reconstruction plan will alter PWCC's compliance with plans for achieving approximate original contour found in Chapters 21 and 26 or as depicted on Drawing 85352 and shown on maps presented with the annual Surface Stabilization Report.

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ATTACHMENT 22-1

SITE CLEARING AND ADVANCE SOIL

REMOVAL DISTANCE RESTRICTIONS

Revised 03/15/02

Attachment 22-1

Index

ATTACHMENT 22-1

SITE CLEARING AND ADVANCE SOIL REMOVAL

DISTANCE RESTRICTIONS

Introduction

Each mining area will have a maximum linear soil recovery distance and a maximum linear site clearing distance ahead of the most advanced highwall, or the coal recovery limit in cases where preparations are being made to open an initial cut. The specifications are intended to ensure the disturbances are limited to the smallest area practicable while meeting safety, reclamation, and operational requirements. The remainder of Attachment 22-1 provides the distance restrictions and associated justification.

Site Clearing and Soil Recovery Distance Specifications

The maximum linear soil recovery distance in each mining area is 1500 feet ahead of the primary highwall for sagebrush-grassland habitat and 2,000 feet for pinyon-juniper woodland when suitable material is occasionally encountered. The maximum linear site clearing distance in each mining area having advanced into, or advancing into pinyon-juniper woodlands is 2000 feet ahead of the primary highwall. The primary highwall is the most advanced unexcavated face of exposed overburden, coal, and innerburden in an open cast mine or the face or bank on the uphill side of a contour strip mine excavation.

These specifications will be applied to coal and burden removal activities immediately ahead of the primary highwall or the coal recovery limit in cases where preparations are being made to open an initial cut in the mine plan area to ensure mining proceeds in a safe and efficient manner while protecting environmental resources. Other mine support facilities such as sediment ponds, soil stockpiles, powerlines, substation sites, access roads, storage yards, environmental monitoring sites, and deadhead routes located in the mine plan areas that may require site clearing and/or soil removal activities isolated from the main advance disturbance areas are not considered part of the specifications. These isolated activities are permitted and limited to Category I or II disturbance areas shown on the Bonding Map, Drawing No. 89800.

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Justification for Distance Specifications

The specified maximum linear soil recovery distance and maximum linear site clearing distance is required for several reasons, which are discussed under the four major subheadings outlined below.

Safety. The overriding reason is safety--ensuring sufficient visibility to protect people and livestock from exposure to mining-related activities (e.g., blasting).

The Black Mesa Complex permit areas are unique among coal mining operations on Indian lands for several important reasons. Residents live year-round in or adjacent to the permit areas. Sheep herding, wood gathering, and other land use practices occur in close proximity to mining operations. Complicated mining conditions involving multiple seams and variable overburden, innerburden, and seam thicknesses are encountered. Approximately 450 to 500 acres must be disturbed annually to meet production requirements. Blasting frequencies may occur three times or more per day. People that are not local residents and are not employed by the mines are attracted to resources made available by the mines such as potable water, public coal, and firewood. The majority of these people are not aware of the hazards associated with mining activities.

A maximum distance of 2,000 feet of cleared area must be maintained ahead of sections of the pits advancing into or through pinyon-juniper woodland or steep terrain to provide unrestricted visibility. These distances are necessary to ensure an adequate margin of safety is provided for residents and others practicing customary and traditional land use activities in front of the advancing highwalls while minimizing, to the extent practicable, the disturbance area in advance of mining. It is not necessary to clear shrublands in this manner because the low stature of the plants and occurrence on relatively level terrain do not create visibility problems.

The minimum site clearing distance cannot be maintained in circumstances where portions of the pits have advanced in close proximity to lease and/or permit boundaries, public roads, stream buffer zones not authorized for disturbance, permanent facilities, unanticipated cultural resource finds, etc. In addition, the site clearing distance is limited to the minimum practical distance in advance of final pits to minimize unnecessary disturbance of native vegetation beyond the coal recovery line. In such cases, PWCC will utilize additional personnel to block shots and observe the highwall area in order to maintain safe operating conditions.

The approved site clearing procedures are given in Chapter 22 of the permit document. The woody material resulting from site clearing is most often placed ahead of the pits to provide firewood for the residents and others. This supply of wood attracts many people, often accompanied by children, who spend considerable time cutting and loading wood. It can take as much as a year for them to remove all the wood resulting from a given site clearing event. This human activity would place these people in close proximity to blasting and other activities occurring ahead of the highwall unless a buffer zone is maintained. In addition, local residents continue to use their customary use areas in undisturbed portions of the active mining areas. Livestock herding and other activities are conducted up to the edge of disturbance areas. PWCC's mining personnel sometimes must delay blasting procedures until the livestock can be herded away to a safe distance. The dense nature of the pinyon-juniper woodlands makes it difficult to see the livestock or people. These conditions make it imperative to create a wide band of cleared area between areas of local activity and the highwall. PWCC believes the 2,000 foot woodland clearing limit is sufficient to protect these people and provide the visibility needed to operate safely.

Operational Requirements. In addition to safety-related reasons, there are several operational reasons for needing a maximum soil recovery distance of 1,500 feet for sagebrush-grassland habitat and 2,000 feet for pinyon-juniper woodland when suitable material is occasionally encountered.

Mining conditions at the Black Mesa Complex create the need to maintain the specified soil recovery distances. Multiple seams, variable overburden, innerburden, and seam thicknesses, and variable coal quality within and between seams are encountered in all pits. A large number of acres must be disturbed to meet annual production requirements. Occasionally, benches must be developed in advance of the main burden stripping operations to recover perched seams in order to maximize coal recovery and to bench rolling hills to level the drilling and dragline highwall benches or remove thick burdens. These benching operations are performed using auxiliary stripping equipment (dozers, scrapers, trucks, and shovels).

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Substantial amounts of coal inventory must be exposed in the pits for blending purposes. PWCC's contract commitments require providing a product containing the lowest possible sulfur content to assist the customer in efforts to protect regional air quality and visibility.

In addition, the pits typically are shaped in a "U" or have doglegs to extend pit length. In "U"-shaped pits (e.g., N-9, J-21) and pits with both (J-19), mining equipment must cycle from one leg of the "U" or dogleg to the other. It is necessary to provide access for the stripping equipment and electrical power distribution system to cross the interior area and top of the "U" or dogleg. Soil must be removed in these areas to avoid contamination caused by equipment maintenance, cable maneuvering, traffic, etc. This area can extend 1,500 to 2,000 feet, based on the length of the dogleg or arms of the "U".

The formation of advance benches necessitates extending soil recovery further in advance of mining to avoid flyrock contamination, and equipment-related disturbances. In addition, adequate visibility must be maintained when blasting is conducted.

The variable coal quality and seam and burden layout mandates utilization of more mining equipment dispersed in more locations throughout the pits at the Black Mesa Complex than other operations conducted in areas with fewer and thicker seams and more regular partings. This necessitates distributing electrical power to several separate locations, and moving power transmission cables frequently. A trunk power line is typically run the entire length of the pit and is kept at least 1,000 feet ahead of advance benches to protect it from blasting damage. Lateral feeder cables distribute power to the portable substations located in the advance soil recovery area, which in turn distribute power to the various operating equipment. This required power distribution necessitates deployment and movement of ground cable over considerable distances, at numerous points, and at high frequencies to accommodate equipment movement. This condition is further complicated by doglegs in the pits where power must be distributed to two pit sides. Dragging the cable and portable substations from place to place cannot be conducted efficiently unless the vegetation and soil is removed. Soil contamination could occur if it was not removed prior to working in these areas. Cable crossover hazards would be created when scrapers are actively recovering soil unless it is removed prior to cable layout. In addition, sufficient distance must be maintained to pull cable back away from the highwall to avoid damage by flyrock.

Reclamation Requirements. PWCC is required to maintain a dynamic inventory of suitable plant growth media to ensure adequate material is available to mitigate acid- or toxic-forming materials that may be encountered near the surface of graded mine spoils with a minimum of four feet of suitable material. Soil deposits are not uniformly distributed. The main deposits of soil material occur in sagebrush communities in drainage bottoms or nearby terraces and on upland benches. These areas are separated by larger acreages of pinyon-juniper woodland where the soils are thinner and typically cannot be recovered due to high rock content, unsuitability, or slope restrictions. Mining operations result in the disturbance of approximately 450 acres per year. Comparable acreages are reclaimed, although as many as 900 acres have been reclaimed in years where average disturbance levels were exceeded or when pit closures occurred. In order to meet this reclamation demand, soil recovery in the main sagebrush-grassland deposit areas must extend well ahead of mining areas (up to a maximum of 1,500 feet). The adjacent pinyon-juniper woodland areas are cleared primarily for the aforementioned safety reasons, for the firewood resource, and to facilitate routing soil recovery equipment from recovery to redistribution or storage areas.

The approved minesoil reconstruction plan (Chapter 22) states that soil will be promptly redistributed on final graded spoils, when practicable. In order to accomplish this task, earth bridges or plugs are constructed across the active pits to reduce haulage distances. The plugs are temporary since cycling of the major excavation equipment occurs every 90 to 180 days and coal loading equipment occurs in less than 20 to 30 days, depending upon pit length and burden depth. Soil recovery activities in a given section of recovery area must be concentrated for as long as possible during the period a plug is available. This occasionally necessitates extending the recovery area 1,500 feet in advance of the pit to meet reclamation demand and to control costs. It would be impractical and costly to continue soil recovery after the plug is removed by mining because of the long haulage distances created.

PWCC's Black Mesa Complex that includes former mines separately designated as Kayenta Mine and Black Mesa Mine, maintains a fleet of scrapers for soil handling and also has a contracted fleet to support the additional soil handling demands. The mines have been in operation for about 30 years. Experience has shown that the current equipment is sufficient to meet the mines' soil handling needs and other miscellaneous tasks (e.g., impoundment construction) without creating costly idle time and unnecessary mobilization and demobilization costs. The equipment must conduct soil activities at multiple pits during the permit term. To control mobilization and demobilization costs and maintenance efficiency, and to provide adequate supervision, the fleets are deployed in concentrated areas for extended periods of time to handle soil. As much material as possible must be moved in a given pit or pit subarea before the fleets are moved to new locations. Restricting maximum recovery distances to less than 1,500 feet would cause mobilization and demobilization of the scraper fleets at greater frequencies with concomitant cost increases, lower efficiency, and fewer graded acres topsoiled at a given pit and time.

In summary, the previously specified maximum soil recovery and site clearing distances at the Black Mesa Complex are required for numerous operational, reclamation, and safety-related reasons. The distances were not arbitrarily chosen, but represent real conditions that have existed for the past 30 years. These conditions are unique to the Black Mesa Complex and Kayenta Mine due to the environmental, vegetative, climatic, soil, and geologic conditions encountered.

The 1500-foot maximum linear soil recovery distance for sagebrush-grassland habitat represents approximately ten cuts at current pit widths. Given the present, short-term pit lengths and production schedules, the pits cycle between 2.5 and 4 cuts per year. Therefore, the specified soil recovery distance represents from 2.5 to 4 years of pit advance. However, changing market or local conditions could cause acceleration in production or shorten pit lengths, thus resulting in shorter periods of time.

<u>Protection of the Environment</u>. The approved permit document contains detailed analyses of the environmental effects of operations at the Black Mesa Complex. Analyses cover all environmental media and consider operational activities (including soil recovery and site clearing) that represent the real on-the-ground conditions. Approved measures to protect the environment or mitigate adverse impacts were developed from the analyses. Ongoing wildlife, vegetation, soils/spoils, air quality, and surface and ground water quality and quantity monitoring programs have been implemented to ensure the operations are conducted in a manner protective of the environment.

Regulatory Compliance

The following discussion addresses compliance with the regulations related to soil recovery.

Part 30 CFR 816.100. The 816.100 contemporaneous reclamation regulation applies to reclamation scheduling on the spoil side, not in the maximum linear soil recovery distance area; however, the soil handling plan has been designed to comply with 30 CFR 816.100 to ensure all reclamation efforts proceed as contemporaneously as practicable pursuant to the reclamation schedule presented in Chapter 20. Sufficient soil must be recovered in a timely manner to prevent loss or contamination of the resource and provide a direct haul resource for final graded areas. The specified maximum linear soil recovery distances are, in fact, the minimum needed to ensure contemporaneous reclamation.

Soil types, distribution of suitable materials, and associated salvage thickness values were based upon detailed order 1/2 soil surveys and approved suitable standards (Chapter 8). An extensive soil salvage schedule and balance for the Black Mesa Complex is presented in Tables 3 through 16 (Chapter 22) for each individual mine pit area. The tables detail the quantity of soil salvaged for the life-of-mine operation. The information given in the tables demonstrates adequate plant growth materials are available and will be salvaged and replaced to achieve reconstructed minesoil productivity consistent with the postmining land uses in each disturbance area.

Part 30 CFR 816.22(c). Pursuant to 30 CFR 816.22(c)(1), all soil material is promptly redistributed on final graded spoil, whenever practicable. Soil storage is required for numerous mine support facilities (Chapter 22, Tables 3 through 16); the box cut spoil area including the first three to five pits, advance soil removal ahead of the pit in new mine areas, final pit areas including highwall reduction, small irregular corner areas of the mine where final reclamation is not practicable until the entire coal area is removed, and thin or zero-salvage areas such as pinyon-juniper habitat. Additionally, large quantities of soil must be salvaged and stored to bury unsuitable spoil with up to four feet of suitable material when unsuitable spoil is encountered. Sufficient long-term soil storage piles are essential to ensure a dynamic inventory of soil resources are available for all final reclamation areas including facilities, final pits, subsequent permit terms, and spoil mitigation.

Pursuant to 30 CFR 816.22(c)(2), soil is segregated and kept separate from any soils or overburden that would not be considered suitable (Chapter 22). Soil stockpiles are located in areas that will not interfere with the mining operation and where wind and water erosion, and contamination are minimized. Soil stockpile locations for the Black Mesa leasehold are shown on Drawing 85210. Stockpiles, including linear piles that will remain in place for more than one year are seeded with the special, quick establishing, persistent stabilization mix (Chapters 22 and 23).

Additional protection measures are also used to prevent soil loss, prevent compaction or contamination, and protect the vegetation. These measures include perimeter berms and/or ditches, fencing, and signs (Chapter 22).

The aforementioned procedures presented in Chapters 22 and 23 of the Black Mesa Complex Permit AZ-0001D ensure the soil is chemically and physically maintained in a usable noncontaminated condition for sustaining vegetation when restored during reclamation.

Pursuant to 30 CFR 816.22(c)(3), temporary redistribution of soil materials near facility sites is not typically practiced in order to prevent contamination of the resource and because stockpiling has not been detrimental to the quality or quantity of the soil resource. In addition, this practice would result in substantially increased disturbances in non-mining areas to create the space needed to accommodate the millions of cubic yards of material in storage. The loss of habitat and grazing capacity is not warranted.

<u>Part 30 CFR 816.95(a)</u>. Soil stockpiles are located in areas where wind and water erosion are minimized (Chapter 22). The exposed surfaces of soil stockpiles in place for more than one year are seeded with the special, quick establishing, persistent stabilization mix (Chapters 22 and 23). Perimeter berms and/or ditches, fencing, and signs are additional protection measures used at stockpile sites to prevent erosion and protect the vegetation (Chapter 22).

Exposed surfaces created by grading and topsoiling are protected and stabilized by contemporaneous reclamation practices (soil redistribution, contour furrowing, seeding and mulching).

Once the soil has been removed, the exposed surface in advance salvage areas most often consists of slightly consolidated weathered bedrock. This material resists transport and has low susceptibility to wind and water erosion. In high traffic areas, water trucks are assigned to control dust and minimize wind erosion. The results of monitoring air quality and surface water quality and quantity clearly show that surfaces exposed in soil recovery areas are not contributing to air pollution or increased sediment loads in receiving streams.

Part 30 CFR 816.42. All surface runoff from advance soil salvage areas is controlled by the pit area and/or perimeter sedimentation ponds. The ponds assure compliance with the applicable provisions of the Clean Water Act and with the effluent limitations for coal mining promulgated thereunder. The NPDES monitoring is described in Chapters 6, 16, and 17.

Part 30 CFR 816.41(a). The advance soil salvage area is minimized to the extent practicable as specified in Chapter 6 and discussions included herein. Protection of the hydrologic balance is thoroughly addressed in Chapters 16 and 17.

Part 30 CFR 816.45(b)(1). This rule applies to elective alternative sediment control methods and emphasizes limiting the area disturbed at any given time through contemporaneous reclamation behind the pit. Disturbing the smallest practicable area is one method considered by PWCC in the sediment control program. In order to avoid enforcement actions, PWCC must permit a maximum linear soil recovery distance area; however, from an operational standpoint only the smallest practicable area within the maximum linear soil recovery distance area is actually disturbed to facilitate an efficient mining operation. In actuality, the total distance between the leading edge of the reclamation to maximum ahead-of-pit disturbance limits is small relative to other large surface mines. This is indicative of successful efforts to conduct contemporaneous reclamation.

Part 30 CFR 800.4(c). As stated herein and as provided in Chapter 24, Bonding, the maximum linear soil recovery distance area is included in the bond calculations and adequate bond is included to reclaim the advance soil salvage area.

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Section 515(b)(5) and (6) of the Surface Coal Mining and Reclamation Act of 1977 (SMCRA) states, "...if not utilized immediately, segregate it (topsoil) in a separate pile from other spoil and when the topsoil is not replaced on a backfill area within a time short enough to avoid deterioration of the topsoil, maintain a successful cover by quick growing plants, or other means thereafter so that the topsoil is preserved from wind and water erosion, remains free of any contamination by other acid or toxic material, and is in a usable condition for sustaining vegetation when restored during reclamation..." and "restore the topsoil or the best available subsoil which is best able to support vegetation".

The current soil handling plan in the AZ-0001D PAP addresses Section 515(b)(5) and (6) of the Surface Coal Mining and Reclamation Act of 1977 (SMCRA). Recent studies conducted in the southwest show microbial numbers and populations can be established on soil replaced from long-term stockpiles within a few years following topsoiling and revegetation. A list of relevant studies is contained in the Referenced Literature section of this attachment. Studies performed at the Black Mesa Complex indicate microbial populations and activity levels for soil respread from stockpiles recovers quickly (one to four years) and does provide a biologically active (nutrient cycling and mineralization) environment for successful reclamation.

PWCC agrees that live handling soil to graded spoils is a highly beneficial and economic method of handling soil as compared to stockpiling. PWCC has increased this method of handling soil over the last several years where operations permit. PWCC has also increased its use of short duration long linear soil stockpiles. A mosaic of direct hauled and stockpile soiled areas are being established over the reclaimed landscape.

Soil biological activity, including microbial numbers, dehydrogenase activity, and fungal distribution, is reduced during storage. The low microbial activity of stockpiled soil is attributed to the lack of a continuous flow of organics into them from a vegetative cover and to the poor physical environment. Although the biological component may be significantly altered because of soil segregation and storage, when stockpiled soil is respread, the biological activity is restored and reestablished in reclaimed soil areas quite quickly by topsoiling, mulching, seeding native host species, using inoculated seed, planting inoculated host seedlings, microbial applications, and/or topdressing with direct hauled soil.

Even under ideal reclamation circumstances, the first year of reclamation is dominated by annual vegetation communities with the second year less so as perennial species become established and more dominant. During this period, even direct hauled, toplifted soil areas would lose soil microbial viability because of a reduction in host plant availability. In particular, vesicular-arbuscular mycorrhizal (VAM) will be reduced regardless of topsoiling methods because annuals do not form mycorrhizae associations and early to mid-seral species form different mycorrhizal associations from those found in late seral to climax communities.

Stockpiling soil for a short period of time (two years or less as suggested) will not greatly enhance the viability or productivity of the soils for the reasons stated above. Even seeded stockpiles will have an early annual dominated composition and at best perennial grass composition representing early to mid-seral species. Root activity will be restricted to the upper layers of the pile, and any microbial associations will be concentrated there. The interior of the pile, representing the vast majority of the volume will have reduced viability because of the lack of host species and the physical environment.

Numerous researchers in the west suggest a majority of the soil microbial activity occurs in the top 15 cm of pinyon-juniper and sagebrush soils. Activity occurs at deeper rooting depths, but at a much-reduced level. PWCC salvages large quantities of sagebrush soils that make up the majority of the soil placed in stockpiles. Salvage depths for these soils can reach 10 to 20 feet. Since much of the salvaged soil comes from below the maximum rooting depth of four to six feet, and well below the zone of primary activity, it will have inherently reduced microbial levels or no activity. Thus, the reduced viability of stockpiled soil is more a function of the nature and depth of the salvaged material than time of storage.

Research studies indicate even long-termed stored soil helps assure a more rapid reestablishment of many critical biological processes such as mineralization, carbon and nitrogen recycling, stable organic matter production, and symbiotic relationships with host plants. Studies conducted in the southwest show microbial numbers can be established on soil replaced from long-term stockpiles within three months while a diverse, stable microbial population similar to undisturbed soils can be obtained within four years after topsoiling and revegetation.

Recolonization of topsoiled reclaimed sites by various bacteria and fungi occurs because of the apparent presence of propogules either in the soil or from adjacent sources and the reestablishment of the critical symbiotic relationships by establishing the necessary host plant species by seeding predominately native seed mixes. These plants provide necessary exudates, photosynthate, and carbon sources for microbes. PWCC seeds predominately native seed mixes at the Black Mesa Complex.

PWCC agrees that the maintenance or restoration of microbial populations in reclaimed areas is a critical factor in reclamation success, particularly for certain species. PWCC is concentrating pinyon plantings in direct hauled, toplift native pinyon-juniper soils and weathered residual upper overburden replaced on selected reclaimed sites. PWCC has been increasing the direct hauling of soil where practicable. This use of direct hauled soil in combination with stockpiled soil results in patchy or mosaic patterns that have more viable microbial populations. These patches or islands provide additional propagules for spread into adjacent areas. In 1993, PWCC directed its seed vendor to inoculate all seed with a product called AZ-KOTE. This is a nitrogen fixing bacterium inoculant for grasses based on a strain of Azospirillum brasilense.

Extensive monitoring data collected in reclaimed areas to evaluate the progress and success of revegetation for the past 20 years further documents the viability of reclaimed minesoils to support diverse and sustained vegetation communities. This is the ultimate testimonial to the success of PWCC's soil handling practices at the Black Mesa Complex that should not be ignored.

Bonding Considerations

The Category I active pit bonding area for each mine plan area is given in Chapter 24 entitled "Bonding" (see Attachment 24-2, Table 24-2-2). The total area bonded for soil redistribution is shown on Table 24-2-7, "Topsoil Distribution Area". The maximum linear soil recovery distance area is included in the bond calculations and adequate bond is included to reclaim the advance soil salvage area.

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ATTACHMENT 22-2

Justification for Using Suitable Overburden
in Steep Slope, Key Habitat, Main Drainage Channel, and
Cultural Planting Reclamation Areas

Revised 03/15/02

Attachment 22-2

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ATTACHMENT 22-2

Justification for Using Suitable Overburden in Steep Slope, Key Habitat, Main Drainage Channel, and Cultural Planting Reclamation Areas

Steep Slope Areas. The proposed postmine landscape plan for the Black Mesa leasehold includes steep slope (3:1 and 4:1) reclamation areas. Reclamation efforts may be hindered if existing soil reserves are utilized in steep slope areas. Therefore, suitable overburden will be utilized as a supplemental surface plant growth media (topsoil supplements) for reclamation of steep slope areas on the Black Mesa leasehold. Suitable overburden is recommended primarily for its inherent stability and low erodibility potential.

Research studies indicate that when overburden is used as a topdressing or plant growth medium for mined land reclamation, it must have at least 30 percent by volume fines (less than 2 mm in size) to adequately support and maintain satisfactory vegetative cover (Smith et al., 1976; BLM, 1977; Schafer, 1979; Fisher and Deutsch, 1983; Soil Survey Staff, 1983; Daniels and Amos, 1985). Additionally, the content of rock fragments greater than 3 inches should be less than 35 percent by volume (OSMRE, 1985). These rock fragment standards will be utilized to evaluate plant growth media suitability within the 0 to 1 foot depth of steep slope, key habitat, cultural planting, and main drainage channel reclamation areas.

Rock fragments on the surface and in the surface layer will protect the plant growth medium from wind and water erosion (Box, 1981; Edwards et al., 1984; Simonton et al., 1984). Rock fragments protect the soil from erosion mainly by attenuating raindrop impact energy, causing flow energy to be dissipated on nonerodible fragments, and slowing the velocity of surface runoff (McCormack et al., 1984). The effect of rock fragments on K values in the Revised Universal Soil Loss Equation (RUSLE) has been evaluated and is discussed in Toy and Foster (1998). Rock fragments resting upon the soil surface that protect the soil from raindrop impact and runoff are taken into account in the cover-management (C) factor of RUSLE.

Suitable spoil erodibility K values were determined for 38 reclamation sites located in the J-3, J-7, J-1/N-6, N-1, N-2, and N-7/8 pit areas (see Drawing 85302, Volume 18 for locations of sample sites). Erodibility values for the dominantly clay loam/sandy clay loam plant growth media ranged from 0.04 to 0.21 with a mean of 0.12 and a standard deviation of 0.04 (see Chapter 26, Attachment A, Table 5). Volumetric rock fragment content for these 38 sites ranged from 15 to 70 percent with a mean of 40 percent and a standard deviation of 13 percent. Regraded spoil sampling in the J-21 pit reclamation area during 1986 and 1987 showed the codominant textures to be sandy loam and loam based upon 208 suitable (according to Table 11) overburden sample sites (see Table 22-2-1). The estimated K factor is 0.10 for sandy loam, loam, sandy clay loam, and clay loam suitable plant growth media with 35 to 70 percent rock fragments (Soil Conservation Service, 1984).

Rock fragments in plant growth media reduce water-holding capacity, but increase the infiltration and permeability rates (Munn et al., 1987). The high infiltration and permeability rate of the plant growth medium is important for successful steep slope reclamation because of the high intensity precipitation events that are common throughout the Black Mesa leasehold. In semiarid regions, the deeper penetration of precipitation will also reduce the upward movement of water in response to evaporation (Rivers and Shipp, 1972). In semiarid regions, the deeper penetration of precipitation and greater relative availability of water at low moisture contents in soils containing rock fragments often result in these plant growth media being more productive than finer textured soils in comparable upland topographic positions (Munn et al., 1987). Rock fragments are not inert, but may contribute in varying degrees to water-holding capacity, including free water between rocks, and nutrient availability (Schafer, 1979; Ashby et al., 1984; Kolar, 1985; Ashby and Kolar, 1985). Weathered and soft rock fragments also serve as pathways for root growth and water/air movement (increased porosity and aeration) through dense or compacted fine earth material (reduced density).

Overburden which meets the soil suitability criteria defined in Table 11 will be utilized as supplemental surface plant growth media on steep slope (4:1 or greater), key habitat, cultural planting, and main drainage channel reclamation areas. Suitable spoil, near-surface spoil, and topsoil characteristics for reclamation sites located in the J-3, J-7, J-1/N-6, N-1, N-2, N-7/8, and J-21 reclamation areas are presented in Tables 22-2-1, 22-2-2, and 22-2-3, respectively. Suitable spoil typically has a neutral to slightly

TABLE 22-2-1

Suitable Spoil (Supplemental Surface Plant Growth Media) Characteristics for Reclamation Sites Located in the J-3, J-7, J-1/N-6, N-1, N-2, N-7/8, and J-21 Reclamation Areas

Sample Site[1]	Hot Water Soluble Boron ppm	Hot Water Soluble Selenium ppm	Paste pH	Paste Extract EC mmhos/cm	SAR	Acid Base Potential[2]	Saturation Percentage %	Particle Size Sand (%)	Particle Size Silt (%)	Particle Size Clay (%)	Very Fine Sand %	Texture[3]
J3/S/6	0.6	0.06	7.5	3.0	7.6	16.6	54.3	23.5	28.6	47.9	7.7	C
J3/S/7	0.5	0.02	7.7	2.7	1.1	54.6	44.8	39.3	29.2	31.5	12.7	CL
J3/N/3	0.3	0.03	7.8	2.3	2.3	31.1	40.7	47.2	21.7	31.1	12.5	SCL
J3/N/4	0.1	0.09	7.6	2.8	3.2	33.4	47.6	40.6	21.8	37.6	11.5	CL
J3/N/5	0.3	0.04	7.7	1.4	2.9	46.6	38.3	54.1	19.0	26.9	13.7	SCL
J3/N/9	0.4	0.03	7.7	4.0	2.8	10.0	46.3	34.1	29.5	36.4	15.7	CL
J3/N/7	0.2	0.03	7.4	3.6	3.0	13.3	54.8	28.0	25.4	46.6	11.5	C
J3/N/8	0.2	0.10	7.5	3.8	3.7	20.0	46.4	31.9	29.2	38.9	14.1	CL
J3/N/12	0.4	0.07	6.6	4.4	3.3	15.0	54.0	37.3	20.4	42.3	6.9	C
J3/N/13	0.3	0.21[4]	7.0	5.1	7.9	6.8	57.8	28.3	21.4	50.3	6.0	C
J3/S/1	0.1	0.03	7.6	2.2	1.4	41.2	56.0	21.3	32.0	46.7	8.2	C
J3/S/2	0.1	0.02	7.9	2.5	1.9	38.0	44.4	39.1	27.5	33.4	15.6	CL
J3/S/3	0.7	0.06	7.7	2.8	1.9	27.6	48.9	23.9	34.6	41.5	10.6	C
J3/N/6	0.7	0.13	6.9	2.7	2.2	4.3	40.5	49.1	21.5	29.4	9.8	SCL
J3/N/2	0.3	0.07	7.0	1.5	0.7	17.2	42.9	48.7	21.2	30.1	7.6	SCL
J7/2/2	1.3	0.05	7.3	5.7	5.6	9.3	39.2	54.1	25.3	20.6	15.5	SCL
J7/2/3	0.4	0.03	7.4	5.5	7.5	12.9	36.6	50.8	27.2	22.0	14.6	SCL
J7/1/3	1.2	0.01	8.0	2.5	4.4	95.1	43.4	57.9	18.2	23.9	16.7	SCL
J1-N6/1/1	0.8	0.02	7.6	3.1	1.4	49.3	42.7	49.1	23.0	27.9	19.8	SCL

Table 22-2-1 (Continued)

Suitable Spoil (Supplemental Surface Plant Growth Media) Characteristics for Reclamation Sites Located in the J-3, J-7, J-1/N-6, N-1, N-2, N-7/8, and J-21 Reclamation Areas

Sample Site[1]	Hot Water Soluble Boron ppm	Hot Water Soluble Selenium ppm	Paste pH	Paste Extract EC mmhos/cm	SAR	Acid Base Potential[2]	Saturation Percentage(%)	Particle Size Sand (%)	Particle Size Silt (%)	Particle Size Clay (%)	Very Fine Sand(%)	Texture[3]
J1-N6/1/2	0.7	0.02	6.9	4.5	2.7	2.3	45.3	47.2	24.9	27.9	12.9	SCL
J1-N6/2/5	0.6	0.01	6.5	3.9	1.4	28.8	46.9	52.5	19.0	28.5	6.8	SCL
J1-N6/4/2	0.9	0.06	7.3	4.4	3.3	10.9	42.8	46.0	24.7	29.3	10.6	SCL
J1-N6/4/3	0.3	0.01	7.8	2.7	2.5	66.8	45.0	49.3	23.4	27.3	14.1	SCL
J1-N6/5/2	1.2	0.06	6.4	4.4	3.9	3.8	40.2	49.8	22.6	27.6	11.3	SCL
J1-N6/5/3	2.9	0.03	5.9	6.1	3.3	4.5	40.0	54.2	21.2	24.6	8.2	SCL
J1-N6/6/2	0.6	0.01	8.0	3.5	2.1	57.4	34.9	68.8	14.8	16.4	11.4	SL
J1-N6/6/4	0.6	0.01	8.0	2.7	2.1	88.1	43.6	52.7	17.8	29.5	23.8	SCL
N1/1/3	0.5	0.05	7.3	5.4	4.7	27.0	55.3	32.0	28.9	39.1	11.3	CL
N1/1/4	0.6	0.02	6.9	4.1	1.7	24.0	49.6	38.5	26.5	35.0	17.8	CL
N1/1/5	0.5	0.04	7.4	4.6	2.9	46.0	45.9	39.5	27.7	32.8	13.6	CL
N1/2/7	0.8	0.01	6.9	7.0	8.6	12.1	42.1	56.0	20.8	23.2	10.7	SCL
N1/3/1	0.2	0.03	7.5	3.7	3.8	29.6	47.0	42.4	26.8	30.8	12.4	CL
N1/3/2	0.5	0.04	7.2	5.3	8.0	22.4	51.7	42.6	25.1	32.3	11.5	CL
N2/1/4	0.6	0.10	7.4	3.7	1.4	83.1	37.4	47.9	27.1	25.0	13.2	SCL
N2/2/2	0.7	0.03	7.4	6.3	2.4	17.2	46.4	46.0	27.4	26.6	14.0	SCL
N2/2/4	0.5	0.02	7.2	7.3	7.8	21.8	44.7	42.0	28.0	30.0	15.5	CL

Table 22-2-1 (Continued)

[S]uitable Spoil (Supplemental Surface Plant Growth Media) Characteristics for Reclamation Sites Located in the J-3, J-7, J-1/N-6, N-1, N-2, N-7/8, and J-21 Reclamation Areas

Sample Site[1]	Hot Water Soluble Boron ppm	Hot Water Soluble Selenium ppm	Paste pH	Paste Extract EC mmhos/cm	SAR	Acid Base Potential[2]	Saturation Percentage (%)	Particle Size Sand (%)	Particle Size Silt (%)	Particle Size Clay (%)	Very Fine Sand (%)	Texture[3]
J1-N6/6/3	1.6	0.04	7.8	5.5	3.2	60.6	42.5	50.6	22.0	27.4	12.8	SCL
N7-8/1/1	1.6	0.10	7.5	7.0	1.9	7.7	42.3	37.9	27.7	34.4	11.6	CL
MEAN	0.6	0.05	7.3	4.0	3.5	30.4	45.3	43.5	24.6	31.9	12.5	CL
STD. DEV.	0.5	0.04	0.5	1.5	2.2	24.4	5.7	10.5	4.3	7.9	3.7	--
(N = 38)												
J21 Summary[5]												
MEAN	1.1	0.02	7.1	4.1	3.0	31.7	42.0	57.5	27.7	14.8	--	SL
STD.DEV.	0.5	0.03	0.5	1.7	2.6	30.5	5.9	10.1	5.8	5.6	--	--
(N = 208 except for B, N=11; and Se, N=38)												

(1) For sample site location, see Drawing 85302, Volume 18.

(2) Unit is tons calcium carbonate equivalent per 1000 tons of material.

(3) C - clay; CL - clay loam; SCL - sandy clay loam; SL - sandy loam.

(4) Not actually representative of suitable supplemental surface plant growth media since clay content exceeds 45 percent

(5) Summary of regraded spoil data from the J-21 reclamation area. Those sites which met the suitability criteria presented in Table 11 were utilized in this analysis (55 percent of total number of sites). The J-21 regraded spoil data is presented in the Vegetation, Wildlife, and Soils Resources 1986 Report for Black Mesa and Kayenta Mines.

Table 22-2-2

Suitable Spoil (Supplemental Surface Plant Growth Media) Characteristics of the Surface 6 to 12 Inches for Reclamation Sites Located in the J-3 Reclamation Area

Sample Site[1]	Paste (pH)	Paste Extract EC (mmhos/cm)	SAR	Acid Base Potential[2]	Saturation Percentage (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Texture[3]	Organic Matter (%)	Total Nitrogen (ppm)	$NaHCO_3$ Phosphorus (ppm)	NH_4OAc Potassium (ppm)
J3/S/6	7.7	0.9	3.9	12.9	46.2	25.3	30.4	44.3	7.4	C	7.9	10	5.2	284
J3/S/7	7.8	0.4	0.9	37.7	48.1	21.6	37.3	41.1	10.4	C	2.3	6	12.5	227
J3/N/3	7.9	0.6	1.0	30.0	41.2	41.5	22.3	36.2	12.1	CL	1.6	4	5.5	144
J3/N/4	7.7	0.6	2.2	28.7	41.2	37.1	24.9	38.0	12.8	CL	2.5	5	6.0	238
J3/N/5	7.7	0.5	1.2	36.7	34.7	53.7	19.5	26.8	14.7	SCL	1.1	5	7.0	145
J3/N/9	7.6	0.6	0.8	9.1	42.3	28.7	31.8	39.5	14.3	CL	2.4	2	10.9	179
J3/N/7	7.7	1.1	2.3	19.9	54.6	21.3	26.0	52.7	10.4	C	2.6	4	8.6	216
J3/N/8	7.8	0.7	3.8	19.2	40.7	28.3	27.8	43.9	11.9	C	2.5	3	2.2	172
J3/N/13	7.4	1.7	5.4	13.3	46.2	21.3	24.5	54.2	5.0	C	11.3	10	7.1	364
J3/S/1	7.7	1.0	0.7	34.3	57.3	21.9	32.0	46.1	7.8	C	3.0	10	8.0	291
J3/S/2	7.9	0.4	0.6	26.4	45.4	29.0	33.3	37.7	11.9	CL	1.2	4	4.5	205
J3/S/3	7.5	0.5	0.7	20.7	45.4	20.4	36.0	43.7	9.3	C	2.8	6	9.7	225
MEAN	7.7	0.8	2.0	24.1	45.3	29.2	28.8	42.0	10.7	C	3.4	6	7.3	224
STD.DEV.	0.1	0.4	1.6	9.7	6.1	10.2	5.5	7.4	2.9	--	3.0	3	2.9	64
(N = 12)														

(1) For sample site location, see Drawing 85302, Volume 18.

(2) Unit is tons calcium carbonate equivalent per 1000 tons of material.

(3) C - clay; CL - clay loam; SCL - sandy clay loam.

Table 22-2-3

Soil Characteristics for Reclamation Sites Located in the J-3, J-7, J-1/N-6, N-1, N-2, and N-7/8 Reclamation Areas

Sample Site(1)	Paste pH	Paste Extract EC (mmhos/cm)	SAR	Acid Base Potential(2)	Saturation Percentage (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Texture(3)	Organic Matter (%)	Total Nitrogen (ppm)	$NaHCO_3$ Phosphorus (ppm)	NH_4Oac Potassium (ppm)
J3/N/12	7.9	0.4	1.2	103.3	42.5	38.3	25.9	35.8	16.1	CL	0.9	3	3.3	116
J3/N/6	7.6	0.6	0.3	16.0	44.1	33.8	28.7	37.5	11.4	CL	2.0	7	7.5	269
J3/N/2	7.3	2.8	1.3	26.6	42.5	38.0	26.5	35.5	11.4	CL	3.2	3	7.8	326
J7/2/2	7.6	2.5	1.1	7.7	36.7	62.2	19.0	18.8	20.4	SL	2.5	4	6.7	59
J7/2/3	7.9	0.5	0.4	35.8	36.7	56.2	21.3	22.5	19.6	SCL	1.2	2	4.2	75
J7/1/3	8.1	0.7	0.4	18.6	27.8	79.9	6.7	13.4	14.8	SL	0.5	5	1.5	56
J1-N6/1/1	8.0	0.4	0.4	26.8	37.2	60.4	16.8	22.8	20.6	SCL	0.7	8	7.7	146
J1-N6/1/2	7.8	0.5	0.2	22.9	37.8	59.3	17.7	23.0	27.3	SCL	1.1	5	14.2	188
J1-N6/2/5	7.9	0.5	1.1	41.4	37.4	57.0	18.8	24.2	27.9	SCL	1.3	5	6.6	121
J1-N6/4/2	8.2	0.5	4.8	11.4	34.8	58.8	25.7	15.5	42.5	SL	0.5	1	5.8	121
J1-N6/4/3	8.0	0.4	0.4	28.5	35.5	71.6	14.5	13.9	41.0	SL	0.9	2	2.6	112
J1-N6/5/2	7.9	1.1	1.6	48.8	40.3	67.6	15.2	17.2	40.7	SL	0.9	11	2.6	114
J1-N6/5/3	7.9	0.4	1.0	25.2	35.5	69.2	17.8	13.0	47.1	SL	0.3	4	4.3	144
J1-N6/6/2	8.2	0.4	1.6	63.3	35.5	60.4	16.6	23.0	29.2	SCL	0.3	3	3.0	97
J1-N6/6/4	8.2	0.6	2.5	50.1	32.7	65.1	13.1	21.8	29.8	SCL	0.4	1	1.7	106
N1/1/3	7.8	0.7	0.5	29.8	40.9	51.8	27.7	20.5	34.2	SCL	1.1	1	2.4	224
N1/1/4	7.7	0.9	0.4	39.8	40.6	45.8	29.0	25.2	25.5	L	1.6	1	5.2	176
N1/1/5	7.5	1.3	0.2	28.7	37.3	44.8	28.9	26.3	24.8	L	3.1	5	6.8	231
N1/2/7	7.7	1.0	1.2	29.9	33.7	68.1	16.6	15.3	21.0	SL	1.5	3	4.1	107

Table 22-2-3 (Continued)

Soil Characteristics for Reclamation Sites Located in the J-3, J-7, J-1/N-6, N-1, N-2, and N-7/8 Reclamation Areas

Sample Site[1]	Paste pH	Paste Extract EC (mmhos/cm)	SAR	Acid Base Potential[2]	Saturation Percentage (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Texture[3]	Organic Matter (%)	Total Nitrogen (ppm)	$NaHCO_3$ Phosphorous (ppm)	NH_4OAc Potassium (ppm)
N1/3/1	8.1	0.6	0.4	46.8	38.5	57.0	24.0	19.0	34.2	SL	0.6	5	14.2	155
N1/3/2	7.8	0.9	1.1	131.1	44.2	43.3	28.4	28.3	29.0	CL	1.2	7	9.4	277
N2/1/4	7.5	1.1	1.4	23.3	40.6	56.3	24.0	19.7	18.8	SL	1.7	2	1.7	159
N2/2/2	7.9	5.9	1.3	20.9	47.1	34.6	34.3	31.1	17.6	CL	1.8	5	9.5	151
N2/2/4	7.6	3.6	0.5	24.1	38.7	54.9	22.9	22.2	22.4	SCL	1.5	5	3.7	77
J1-N6/6/3	8.4	0.5	5.0	61.0	33.4	71.9	13.5	14.6	43.1	SL	0.2	5	1.7	59
N7-8/1/1	7.8	2.3	1.8	19.2	38.8	46.0	27.7	26.3	19.6	SCL	1.3	17	3.5	194
MEAN	7.9	1.2	1.2	37.7	38.1	55.9	21.6	22.5	26.5	SCL	1.2	5	5.4	148
STD.DEV.	0.3	1.3	1.2	27.5	4.2	12.3	6.6	6.9	10.1		0.8	3	3.5	71
(N = 26)														

(1) For sample site location, see Drawing 85302, Volume 18.

(2) Unit is tons calcium carbonate equivalent per 1000 tons of material.

(3) CL - clay loam; SCL - sandy clay loam; L - loam; SL - sandy loam.

alkaline reaction (pH = 7.1-7.3), low sodicity (SAR = 3 to 4), and slight salinity hazard (EC = 4 mmhos/cm). An excess neutralizing capacity of 30 to 40 tons of calcium carbonate equivalency is indicated by the positive acid-base potential.

The texture of suitable surface plant growth media will include predominantly sandy loam, loam, sandy clay loam, and clay loam materials based upon previous sampling results completed for the J-3, J-7, J-1/N-6, N-1, N-2, N-7/8, and J-21 reclamation areas (Table 22-2-1). Saturation percentage values were highly favorable (40-45 percent) indicating loamy material. This plant growth material with 35 to 70 percent volumetric rock fragment content and slight to moderate salinity should have a minimum available water-holding capacity range of 0.05 to 0.13 inches/inch (SCS, 1978; SCS, 1981; Soils Committee, 1984). This available water-holding capacity range is within the fair to good suitability classification for plant growth media (BLM, 1977; Schafer, 1979; Soil Survey Staff, 1983; OSMRE, 1985).

Soil and near-surface overburden characteristics for reclamation sites located in the J-3, J-7, J-1/N-6, N-1, N-2, and N-7/8 reclamation areas are similar for soil reaction, salinity, sodicity, acid-base potential, saturation percentage, silt content, organic matter, total nitrogen, phosphorous, and potassium (Tables 22-2-2 and 22-2-3). The near-surface suitable spoil has a significantly higher clay content. The soil has a significantly higher sand and very fine sand content.

A greenhouse evaluation of plant species for use in revegetation of Black Mesa overburden material was conducted in 1976 and 1977 (Mitchell, 1979). Results indicated that suitable spoil was generally superior in fertility and had fewer undesirable characteristics than surrounding native undisturbed soils. There was no significant plant production difference between soil and spoil materials. The spoil media generally showed less water stress than the Gila loam check soil. Differences in plant production were attributed to application rates of nitrogen and phosphorous fertilizer.

Forage quality studies were conducted in several reclaimed units in 1984 and 1985 to assess selected essential macro- and microelement concentrations in the reclaimed forage (Peabody Coal Company, 1986). The results suggest that the spoil chemistry and weathering processes that occur on the leasehold are not adversely affecting the uptake of either essential or toxic elements by the reclaimed vegetation. Rather, they indicate the forage is generally of high nutritive quality, and is capable of supporting the intended postmining land uses.

Sufficient volumes of suitable (according to Table 11) overburden or supplemental surface plant growth medium exist within the Black Mesa leasehold to reclaim all steep slope, key habitat, cultural planting, and main drainage channel reclamation areas. Approximately 14.8 feet of suitable near surface overburden currently exists throughout the Black Mesa leasehold (see Table 3). A minimum of about 8.9 feet exists in Mining Area J-7, while 23.8 feet occurs in Mining Area N-11. Additional suitable deep overburden is available throughout the leasehold as evidenced by a cursory overview of core data presented in Chapter 8 and Volume 12, Appendix B. The availability of excess suitable quality material is confirmed by the regraded spoil sampling data that indicate slightly more than 50 percent of all 1986 to 2000 sample sites consisted of suitable material (PCC, 1988; PCC, 1992; and PWCC, 1993-2001).

Following final grading, the upper three or four feet of spoil within steep slope reclamation areas will be sampled utilizing existing procedures described in the Graded Spoil Sampling Plan section of this chapter. The volumetric rock fragment content shall be determined for the 0 to 1 foot increment at each reclaimed parcel (Table 12). Graded spoils that are determined to be unsuitable according to criteria listed in Table 11, will be mitigated as previously described in the Graded Spoil Sampling Plan section of this chapter.

Soil testing and amendment applications for steep slope reclamation areas will be implemented on an as-needed basis. Revegetation success monitoring and revegetation trials will be utilized within the steep slope reclamation areas as described in Chapter 23. Soil and spoil samples will be collected at representative revegetation soil sample sites located in steep slope reclamation areas to correlate revegetation data (including forage quality) with soil chemical and physical characteristics and to verify the acceptability of using supplemental soil materials in this area. The list of soil and spoil analyses will, at a minimum, include all parameters listed in Table 12.

Key Habitat and Cultural Planting Areas. The proposed revegetation plan for the Black Mesa leasehold includes key wildlife habitat and cultural planting reclamation areas. A site-specific seed and seedling list is proposed for the key habitat and cultural planting areas (see Chapter 23). Utilization of existing soil and subsoil reserves within the key habitat and cultural planting reclamation areas may hinder revegetation efforts when using certain of the proposed plant materials. Therefore, supplemental residual soil and supplemental surface plant growth media will be utilized, in addition to existing soil reserves, to reclaim key habitat and cultural planting reclamation areas.

Three types of plant growth media, including supplemental residual soils, supplemental suitable overburden or spoil, and aeolian/alluvial soils, are used on final graded spoil within key habitat and cultural planting reclamation areas. Supplemental surface plant growth media will be used in the steep slope (4:1 to 3:1) key habitat reclamation areas whenever direct haul of residual soils is not feasible.

The supplemental residual soils will be used on all slope classes of key habitat and cultural planting reclamation areas whenever direct haul is feasible. Existing aeolian and alluvial soil will be utilized on key habitat and cultural planting reclamation areas that predominantly have slopes of 5:1 or flatter. Additional information pertaining to plant growth media preference, site-specific topography, and specie selection within key habitat and cultural planting areas is presented in the Revegetation Plan, Chapter 23.

Justification for utilizing a supplemental surface plant growth media within steep slope reclamation areas is contained in the steep slope section of this attachment. Sufficient quantities of suitable soil (1.8 feet) and suitable overburden (14.8 feet) or supplemental surface plant growth media, identified by the baseline soil survey, near-surface overburden, deep-core hole, regraded spoil, and highwall sampling programs are currently, or will be available within each Black Mesa mining area to replace the required four feet of suitable plant growth material within the upper portion of all reclamation landscapes, including steep slope key habitat and cultural planting areas (volume estimates and suitability evaluations are presented in the Steep Slope section of this attachment).

Physical and chemical analysis data for all premine soil types, including residual soils, is included in Volume 11, Appendix A, Attachments 2 through 6. The coarse-textured residual soils (Dulce and Travessilla) have no chemical properties limiting suitability. Physically, a moderately high rock fragment content (20 to 50 percent) makes these soils only marginally suitable as a source of salvageable topsoil (Volume 11, Appendix A, Page 25; Volume 8, Chapter 8, Page 13).

PWCC proposes to utilize residual soil or supplemental surface plant growth media with a moderate to high (15 to 70 percent by volume) rock fragment content within key habitat and cultural planting reclamation areas. Several authors have shown that woody plant establishment is benefited on plant growth media that have a moderate to high rock fragment content (Blake, 1987; Redente and Hargis, 1985; WRDC and Bunin, 1985; Ashby et al., 1984; DePuit, 1984; and Amendola et al., 1984). These supplemental plant growth media are equal to or more suitable for establishing and sustaining revegetation within proposed planting areas than the existing aeolian or alluvial soil for the following reasons. First, soil media with moderate to high rock fragment content are recommended for steep slope key habitat and cultural planting areas for site stability and low erodibility potential (see Steep Slope area discussion within this attachment). The Dulce and Travessilla soils have low erodibility values of 0.19 and 0.13, respectively (see Chapter 26, Appendix A, Table 4). Second, establishment of and competition from shallow-rooted herbaceous vegetation is effectively reduced by soils with a moderate to high rock fragment content. Third, the salvage and direct application of residual soils provides the potential for increasing the number of viable plant propogules from the woodland vegetation, under which the residual soils developed. Fourth, rock fragments in plant growth media reduces water-holding capacity, but increase the infiltration and permeability rates (Munn et al., 1987). Rock fragments may even contribute in varying degrees to water-holding capacity and free water storage between rocks (Schafer, 1979; Ashby et al., 1984; Kolar, 1985; and Ashby and Kolar, 1985). Increased infiltration and permeability rates will permit additional water to penetrate more deeply into the reclaimed soil profile. Free water storage and deep percolation will promote the establishment and perpetuation of deep rooted woody plants within key habitat and cultural planting reclamation areas.

The residual soils, including map units 1A, 1, 1B, 1C, 1D, 3A, 3BC, 3C, 3D, 3DE, 3E, 7B, 7C, 7D, and 7E are evenly distributed across the life-of-mine pit disturbance areas as identified on Drawings 85305A and 85305B, Sheets 1 through 15 (Volumes 19 and 20). The residual soils comprise a minimum of 35 percent of the J-1/N-6 mining disturbance area and a maximum of 75 percent of the N-10 area with a mean of about 50 percent for the entire Black Mesa disturbance area (see Volume 11, Appendix A, Table 15). PWCC proposes to utilize residual soils within key habitat and cultural planting reclamation areas as necessitated by demand and feasibility. Residual soils were originally proposed to be salvaged on an as needed direct haul basis as discussed in the Topsoil Material Suitability Evaluation section of Chapter 8 (Volume 8). The demand is dictated by the creation of key habitat, steep slope, and cultural planting reclamation areas. Feasibility is dependent upon availability of premine residual soil landscapes that can be accessed by soil salvage equipment. Soil salvage within Soil Map Units 1A, 1, 1B, 1C, 1D, 3A, 3BC, 3C, 3D, 3E, 7B, 7C, 7D, and 7E will often be restricted due to steep highly dissected sideslopes, clay textured areas, deeply incised drainage channels, severely eroded soils (predominantly affects depth to bedrock), and the juniper/pinyon pine canopy. The access, maneuverability, and efficiency of the salvage equipment would be severely restricted due to these conditions. Operator safety would also be in jeopardy. Therefore, soil salvage equipment will generally be limited to the longer and more continuous foothill sideslopes and transition zones between residual and alluvial soil map units, the less steep slopes (15 percent or less), localized swales, or concave bowls of ridges and sideslopes. After considering the aforementioned factors in conjunction with the premine affected lands topography (Volume 20, Drawing 85360, Sheets 1-4), soil salvage will be feasible over approximately 20 percent of soil map units with A, B, or C slope classes and less than 5 percent of soil map units with a D or E slope class.

Following final grading and prior to soil/subsoil, supplemental surface plant growth media, or supplemental residual soil redistribution, the upper three or four feet of spoil within key habitat and cultural planting reclamation areas will be sampled utilizing existing procedures described in the Graded Spoil Sampling Plan section of this chapter. The volumetric rock fragment content shall be determined for the 0 to 1 foot increment at each reclaimed parcel where residual, aeolian, or alluvial soils are not replaced (Table 12). Graded spoils that are determined to be unsuitable according to criteria listed in Table 11, will be mitigated as previously described in the Graded Spoil Sampling Plan section of this chapter.

PWCC will maintain records of the salvage, redistribution, and sampling of residual soils utilized for key habitat and cultural planting reclamation areas. Soil salvage depths within the traversable portions of the residual soil map units will likely average about 6 to 24 inches, although localized areas of deeper salvage are possible where weathered and fractured bedrock occurs (Volume 11, Appendix A). Records for key habitat and cultural planting areas are kept on file for inspection and reference at the mine site.

Soil testing and amendment applications for key habitat and cultural planting reclamation areas will be implemented on an as-needed basis. Revegetation success monitoring and revegetation trials will be utilized within the key habitat reclamation areas as described in Chapter 23. Soil and spoil samples will be collected at representative revegetation soil sample sites located in key habitat and cultural planting reclamation areas to correlate revegetation data (including forage quality) with soil chemical and physical characteristics and to verify the acceptability of using supplemental soil materials in these areas. The list of soil and spoil analyses will, at a minimum, include all parameters listed in Table 12.

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