

Table 1. Continued

Species	North exposures and shady areas		Sunny exposures (south, west, east)	
	Broadcast	Drilled	Broadcast	Drilled
-Pounds per acre-				
Shrubs:				
Rubber rabbitbrush	1/2	1/4	1/2	1/4
Douglas rabbitbrush	1/2	1/4	1/2	1/4
Big sagebrush	0	0	1/2	1/4
Fourwing saltbush	0	0	1	1/2
Totals	17	8 1/2	20 1/2	10 1/4
Shrubs for pits, major disturb- ance areas, cleat marks, and drilled areas:				
Antelope bitterbrush	1	1/2	2	1
Golden currant	1/2	1/4	1/2	1/4
Birchleaf mountain mahogany	1	1/2	1/2	1/4
Curlleaf mountain mahogany	0	0	1/2	1/4
Cliffrose	0	0	1/2	1/4
Green ephedra	1/2	1/4	1/2	1/4
Fourwing saltbush	0	0	1	1/2
Woods rose	1	1/2	1/2	1/4
Saskatoon serviceberry	0	0	1	1/2
Totals	4	2	7	3 1/2

 Alternate Species for Mountain Brush Associations

Grasses:

Bearded bluebunch wheatgrass	Great Basin wildrye	Sand dropseed*
Beardless bluebunch wheatgrass	Green needlegrass*	Siberian wheatgrass
Big bluegrass *	Hard sheep fescue	Slender wheatgrass
Bluestem wheatgrass	Indian ricegrass*	Standard crested wheatgrass
Bottlebrush squirreltail *	Kentucky bluegrass*	Sulcata sheep fescue
Bulbous barley*	Meadow brome*	Tall wheatgrass *
Bulbous bluegrass*	Mountain rye *	Winter rye *

Forbs:

American vetch*	Louisiana sagebrush*	Small burnet
Bouncing-bet	Low penstemon*	Stream globemallow*
Bramble vetch*	Nevada showy goldeneye	Sweetanise*
Common cowparsnip*	Nuttall lomatium	Tall milkvetch*
Cutleaf balsamroot	Palmer penstemon*	Tarragon sagebrush*
Eaton penstemon*	Parry goldenrod*	Thickleaf penstemon*
German iris*	Sicklepod milkvetch	Toadflax penstemon*
Gooseberryleaf globemallow*	Sidehill penstemon*	Wasatch penstemon*
Lewis (or blue) flax	Silky lupine*	Cushion eriogonum*

Shrubs:

Apache-plume*	Desert bitterbrush*	Nevada ephedra*
Arizona cypress*	Desert peachbrush*	New Mexican forestiera*
Black common chokecherry*	Dwarf rabbitbrush*	Oldman wormwood (stem cut-
Black sagebrush	Fringed sagebrush*	tings)*
Blueberry elder *	Gambel oak*	Parry rabbitbrush*
Boxelder*	Gardner saltbush*	Peking cotoneaster*
Common bladdersenna*	Longflower snowberry*	Purpleosier willow*
Common lilac*	Martin ceanothus*	Redberry elder*
Creeping barberry*	Mountain snowberry*	Rocky Mountain sumac*

Table 1. Continued

Alternate Species for Mountain Brush Associations

Shrubs: (continued)

Rocky Mountain juniper*

Roundleaf buffaloberry*

Russian-olive*

Siberian peashrub*

Silver buffaloberry*

Skunk bush sumac*

Squaw apple*

Tatarian honeysuckle*

Utah serviceberry

Western virginsbower*

Winterfat*

Wyeth eriogonum

Yellowbrush

Table 2. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed aspen and spruce-fir habitats in the montane ecological association. Restoration of tree species should be accomplished with seedling transplants at a rate of about 500 plants per acre. This figure can be greatly influenced by the site index which must be determined by a silviculturist. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times and contact appropriate expertism for input relative to tree replacement. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Shade	Openings	Alternate Species	
	-Pounds per acre-			
Grasses:			Grasses:	
Smooth brome (equal portions of northern and southern strains)	4	4	Bearded wheatgrass	Nodding brome
Orchardgrass (Intermountain area)	2	1	Blue wildrye	Slender wheatgrass
Tall oatgrass	2	1	Fairway crested wheatgrass	Subalpine brome
Intermediate wheatgrass	0	2	Meadow brome	Thurber fescue
Mountain brome	1	1		
Meadow foxtail	1	1		
Kentucky bluegrass	1/2	1/2		
Forbs:			Forbs:	
Alfalfa	0	1	Alpine leafybract aster	Pacific aster
Chickpea milkvetch	0	1	American vetch	Porter ligusticum
Mountain lupine	2	1	Bramble vetch	Small-leaf angelica
Silky lupine	1	1	Butterweed groundsel	Smooth aster
Common cowparsnip	1	0	Colorado columbine	Spreading sweetroot
Sweetanise	1	1	Engelmann aster	Sticky geranium
Showy goldeneye	1/2	1/2	Low goldenrod	Thickleaf peavine
			Nettleleaf gianthyssop	Utah peavine
			Northwestern painted-cup	Vegetable-oyster salsify
			Oregon checkermallow	

Table 2 . Continued

Species	Shade	Openings	Alternate Species
	-Pounds per acre-		
Shrubs:			Shrubs:
Antelope bitter brush	0	1	Big sagebrush
Mountain snowberry	1	1/2	Bigtooth maple
Rubber rabbitbrush	1	1/2	Blueberry elder
			Creeping barberry
			Redberry elder
			Woods rose
Totals	18	18	

Table 3. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed wet and semi-wet meadows. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Semi-wet soil		Wet soil		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Semi-wet	Wet
-Pounds per acre-						
Grasses:					Grasses and Sedges:	
Reed canarygrass	4	2	8	4	Great Basin wildrye	Meadow barley
Meadow foxtail	3	1 1/2	2	1	Kentucky bluegrass	Ovalhead sedge
Redtop	1	1/2	1	1/2	Meadow barley	Tufted hairgrass
Smooth brome (northern strain)	3	1 1/2	0	0	Ovalhead sedge	
Timothy	1	1/2	1	1/2		
Forbs:					Forbs:	
Alsike clover	1	1/2	3	1 1/2	Alpine leafybract aster	Edible valerian
Strawberry clover	2	1	3	1 1/2	Pacific aster	Pacific aster
Black medick	2	1	0	0		
Oregon checkermallow	2	1	0	0		
Totals	19	9 1/2	18	9		

Table 4. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed inland saltgrass stands typical of riparian sites in the desert scrub habitat of the cold desert ecological association. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Mosen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Wet Lands		Dry Lands		Alternate Species
	Broadcast	Drilled	Broadcast	Drilled	
	-Pounds per acre-				
Grasses:					Grasses:
Russian wildrye	4	2	4	2	Alkali sacaton
Tall wheatgrass	2	1	1	1/2	Reed canarygrass
Fairway crested wheatgrass	0	0	2	1	Bluestem wheatgrass
Tall fescue	2	1	0	0	Meadow foxtail
Great Basin wildrye	2	1	2	1	Quackgrass
Forbs:					Forbs:
Yellow sweetclover	4	2	4	2	Alfalfa (creeping strain or Ladak)
Strawberry clover	2	1	1	0	Black medick
Pacific aster	1	1/2	1	1/2	Fivehook Bassia
Shrubs:					Shrubs:
Gardner saltbush	3	1 1/2	3	1 1/2	American plum
Fourwing saltbush	0	0	4	2	Black greasewood
Totals	20	10	21	10 1/2	Purpleosier willow
					Rubber rabbitbrush
					Russian-olive
					Silver buffaloberry
					Tatarian honeysuckle
					Winterfat

Table 5. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed shadscale stands typical of the desert scrub habitat of the cold desert ecological association. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Application		Alternate Species
	Broadcast	Drilled	
Grasses:			
Russian wildrye	1 1/2	1	Grasses:
Fairway crested wheatgrass	1 1/2	1	Alkali sacaton
Standard crested wheatgrass	1 1/2	1	Bottlebrush squirreltail
Indian ricegrass	1 1/2	1	Salina wildrye
Forbs:			
Gooseberryleaf globemallow	1 1/2	1	Lewis (or blue) flax
Alfalfa	1 1/2	1	Small burnet
Shrubs:			
Winterfat	1 1/2	1	Shrubs:
Fourwing saltbush	1 1/2	1	Big sagebrush
			Black sagebrush
			Bud sagebrush
			Fringed sagebrush
Totals	12	8	Parry rabbitbrush
			Rubber rabbitbrush
			Small rabbitbrush
			Yellowbrush

Table Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed blackbush stands typical of the desert scrub habitat of the cold desert ecological association. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Application		Alternate Species
	Broadcast	Drilled	
-Pounds per acre-			
Grasses:			Grasses:
Pubescent wheatgrass	2	1	Alkali sacaton
Intermediate wheatgrass	2	1	Orchardgrass (Mediterranean type)
Fairway crested wheatgrass	1	1/2	Russian wildrye
Sand dropseed	1	1/2	Spike dropseed
Forbs:			Forbs:
Alfalfa	2	1	Alfileria
Small burnet	3	1 1/2	German Iris
Gooseberryleaf globemallow	1	1/2	Lewis flax
Shrubs:			Shrubs:
Fourwing saltbush	5	2 1/2	Antelope bitterbrush
Winterfat	3	1 1/2	Apache-plume
Totals	20	10	Cliffrose
			Desert bitterbrush
			Nevada showy goldeneye
			Palmer penstemon
			Toadflax penstemon
			Desert peachbrush
			Longflower snowberry
			Utah serviceberry

Table 7. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed alpine herblands or parklands of the montane ecological association. Also included are acceptable alternates if seed for a plant species is not available. Alternates marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	<u>Well drained soils</u>		<u>Moist soils</u>		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Well drained Soils	Moist Soils
Grasses:						
Smooth brome (northern strains)	3	1 1/2	4	2	Bearded wheatgrass	Kentucky bluegrass
Smooth brome (southern strains)	3	1 1/2	4	2	Hard sheep fescue	Meadow barley
Intermediate wheatgrass	1	1/2	0	0	Kentucky bluegrass	Meadow brome
Meadow foxtail	1	1/2	2	1	Slender wheatgrass	Ovalhead sedge
Subalpine brome	1	1/2	1	1/2	Sulcata sheep fescue	Timothy
Tall oatgrass	1	1/2	0	0	Timothy	
Orchardgrass (Intermountain area)	1	1/2	0	0		
Mountain brome	1	1/2	0	0		
Reed canarygrass	0	0	2	1		
Forbs:						
Alfalfa (creeping type or Ladak)	1	1/2	1	1/2	Lewis (or blue) flax	Alpine leafybract aster
Mountain lupine	2	1	2	1	Nuttall lomatium	Fat solomon-plume
Common cowparsnip	0	0	1	1/2	Oneflower	Low goldenrod
Sweetanise	1	1/2	1	1/2	heliathella	Pacific aster
Chickpea milkvetch	2	1	0	0	Oregon fleabane	Edible valerian
					Porter ligusticum	
					Showy goldeneye	
					Silky lupine	
					Smooth aster	

Table 7 . Continued

Species	<u>Well drained soils</u>		<u>Moist soils</u>		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Well drained Soils	Moist Soils
Shrubs:					Shrubs:	
Mountain snowberry	1	1/2	0	0	Big sagebrush	Bush cinquefoil
Yellowbrush	1	1/2	0	0	Bush cinquefoil	Geyer willow
					Parry rabbitbrush	Scouler willow
					Redberry elder	Silver sagebrush
Totals	20	10	18	9	Rubber rabbitbrush	
					Silver sagebrush	
					Squaw currant	
					Sticky currant	
					Woods rose	
					Wyeth eriogonum	

Table 8. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed black greasewood stands typical of the desert scrub habitat of the cold desert ecological association. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Mosen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Wet to moist soils with high water table.		Dry soils with low water table.		Alternate Species
	Broadcast	Drilled	Broadcast	Drilled	
-Pounds per acre-					
Grasses:					
Tall wheatgrass	3	1 1/2	1	1/2	Grasses:
Fairway crested wheatgrass	1	1/2	3	1 1/2	Alkali sacaton
Pubescent or intermediate wheatgrass	1	1/2	1	1	Creeping wildrye
Reed fescue	2	1	0	0	Bluestem wheatgrass
Russian wildrye	2	1	4	2	Great Basin wildrye
Quackgrass ¹	2	1	2	1	Bottlebrush
					Reed canarygrass
					squirreltail
Forbs:					
Strawberry clover	1	1/2	0	0	
Yellow sweetclover	3	1	2	1	
Shrubs:					
Fourwing saltbush	1	1/2	2	1	Shrubs:
Gardner saltbush	1	1/2	1	1/2	Big sagebrush
Rubber rabbitbrush	1/2	1/4	1	1/2	Russian-olive
Winterfat	0	0	1	1/2	Russet buffaloberry
					Yellowbrush
Totals	17 1/2	8 1/4	18	9 1/2	

¹ Not recommended if site is near agricultural areas onto which it might spread.

Table 9. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed sagebrush habitats of the submontane ecological association. Also included are acceptable alternatives if seed for a plant species is not available. Alternates marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Precipitation less than 11 inches		Precipitation 11 inches or more		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled		
Grasses:						
Fairway crested wheatgrass	3	2	4	2	Grasses: Alkali sacaton* Bottlebrush squirreltail Bulbous barley* Bulbous bluegrass* Great Basin wildrye Hard sheep fescue* Indian ricegrass Orchardgrass* Sand dropseed* Siberian wheatgrass Smooth brome (southern strain)* Winter rye*	
Standard crested wheatgrass	2	1	0	0		
Bearded bluebunch wheatgrass	1/2	1/2	1	1/2		
Bluestem wheatgrass	1/2	1/2	1	1/2		
Intermediate wheatgrass	1/2	1/2	1	1		
Pubescent wheatgrass	1/2	1	1	1		
Russian wildrye	1	1	1	1		
Forbs:						
Alfalfa (Rambler, Nomad or Ladak - equal amount of each)	1	1	1	1		Forbs: Bouncing-bet* Cushion eriogonum* Cutleaf balsamroot* Eaton penstemon* Goosebearyleaf globemallow* Lewis flax Louisiana sagebrush* Nevada lupine* Nevada showy goldeneye* Oneflower helianthella* Pacific aster* Palmer penstemon* Showy goldeneye* Silky lupine* Smooth aster* Vegetable-oyster salsify* Wasatch penstemon* Sicklepod milkvetch
Utah sweetvetch	0	0	1/2	1/2		
Arrowleaf balsamroot	1/2	1/4	1/2	1/2		
Small burnet	0	0	1/2	1/2		
Forbs:						
Fourwing saltbush	1	1/2	1	1/2		
Rubber rabbitbrush	1/2	1/2	1/2	1/2		
Totals:	11	8-3/4	13	9-1/2		

Table 9 . Continued

Species	Precipitation less than 11 inches		Precipitation 11 inches or more		Alternate Species
	Broadcast	Drilled	Broadcast	Drilled	
Shrubs:					
Shrubs for separate planting in major disturbance areas - pits, tractor cleat marks, and dozer scalps:					
Antelope bitterbrush	2	1	3	2	
Cliffrose or desert bitterbrush	1	1/2	1-1/2	1	
Fourwing saltbush	2	2	2	2	
Utah serviceberry	1	1	1	1	
Winterfat	1-1/2	1	1	1	
Totals:	7-1/2	5-1/2	8-1/2	7	
Shrubs:					
Big sagebrush					Martin ceanothus*
Black sagebrush					Nevada ephedra
Bud sagebrush*					Rocky Mountain smooth sumac*
Desert peachbrush*					Spineless hopsage*
Douglas rabbitbrush					Spiny hopsage*
Gardner saltbush*					Squaw-apple*
Green ephedra					Wyeth eriogonum*
Longflower snowberry*					

Table 10. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed pinyon-juniper habitats of the submontane ecological association. Also included are acceptable alternatives if seed for a plant species is not available. Alternatives marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species Mixture	Lower elevation (Precipitation less than 12 in.)		Upper elevation (Precipitation 12 in. or more)		Alternate Species
	Broadcast	Drilled	Broadcast	Drilled	
Grasses:					
Fairway crested wheatgrass	4	2	3	1-1/2	Bearded or beardless blue-bunch wheatgrass
Standard crested wheatgrass	1	1	1	1/2	Mountain rye*
Bluestem wheatgrass	1	1/2	0	0	Orchardgrass
Intermediate wheatgrass	1	1/2	1	1	Bottlebrush squirreltail
Pubescent wheatgrass	1	1/2	1	1	Sheep fescue
Russian wildrye	1	1/2	1	1/2	Bulbous barley
Smooth brome (southern strain)	0	0	1	1	Bulbous bluegrass
					Great Basin wildrye
					Sulcata sheep fescue
					Hard fescue
					Indian ricegrass
					Meadow brome*
					Tall wheatgrass*
					Winter rye*
Forbs:					
Alfalfa (Rambler, Nomad, Travois, or Ladak - equal amount of each	1	1	2	1	Lewis ⁴ flax
Chickpea milkvetch	0	0	1	1/2	Nevada showy goldeneye
Utah sweetvetch	1	1/2	1	1/2	Nuttall lomatium
Yellow sweetclover	1	1/2	1	1/2	Pacific aster
Arrowleaf balsamroot	1	1/2	1	1/2	Showy goldeneye
Small burnet	1	1	1	1	Eaton penstemon*
					Gooseberryleaf globe- mallow*
					Louisiana sagebrush*
					Nevada lupine*
					Bouncing-bet*
					Bramble vetch*
					German iris*
					Cutleaf balsamroot*
					Sicklepod milkvetch
					Oneflower
					helianthella *
					Palmer penstemon*
					Parry goldenrod*
					Silky lupine*
					Small aster*
					Tarragon sagebrush*
					Thickleaf penstemon*
					Toadflax penstemon*
					Vegetable-oyster salsify*
					Wasatch penstemon*

Table 10 . Continued

Species Mixture	Lower elevation (Precipitation less than 12 in.)		Upper elevation (Precipitation 12 in. or more)		Alternate Species
	Broadcast	Drilled	Broadcast	Drilled	
Shrubs:					
Big sagebrush	1	1/2	1	1/2	Shrubs:
Black sagebrush	1	1/2	1	1/2	Nevada ephedra
Rubber rabbitbrush	1	1/2	1	1/2	Littleleaf mountain- mahogany
Winterfat	1	1/2	1	1/2	Squaw-apple
Fourwing saltbush	1	1	1	1	Tatarian honeysuckle
					Apache-plume*
Totals:	19	11-1/2	20	12-1/2	Arizona cypress*
					Black common chokecherry*
Shrubs for pits, major disturb- ance areas, and tractor cleat marks by dribblers:					
Antelope bitterbrush	2	1	3	2	Blueberry elder*
Cliffrose or desert bitterbrush	1	1/2	0	0	Common lilac*
Fourwing saltbush	2	2	1-1/2	1	Desert peachbrush*
Utah serviceberry	1	1/2	0	0	Fringed sagebrush*
Green ephedra	1	1/2	1	1	Gardner saltbush*
Birchleaf mountain-mahogany	1	1/2	1-1/2	1	
Curlleaf mountain-mahogany	1	1/2	1-1/2	1	
Woods rose	0	0	1	1	
Golden currant	0	0	1/2	1/4	
Totals:	9	5-1/2	10	7-1/4	

Longflower snowberry*
 Martin ceanothus*
 Mountain snowberry*
 Peking cotoneaster*
 Rocky Mountain
 smooth sumac
 Roundleaf buffalo-
 berry*
 Russian-olive*
 Siberian peashrub*
 Skunk bush sumac*
 Spineless hopsage*
 Spiny hopsage*
 Wyeth eriogonum*

Table 11. Recommended seed mixtures and seedling or larger sized transplants that will benefit wildlife through enhancement of moderately disturbed riparian habitats characterized as upland stream side vegetation in the submontane ecological association. Also included are acceptable alternatives if seed for a plant species is not available.

Species	North exposures and shady areas		Sunny exposures (south,west,east)		Mixture for tall mountain brush type, shaded sites. Broadcast
	Broadcast	Drilled	Broadcast	Drilled	
-Pounds per acre-					
Grasses:(seed mixture, transplants are not practicable)			Grasses:(seed mixture, transplants not practicable)		
Fairway crested wheatgrass	2	1	2	1	Smooth brome (Southern strain) 5
Smooth brome (Southern Strains)	4	2	2	1	Fairway crested wheatgrass 1
Intermediate wheatgrass	4	2	2	1	Intermediate wheatgrass 3
Pubescent wheatgrass	0	0	2	1	Orchardgrass (Utah grown) 2
Bluestem wheatgrass	0	0	1	1/2	Tall oatgrass 1
Orchardgrass	1	1/2	1	1/2	Mountain brome 1
Russian wildrye	0	0	1	1/2	
Tall oatgrass	1	1/2	0	0	
Forbs:(seed mixture, transplants are not practicable)			Forbs:(seed mixture, transplants not practicable)		
Alfalfa(Nomad, Rambler, Travois, Ladak-equal parts)	2	1	2	1	Alfalfa (creeping strains or Ladak) 1
Chickpea milkvetch	0	0	1	1/2	Pacific aster 1/4
Utah Sweetvetch	0	0	1	1/2	Oneflower helianthella 1/2
Yellow sweetclove	0	0	1	1/2	Snowy goldeneye 1/4
Arrowleaf balsamroot	1	1/2	1	1/2	
Pacific aster	1	1/2	1	1/2	
Shrubs:(seed mixture, transplants not usually successful)					
Fourwing saltbrush	0	0	1	1/2	
Rubber Rabbitbrush	1/2	1/4	1/2	1/4	
Douglas Rabbitbrush	1/2	1/4	1/2	1/4	

Species	Any exposure
	Density per acre
Shrubs and Trees: (seedling or larger sized transplants)	
Big sagebrush	A mixture of all trees and shrubs so that one plant will be planted in every 50 square feet of disturbed area. This equals 1,000 plants per acre.
Antelope bitterbrush	
Golden currant	
Birchleaf mountain mahogany	
Curlleaf mountain mahogany	
Cliffrose	
Green ephedra	
Woods rose	
Saskatoon serviceberry	
Narrow leaf cottonwood	
Bigtooth maple	
Rocky mountain maple	
Willow (use shoots or entire clumps from local area)	
Dogwood	
Birch	
Alder	

Table 11. Continued

Alternate Species for Upland Stream side Vegetation in the transition life zone

Grasses:

Bearded bluebunch wheatgrass	Great Basin wildrye	Sand dropseed*
Beardless bluebunch wheatgrass	Green needlegrass*	Siberian wheatgrass
Big bluegrass *	Hard sheep fescue	Slender wheatgrass
Bluestem wheatgrass	Indian ricegrass*	Standard crested wheatgrass
Bottlebrush squirreltail *	Kentucky bluegrass*	Sulcata sheep fescue
Bulbous barley*	Meadow brome*	Tall wheatgrass *
Bulbous bluegrass*	Mountain rye *	Winter rye *

Forbs:

American vetch*	Louisiana sagebrush*	Small burnet
Bouncing-bet	Low penstemon*	Stream globemallow*
Bramble vetch*	Nevada showy goldeneye	Sweetanise*
Common cowparsnip*	Nuttall lomatium	Tall milkvetch*
Cutleaf balsamroot	Palmer penstemon*	Tarragon sagebrush*
Eaton penstemon*	Parry goldenrod*	Thickleaf penstemon*
German iris*	Sicklepod milkvetch	Toadflax penstemon*
Gooseberryleaf globemallow*	Sidehill penstemon*	Wasatch penstemon*
Lewis (or blue) flax	Silky lupine*	Cushion erlogonum*

Shrubs:

Apache-plume*	Desert bitterbrush*	Nevada ephedra*
Arizona cypress*	Desert peachbrush*	New Mexican forestiera*
Black common chokecherry*	Dwarf rabbitbrush*	Oldman wormwood (stem cut-
Black sagebrush	Fringed sagebrush*	tings)*
Blueberry elder*	Gambel oak*	Parry rabbitbrush*
Boxelder*	Gardner saltbush*	Peking cotoneaster*
Common bladdersenna*	Longflower snowberry*	Purpleosier willow*
Common lilac*	Martin ceanothus*	Redberry elder*
Creeping barberry*	Mountain snowberry*	Rocky Mountain sumac*

Table 11. Continued

Alternate Species for ~~Upland~~ stream side Vegetation in the transition life zone

Shrubs: (continued)

Rocky Mountain juniper*

Roundleaf buffaloberry*

Russian-olive*

Siberian peashrub*

Silver buffaloberry*

Skunk bush sumac*

Squaw apple*

Tatarian honeysuckle*

Utah serviceberry

Western virginsbower*

Winterfat*

Wyeth eriogonum

Yellowbrush

Table 12. Recommended guidelines for reclamation that utilizes only willow transplants to benefit wildlife through enhancement of moderately disturbed riparian habitats characterized as pure willow stands in the cold desert and submontane ecological associations.

1. If disturbance was only moderate, the density of willow should approximate a single transplanted stem in every 50 square feet of disturbed area; the willow plantings should be spaced 7 feet apart, this equals 1,000 plants per acre. Total reclamation should establish a willow planting in every four square feet of disturbed area; willow plantings should be spaced 2 feet apart, this equals 1,200 plants per acre.
2. Cut willow stems ranging between $1/4$ and $1/2$ inch in diameter from local wild stock. The stems must be about 18 inches long. Note that the cut should be made at a 30° angle to the stem so that a maximum of bared stem will be exposed to the soil when planted. Multiple cuttings can come from a singular stem as long as the integrity concerning which end goes into the ground is maintained. During the cutting phase of this operation take the necessary precautions to keep the end of the willow to be placed in the ground from drying (place in a bucket of water).
3. When planting, about $2/3$ of the stem should be pushed into the soil and $1/3$ should remain above ground.

Note: Best success in terms of survival is in sandy soil; success decreases in soils characterized as gravel. Willow stems larger than $1/2$ inch in diameter also have shown a low survival rate.

APPENDIX III-4

KING 6 INTERIM REVEGETATION PLAN

October, 1982

King VI Interim Revegetation Plan

The goal of this revegetation plan is to establish a permanent, effective and diverse vegetative cover, capable of self-regeneration and plant succession, for use as rangeland and wildlife habitat. A prompt vegetative cover will be established which, through time, will allow vegetative cover, woody plant density and productivity to recover to levels equal to the cover, density and productivity of reference areas. U.S. Fuel Company has conducted an Interim Revegetation Program to test individual species and a variety of steep slope revegetation methods. The Interim Revegetation Plan will provide information which will help determine the success and survivability of each species planted and whether or not introduced species can aid in establishing a diverse, effective and permanent cover compatible with postmining land use. A variety of steep slope revegetation methods will be tested during the interim to evaluate their effectiveness in soil stabilization and vegetative establishment.

Interim Revegetation Plan

Interim revegetation efforts began soon after site preparation during the fall of 1982. The areas to be revegetated during the interim are listed in Table 1. These areas were formed during construction by clearing vegetation, cut and fill, or excavation. The soils of these areas are a mixture of topsoil and subsoil with slopes up to 90%. In addition to steep slopes, compaction of soils presents a problem to revegetation in the areas under the stacker conveyor and between the truck turnout and haul roads. A variety of steep slope revegetation methods and ripping to a depth of 14-16 inches during seedbed preparation will be used to alleviate these problems. The soil stabilization methods consist of a variety of combinations of chemical tackifier, nylon netting and mulch. Each combination to be tested includes hydraulic application of seed (see seed mix for interim revegetation, 22 pounds pure live seed per acre), fertilizer (as per recommendations based on the results of soil tests) and chemical tackifier (140 pounds per acre). This application will be followed by one of these treatments:

1. Nylon netting oversprayed with wood fiber mulch (2000 pounds per acre) and chemical tackifier (120 lbs/acre).
2. Hydraulic application of straw mulch (1000 lbs/acre) with chemical tackifier (120 lbs/acre), overlaid with nylon netting, oversprayed with wood fiber mulch (1000 lbs/acre) and chemical tackifier (60 lbs/acre).
3. Hydraulic application of straw mulch (2000 lbs/acre) with chemical tackifier (120 lbs/acre), overlaid with nylon netting.
4. Hydraulic application of wood fiber mulch (2000 lbs/acre) with chemical tackifier (120 lbs/acre).

Treatments 1 and 2 will be tested on the steeper slopes of the conveyor, coal pile and truck turnaround areas. Treatments 3 and 4 will be tested on the less steep slopes of the truck turnaround area, under the stacker conveyor, and on the sediment pond outslopes. Specific location of study plots will be determined in consultation with the Utah Division of Oil, Gas and Mining.

Seed Mix For Interim Revegetation

The following seed mix was developed to provide a variety of predominantly native species to be tested for their ability to survive and be successful in stabilizing the soil and establishing a diverse, effective and permanent vegetative cover. The seed mix is composed of grasses (bunchgrasses and sod formers), forbs, and shrubs adapted to the soils and climate of the King VI area.

In addition to the seed mixture listed, U.S. Fuel Company requested and received approval to include 10 pounds of rye and 10 pounds of barley to serve as a nurse crop.

Information from the interim revegetation will help in determining whether or not the use of the introduced species can be justified for final reclamation. The introduced species were selected for their ease of establishment, erosion control and compatibility with post-mining land use.

SEED MIX FOR INTERIM REVEGETATION

Scientific And Common Name % By Weight Of Pure Live Seed

Native Grasses

<u>Agropyron riparium</u> Streambank wheatgrass	7
<u>Agropyron smithii</u> Western wheatgrass	7
<u>Agropyron trachycaulum</u> Slender wheatgrass	7
<u>Elymus cinereus</u> Basin wildrye	7
<u>Poa pratensis</u> Kentucky bluegrass	2

Introduced Grasses

<u>Agropyron intermedium</u> Intermediate wheatgrass	7
<u>Elymus junceus</u> Russian wildrye	7

Native Forbs

<u>Eriogonum umbellatum</u> Sulfur flower	7
<u>Hedysarum boreale</u> Northern sweetvetch	7
<u>Artemisia ludoviciana</u> Louisiana sagebrush	2

Scientific And Common Name

% By Weight Of Pure Live Seed

Introduced Forbs

<u>Medicago sativa</u> Alfalfa	7
<u>Melilotus officinalis</u> Yellow sweetclover	7

Native Shrubs

<u>Artemisia tridentata wyomingensis</u> Big sagebrush	2
<u>Cercocarpus montanus</u> True mountain mahogany	7
<u>Chrysothamnus nauseosus albicaulis</u> Rubber rabbitbrush	7
<u>Ephedra viridis</u> Green ephedra	10

TABLE 1

Disturbed Area In Each Vegetation Type To Be Revegetated
During Interim Revegetation At The King VI Loadout

Vegetation Type	Stacker Conveyor	Sediment Pond	Location			Total
			Coal Pile	Truck Turnout	Conveyor	
Riparian	0.00	0.10	0.00	0.00	0.00	0.10
Pinyon-Juniper	0.00	0.00	0.15	0.40	0.20	0.75
Sagebrush	0.25	0.20	0.10	0.00	0.00	0.55
Total	0.25	0.30	0.25	0.40	0.20	1.40



BIO/WEST, Inc.

P.O. Box 3226

Logan, Utah 84321

(801) 752-4202

November 16, 1982

Mr. Charles J. Jahne
Sharon Steel Corporation
19th Floor, University Club Bldg.
136 East South Temple
Salt Lake City, UT 84111

Dear Mr. Jahne:

Interim revegetation efforts at the King VI Mine were completed on Wednesday, November 3, 1982. The newly-created topsoil stockpile and each of the areas listed in the Interim Revegetation Plan were: seeded at the rate of 42 lbs pure live seed per acre of the mix (including the nurse crop) outlined in the Interim Revegetation Plan; fertilized at the rate of 50 lbs/acre of nitrogen, 100 lbs/acre of phosphate, and 50 lbs/acre of potash; and tackified at the rate of 140 lbs/acre of chemical tackifier. The seed, fertilizer, and tackifier were hydraulically applied by B&R Reclamation Specialists (B&R) on Saturday, October 30, 1982.

Approximately one-half of the area along the conveyor, at the sediment pond and truck turnout, and of the out slopes of the sediment pond was overlaid with erosion control netting and oversprayed with wood fiber mulch (2,000 lbs/acre) and chemical tackifier (120 lbs/acre). The remainder of these areas was mulched with straw (hand applied at 1,000 lbs/acre), overlaid with erosion control netting, and oversprayed with wood fiber mulch (1,000 lbs/acre) and chemical tackifier (180 lbs/acre).

The top of the bank of the sediment pond and the newly-created topsoil stockpile were oversprayed with wood fiber mulch (2,000 lbs/acre) and chemical tackifier (120 lbs/acre).

The compacted areas at the truck turnout and near the stacker conveyor were "ripped" (by B&R) to a depth of about 16 inches on Saturday shortly before hydraulic application of the seed, fertilizer, and tackifier (detailed above). These areas were oversprayed with wood fiber mulch (2,000 lbs/acre) and chemical tackifier (120 lbs/acre). A small area near the stacker conveyor which had been disturbed, but not compacted, was mulched with straw (hand applied at 1,000 lbs/acre), overlaid with erosion control netting, and oversprayed with wood fiber mulch (1,000 lbs/acre), and chemical tackifier (180 lbs/acre).

B/V
Mr. Charles J. Jahne
November 16, 1982
Page 2

The burlap covering the original topsoil stockpile was removed before hydraulic application of the seed, fertilizer and tackifier (detailed above). The stockpile was mulched with straw (hand applied at 2,000 lbs/acre) and overlaid with erosion control netting.

The wood fiber mulch and chemical tackifier were hydraulically applied by B&R on Wednesday, November 3, 1982.

Ms. Jean Semborski asked me to comment on your use of burlap. Burlap, as you used it, was a very effective means of controlling erosion and stabilizing the topsoil stockpile; however, it was a hindrance to plant growth and survival. I was surprised at the cover and density of the grasses under the burlap. As expected, though, most of the plants were in low vigor, judged by their color (pale green and yellow) and the fineness of their leaves. The low vigor was undoubtedly caused by the burlap covering which prevented sunlight from reaching the leaves. Without sunlight, the plants were forced to use carbohydrate reserves to maintain growth, rather than building up reserves as they normally would during the growing season. This winter, the leaves will die back to the crown of each plant and the plants will have to rely on carbohydrate reserves to stay alive. Since most of the plants have little or no reserves, they will die. It is my opinion that, although the burlap was effective at short-term erosion control, it is defeating the long-term erosion control and stabilizing effect of plant establishment and survival.

As I indicated in our telephone conversation yesterday, I will be out of town for the Thanksgiving holidays. If you have any questions or need any additional information, you can contact our secretary, Nancy, who will relay the message to me. Have a happy holiday.

Sincerely,

John Rice

John Rice
Vegetation/Soils Section Manager

JR/nh

cc: Jean Semborski, U.S. Fuel Company

Interim Revegetation Monitoring August 7, 1983

Interim revegetation was monitored during the first year. Percent plant material, litter, rock and bare ground cover were estimated using a 0.5 meter² rectangular quadrat. In addition, percent plant cover was estimated for each individual species. The sample size for each treatment area was considered adequate at 90% confidence with 10% precision using the following formula:

$$n = \frac{s^2 t^2}{D^2}$$

where: n = minimum sample size
t = t distribution for a given level of confidence
s² = the variance estimate from preliminary sampling
D = level of accuracy desired for the estimate of the mean

Results of observations are given in the following tables:

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah

Scientific name ^a	Common name	Habit ^b	Sediment Pond		Conveyor
			Area #1 (Treat. #3)	Area #2 (Treat. #4)	Stacker Finger Area #8 (Treat. #3) (2nd season)
<u>TREES</u>					
<u>Pinus ponderosa</u>	Ponderosa pine	NT	-	-	-
<u>Prunus virginia</u>	Common chokecherry	NT	-	2	-
TOTAL			0	2	0
<u>SHRUBS</u>					
<u>Berberis repens</u>	Oregon grape	NS	-	-	<1 ^d
<u>Rosa woodsii</u>	Wood's rose	NS	-	<1 ^d	-
TOTAL			0	0	0
<u>GRASSES</u>					
<u>Agropyron Spp</u>	Wheatgrass	INPG	<1 ^d	2	-
<u>Agropyron elongatum</u>	Tall wheatgrass	IPG	-	-	-
<u>Agropyron intermedium</u>	Intermediate wheatgrass	IPG	-	-	12
<u>Avena fatua</u>	Wild oats	IAG	<1 ^d	<1 ^d	-
<u>Bromus inermis</u>	Smooth brome	IPG	-	-	2
<u>Bromus tectorum</u>	Cheatgrass	IAG	-	-	1
<u>Dactylis glomerata</u>	Orchardgrass	IPG	-	2	5
<u>Hordeum vulgare</u>	Common barley	IAG	10	4	-
<u>Oryzopsis hymenoides</u>	Indian ricegrass	NPG	-	-	1
<u>Phleum pratense</u>	Timothy	IPG	-	-	1
<u>Poa pratensis</u>	Kentucky bluegrass	IPG	-	-	1
TOTAL			10	8	23

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah (continued)

Scientific name ^a	Common name	Habit ^b	Sediment Pond		Conveyor
			Area #1 (Treat. #3)	Area #2 (Treat. #4)	Stacker Finger Area #8 (Treat. #3) (2nd season)
<u>FORBS</u>					
<u>Artemisia ludoviciana</u>	Louisiana sagewort	NPF	-	-	-
<u>Chenopodium spp.</u> (annuals)	Goosefoot	INAF	2	4	-
<u>Chenopodium album</u>	Lambsquarter	IAF	-	-	2
<u>Cleome serrulata</u>	Rocky Mountain beeplant	NAF NAF	2 <1 ^d	-	-
<u>Descurainia pinnata</u>	Pinnate tansymustard	NPF	-	-	-
<u>Hedysarum spp.</u>	Sweetvetch	NPF	-	-	-
<u>Hedysarum boreale</u>	Sunflower	NAF	2	2	-
<u>Helianthus spp.</u>	Green molly	NHSF	-	-	-
<u>Kochia scoparia</u>	Belvedere summercypress	IAF	6	-	-
<u>Medicago sativa</u>	Alfalfa	IPF	-	-	-
<u>Melilotus officinalis</u>	Yellow sweetclover	IBF	-	<1 ^d	-
<u>Oenothera sp.</u>	Evening primrose	NAPF	-	-	-
<u>Salsola kali</u>	Russian thistle	IAF	8	2	-
<u>Sphaeralcea coccinea</u>	Scarlet globemallow	NPF	-	-	<1 ^d
<u>Tragapogon dubius</u>	yellow salsify	IBF	-	-	-
	TOTAL		20	8	2
TOTAL LIVING COVER			30	18	25

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah (continued)

Scientific name ^a	Common name	Habit ^b	Sediment Pond		Conveyor
			Area #1 (Treat. #3)	Area #2 (Treat. #4)	Stacker Finger Area #8 (Treat. #3) (2nd season)
<u>NON-LIVING COVER</u>					
Rock			10	30	10
Soil			25	50	40
Litter			<u>35</u>	<u>2</u>	<u>25</u>
	TOTAL NON-LIVING COVER		<u>70</u>	<u>82</u>	<u>75</u>
	GRAND TOTAL COVER		<u>100</u>	<u>100</u>	<u>100</u>

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah (continued)

Scientific name ^a	Common name	Conveyor		Lambs Trailer Soil Stockpile	
		Area #9 (Treat. #2)	Area # 10 (Treat. #1)	Area #11 (Treat. #3)	Area #12 (Treat. #4)
<u>TREES</u>					
<u>Pinus ponderosa</u>	Ponderosa pine	-	-	-	-
<u>Prunus virginia</u>	Common chokecherry	-	-	-	-
TOTAL		$\frac{-}{0}$	$\frac{-}{0}$	$\frac{-}{0}$	$\frac{-}{0}$
<u>SHRUBS</u>					
<u>Berberis repens</u>	Oregon grape	-	<1	-	-
<u>Rosa woodsii</u>	Wood's rose	-	-	-	-
TOTAL		$\frac{-}{0}$	$\frac{-}{0}$	$\frac{-}{0}$	$\frac{-}{0}$
<u>GRASSES</u>					
<u>Agropyron Spp</u>	Wheatgrass	5	<1	-	1
<u>Agropyron elongatum</u>	Tall wheatgrass	-	-	-	-
<u>Agropyron intermedium</u>	Intermediate wheatgrass	-	<1	15	-
<u>Avena fatua</u>	Wild oats	1	-	5	-
<u>Bromus inermis</u>	Smooth brome	2	-	-	-
<u>Bromus tectorum</u>	Cheatgrass	<1 ^d	-	2	-
<u>Dactylis glomerata</u>	Orchardgrass	5	-	-	1
<u>Hordeum vulgare</u>	Common barley	3	-	10	-
<u>Oryzopsis hymenoides</u>	Indian ricegrass	-	<1	-	-
<u>Phleum pratense</u>	Timothy	5	<1	-	-
<u>Poa pratensis</u>	Kentucky bluegrass	-	-	-	-
TOTAL		$\frac{-}{21}$	$\frac{-}{1}$	$\frac{-}{32}$	$\frac{-}{2}$

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah (continued)

Scientific name ^a	Common name	Conveyor		Lambs Trailer Soil Stockpile	
		Area #9 (Treat. #2)	Area # 10 (Treat. #1)	Area #11 (Treat. #3)	Area #12 (Treat. #4)
<u>FORBS</u>					
<u>Artemisia ludoviciana</u>	Louisiana sagewort	<1 ^d	-	-	-
<u>Chenopodium spp.</u> (annuals)	Goosefoot	<1 ^d	-	-	2
<u>Chenopodium album</u>	Lambsquarter	-	-	1	3
<u>Cleome serrulata</u>	Rocky Mountain beeplant	-	-	-	10
<u>Descurainia pinnata</u>	Pinnate tansymustard	<1 ^d	-	-	7
<u>Hedysarum spp.</u>	Sweetvetch	-	-	-	-
<u>Hedysarum boreale</u>	Northern sweetvetch	-	-	-	-
<u>Helianthus spp.</u>	Sunflower	1	<1	-	1
<u>Kochia americana</u>	Green molly	-	-	1	5
<u>Kochia scoparia</u>	Belvedere summercypress	2	-	-	-
<u>Medicago sativa</u>	Alfalfa	-	-	-	-
<u>Melilotus officinalis</u>	Yellow sweetclover	1	-	<1 ^d	-
<u>Oenothera sp.</u>	Evening primrose	<1 ^d	-	-	-
<u>Salsola kali</u>	Russian thistle	-	<1	1	30
<u>Sphaeralcea coccinea</u>	Scarlet globemallow	-	-	-	-
<u>Tragapogon dubius</u>	yellow salsify	-	-	<1 ^d	-
	TOTAL	4	1	3	58
TOTAL LIVING COVER		25	2	35	60

Results of observations taken August 7, 1983 on interim revegetation study areas in the vicinity of the U.S. Fuel King VI Mine in South Fork, Hiawatha, Utah (continued)

Scientific name ^a	Common name	Conveyor		Lambs Trailer Soil Stockpile	
		Area #9 (Treat. #2)	Area # 10 (Treat. #1)	Area #11 (Treat. #3)	Area #12 (Treat. #4)
NON-LIVING COVER					
Rock		25	49	2	5
Soil		25	49	15	30
Litter		25	0	48	5
	TOTAL NON-LIVING COVER	75	98	65	40
	GRAND TOTAL COVER	100	100	100	100

FOOTNOTES

^aFor locations of interim revegetation study areas, see the following exhibit III-5

^bStudy areas #3, 4, 5, 6, and 7 were not measured in 1983 but a photograph of study area #4 (treatment #2) is provided in Exhibit. Sites 5 and 6 were destroyed by mining activities. Sites 3,4 and 7 represent identical treatments to sites 10, 9 and 2 respectively.

^cTreatment Codes

#1 Nylon netting oversprayed with wood fiber mulch and chemical tackifier.

#2 Straw mulch and chemical tackifier overlaid with nylon netting oversprayed with wood fiber mulch and chemical tackifier.

#3 Straw mulch and chemical tackifier overlaid with nylon net.

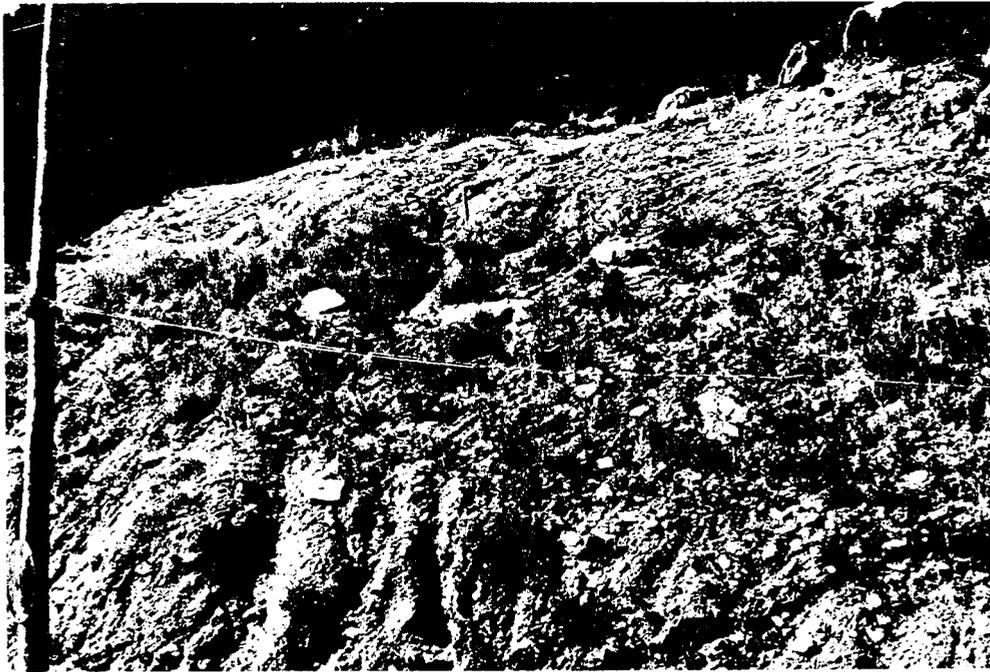
#4 Wood fiber mulch with chemical tackifier.

^dCover values <1% not added into totals except at conveyor with treatment #1 where total living cover added to 2%.

PHOTOGRAPHS OF INTERIM REVEGETATION STUDY TAKEN AUGUST 7, 1983

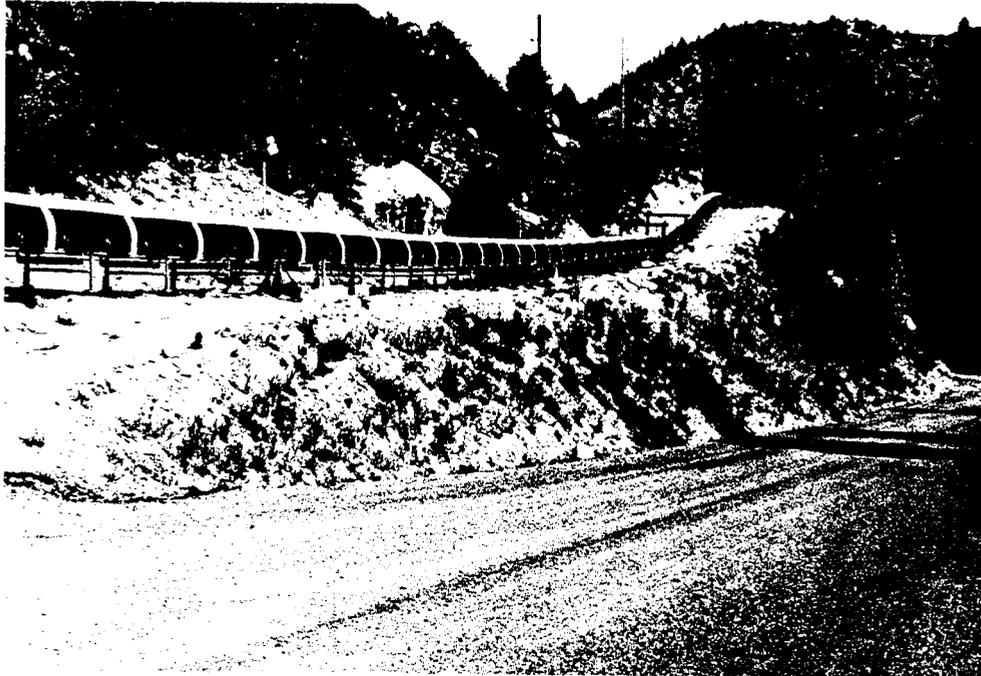


Study Area No. 1 Treatment No. 3



Study Area No. 4 Treatment No. 2

PHOTOGRAPHS OF INTERIM REVEGETATION STUDY TAKEN AUGUST 7, 1983



Study Area No. 9 Treatment No. 2



Study Area No. 10 Treatment No. 1

PHOTOGRAPHS OF INTERIM REVEGETATION STUDY TAKEN AUGUST 7, 1983



Study Area No. 11 & 12 (In background) Treatment No. 3 & 4

APPENDIX III-5

FIELD TRIAL TEST PLOT STUDIES AND MONITORING REPORTS

VEGETATION FIELD TRIAL STUDIES

Upon request of OSM, U.S. Fuel Company has established five field trial test plots. Their intent is to show that reclamation can be accomplished at different sites around the mine permit area.

The reclamation situations to be addressed include the following:

1. The coal slurry impoundments at the east end of Hiawatha and nearby areas influenced by them;
2. The proposed topsoil borrow sites east of the coal slurry impoundments;
3. The mining pads and approaches to them at the mine portals in South, Middle, and North Forks, including sediment ponds, parking lots, conveyor routes, railroad siding areas and other equipment areas;
4. The riparian areas in South, Middle and North Forks that have been or will be disturbed by mining activities.

Field trial studies will be described for each of these situations. The studies, to be described below, incorporate the advice, guidelines, and requirements of the Office of Surface Mining and the Division of Oil, Gas and Mining. All Apparent Completeness Review (ARC) recommendations are included in the test plot designs provided here.

Four seed mixtures, corresponding to each of these situations, are provided in Tables 1,2,3 and 4. A master list for ordering seed is provided in Table 5. In each case the seed mixtures are carefully formulated to provide suitable species for the expected conditions where they will be used. They were formulated in conjunction with the advice of Mr. Lynn Kunzler, DOGM. They are balanced between shrubs, forbs, and grasses. The intention in each mixture is to provide plants with good soil binding characteristics combined with good forage value for wildlife. The existing vegetation in the vicinity of borrow areas A and D, to which the field trials of Study Sites #1 and #2 (Figures 1 and 2) correspond, is shown in Table 6. The seed mixtures (No. 1 and No. 2) to be tested, resemble but are not identical to this list. The seed mixtures No. 3 and No. 4 are intended for the smaller plot studies in South and Middle Forks at the mine pads and riparian areas.

Of these areas, in-depth field trial studies are described herein for the coal slurry area and the topsoil borrow area. Less intensive studies are described for the mine pads and riparian areas. The slurry impoundment and topsoil borrow areas are the largest and have the least information already available for making management decisions. The mine pad areas and riparian areas have already received some attention (interim reclamation results are available). These areas also are quite limited in extent. No large areas are available in

TABLE 1. Trial seed mixture No. 1: For use on slurry impoundment and on sagebrush-dominated soil borrow area

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended shrub density ^e (plants/acre)
				(seeds/ft ²) pure live seed	(lb/acre)	
<u>SHRUBS</u>						
<u>Artemisia tridentata</u> var. <u>tridentata</u>	Big sagebrush	NS	2,500,000	11	0.2	500
<u>Atriplex canescens</u>	Fourwing saltbush	NS	55,000	8	6	300
<u>Chrysothamnus nauseosus</u> var. <u>albicaulis</u>	Whitestem rubber rabbitbrush	NS	400,000	9	1	400
<u>Eurotia (Ceratoides) lanata</u>	Winterfat, white sage	NHS	70,000	10	6	450
				<u>38</u>	<u>13.2</u>	<u>1700</u>
<u>GRASSES</u>						
<u>Agropyron smithii</u>	Western wheatgrass	NPG	125,000	14	5	—
<u>Agropyron trachycaulum</u>	Slender wheatgrass	NPG	160,000	15	4	—
<u>Elymus cinereus</u>	Giant wildrye	NPG	100,000	11	5	—
<u>Oryzopsis hymenoides</u>	Indian ricegrass	NPG	188,000	13	3	—
<u>Sporobolus cryptandrus</u>	Sand dropseed	NPG	5,100,000	12	0.1	—
				<u>65</u>	<u>17.1</u>	
<u>FORBS</u>						
<u>Aster chilensis</u>	Pacific aster	NPF	2,670,000	12	0.2	—
<u>Cleome serrulata</u>	Rocky Mountain beeplant	NAF	50,000*	6	5	—
<u>Melilotus officinalis</u>	Yellow sweetclover	IBF	260,000	12	2	—

TABLE 1. Trial seed mixture No. 1: For use on slurry impoundment and on sagebrush-dominated soil borrow area (continued)

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended shrub density ^e (plants/acre)
				(seeds/ft ²) pure	(lb/acre) live seed	
<u>Penstemon palmeri</u>	Palmer's penstemon	NPF	610,000	14	1	—
<u>Stanleya pinnata</u>	Desert prince's plume	NHSF	80,000*	9	5	—
				53	13.2	
					43.5	

^aIncluded species selected in consultation with Lynn M. Kunzler, Reclamation Biologist, Division of Oil, Gas and Mining, State of Utah, 10/26/83.

^bHabit codes: A = Annual, B = Biennial, F = Forb, G = Grass, GL = Grasslike (sedges and rushes), HS = Half-shrub (woody at base only), I = Introduced or adventive, N = Native, P = Perennial, S = Shrub, T = Tree.

^cSource: Personal communication, Lynn M. Kunzler, 10/28/83, from published references. Starred entries (*) are estimates.

^dRationale provided by Lynn M. Kunzler. First column (seeds/ft²) explained below: Remaining columns are calculated from seed weights and sowing rate (1 acre = 43,560 ft²).

Shrubs: Sow 1,000 x desired reclaimed density due to mortality rate for shrubs.

Grasses and Forbs: Sow a total of 80 to 150 seeds per square foot for combined grasses and shrubs.

^eRounded to nearest 50 or 100. Grass and forb densities are intentionally omitted.

TABLE 2. Trial seed mixture No. 2: For use on sagebrush-dominated soil borrow area

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended shrub density ^e (plants/acre)
				(seeds/ft ²) pure live seed	(lb/acre)	
SHRUBS						
<u>Amelanchier utahensis</u>	Utah serviceberry	NS	26,000	6	10	250
<u>Artemisia frigida</u>	Fringed sagewort	NHS	4,535,000	10	0.1	450
<u>Ephedra viridis</u>	Green ephedra	NS	25,000	6	10	250
<u>Eurotia (Ceratoides) lanata</u>	Winterfat, white sage	NHS	70,000	8	5	350
<u>Purshia tridentata</u>	Antelope bitterbrush	NS	15,000	2	5	100
				32	30.1	1400
GRASSES						
<u>Agropyron dasystachyum</u>	Thickspike wheatgrass	NPG	160,000	15	4	—
<u>Agropyron spicatum</u>	Slender wheatgrass	NPG	117,000	13	5	—
<u>Elymus cinereus</u>	Giant wildrye	NPG	100,000	11	5	—
<u>Oryzopsis hymenoides</u>	Indian ricegrass	NPG	188,000	13	3	—
<u>Sitanian hystrix</u>	Sand dropseed	NPG	119,000	5	2	—
<u>Stipa comata</u>	Needle-and-thread grass	NPG	115,000	8	3	—
				65	22	
FORBS						
<u>Achillea millefolium</u>	Yarrow	NPF	3,000,000	7	0.1	—
<u>Artemisia ludoviciana</u>	Louisiana sagewort	NPF	4,500,000	10	0.1	—
<u>Astragalus cicer</u>	Cicer milkvetch	IPF	115,000	11	4	—
<u>Hedysarum boreale</u>	Northern sweetvetch	NPF	33,000	4	5	—
<u>Linum lewisii</u>	Lewis flax	NPF	290,000	13	2	—
				45	11.2	
					63.3	

TABLE 2. Trial seed mixture No. 2: For use on sagebrush-dominated soil borrow area (continued)

^aIncluded species selected in consultation with Lynn M. Kunzler, Reclamation Biologist, Division of Oil, Gas and Mining, State of Utah, 10/26/83.

^bHabit codes: A = Annual, B = Biennial, F = Forb, G = Grass, GL = Grasslike (sedges and rushes), HS = Half-shrub (woody at base only), I = Introduced or adventive, N = Native, P = Perennial, S = Shrub, T = Tree.

^cSource: Personal communication, Lynn M. Kunzler, 10/28/83, from published references. Starred entries (*) are estimates.

^dRationale provided by Lynn M. Kunzler. First column (seeds/ft²) explained below: Remaining columns are calculated from seed weights and sowing rate (1 acre = 43,560 ft²).

Shrubs: Sow 1,000 x desired reclaimed density due to mortality rate for shrubs.

Grasses and Forbs: Sow a total of 80 to 150 seeds per square foot for combined grasses and shrubs.

^eRounded to nearest 50 or 100. Grass and forb densities are intentionally omitted.

TABLE 3. Trial seed mixture No. 3: For use on disturbed areas in South and Middle Forks where existing surfaces will be prepared for seeding without addition of more topsoil

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended tree and shrub density ^e (plants/acre)
				(seeds/ft ²) (pure live seed)	(lb/acre)	
<u>NURSERY-GROWN STOCK (TREES)</u>						
<u>Abies concolor</u>	White fir	NT	—	—	—	150
<u>Acer glabrum</u>	Smooth maple	NT	—	—	—	100
<u>Picea pungens</u>	Blue spruce	NT	—	—	—	150
<u>Pseudotsuga menziesii</u>	Douglas fir	NT	—	—	—	100
						500
<u>SEED-GROWN VEGETATION</u>						
<u>SHRUBS</u>						
<u>Amelanchier utahensis</u>	Utah serviceberry	NS	26,000	6	10	300
<u>Artemisia tridentata</u> var. <u>vaseyana</u>	Mountain big sage	NS	2,500,000	11	0.2	500
<u>Cercocarpus ledifolius</u>	Curleaf mountain mahogany	NS	52,000	12	10	500
<u>Rhus trilobata</u>	Squawbush, skunkbush sumac	NS	20,000	5	10	200
<u>Sambucus caerulea</u>	Blue elderberry	NS	217,000	5	1	200
<u>Symphoricarpos oreophilus</u>	Snowberry	NS	54,000	5	4	200
				44	35.2	1,900

TABLE 3. Trial seed mixture No. 3: For use on disturbed areas in South and Middle Forks where existing surfaces will be prepared for seeding without addition of more topsoil (continued)

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended tree and shrub density ^e (plants/acre)
				(seeds/ft ²) (pure live seed)	(lb/acre)	
<u>SEED-GROWN VEGETATION (continued)</u>						
<u>GRASSES</u>						
<u>Agropyron spicatum</u>	Bluebunch wheatgrass	NPG	117,000	11	4	—
<u>Bromus carinatus</u> or <u>B. marginatus</u>	Mountain brome	NPG	80,000	9	5	—
<u>Dactylis glomerata</u>	Orchard grass	IPG	540,000	12	1	—
<u>Elymus cinereus</u>	Giant wildrye	NPG	100,000	11	5	—
<u>Festuca ovina</u> var. <u>duriuscula</u>	Sheep fescue, hard fescue	IPG	560,000	13	1	—
<u>Oryzopsis hymenoides</u>	Indian ricegrass	NPG	188,000	13	3	—
<u>Phleum alpinum</u>	Timothy	NPG	1,300,000	9	0.3	—
				78	19.3	—
<u>FORBS</u>						
<u>Hedysarum boreale</u>	Northern sweetvetch	NPF	33,000	6	7	—
<u>Medicago sativa</u>	Ranger alfalfa	IPF	210,000	16	3	—
<u>Sphaeralcea coccinea</u>	Scarlet globemallow	NPF	500,000*	16	1	—
				38	11	—
					65.5	

TABLE 3. Trial seed mixture No. 3: For use on disturbed areas in South and Middle Forks where existing surfaces will be prepared for seeding without addition of more topsoil (continued)

^aIncluded species selected in consultation with Lynn M. Kunzler, Reclamation Biologist, Division of Oil, Gas, and Mining, State of Utah, October 26, 1983.

^bHabit codes: A = Annual, B = Biennial, F = Forb, G = Grass, GL = Grasslike (sedges and rushes), HS = Half-shrub (woody at base only), I = Introduced or adventive, N = Native, P = Perennial, S = Shrub, T = Tree.

^cSource: Personal communication, Lynn M. Kunzler, October 28, 1983; from published references. Starred entries (*) are estimates. Remaining columns are calculated from seed weights and sowing rates (1 acre = 43,560 ft²).

^dRationale provided by Lynn M. Kunzler. First column (seeds/ft²) explained below:

Shrubs: Sow 1,000 x desired reclaimed density due to mortality rate for shrubs.

Grasses and forbs: Sow a total of 80 to 150 seeds per square foot for combined grasses and shrubs.

^eRounded to the nearest 50 or 100. Grass and forb densities are intentionally omitted.

TABLE 4. Trial seed mixture No. 4: For reclamation of disturbed riparian areas in South and Middle Forks where stockpiled topsoil will be used

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended tree and shrub density ^e (plants/acre)
				(seeds/ft ²)	(lb/acre) (pure live seed)	
<u>NURSERY-GROWN STOCK:</u> All woody plants in this habitat will be planted from nursery stock.						
TREES						
<u>Betula occidentalis</u>	Water birch	NT	—	—	—	300
<u>Populus angustifolia</u>	Narrowleaf cottonwood	NT	—	—	—	200
<u>Prunus virginiana</u>	Chokecherry	NT	—	—	—	300
						800
SHRUBS						
<u>Cornus stolonifera</u>	Redosier dogwood	NS	—	—	—	750
<u>Rosa woodsii</u>	Wood's rose	NS	—	—	—	500
<u>Salix exigua</u>	Coyote willow	NS	—	—	—	1,000
						2,250
						3,050
<u>SEED-GROWN VEGETATION</u>						
GRASSES, SEDGES, AND RUSHES						
<u>Agropyron dasystachyum</u>	Thickspike wheatgrass	NPG	160,000	15	4	—
<u>Agropyron smithii</u>	Western wheatgrass	NPG	125,000	11	4	—
<u>Bromus ciliatus</u>	Fringed brome	NPG	90,000	8	4	—
<u>Carex rossii</u> or other C. as available	Ross sedge	NPGL	100,000*	10	4.5	—
<u>Juncus balticus</u>	Baltic rush, wiregrass	NPGL	100,000*	9	4	—
<u>Phleum alpinum</u>	Timothy	NPG	1,300,000	9	0.3	—
<u>Poa pratensis</u>	Kentucky bluegrass	IPG	2,150,000	10	0.2	—
				72	21	

TABLE 4. Trial seed mixture No. 4: For reclamation of disturbed riparian areas in South and Middle Forks where stockpiled topsoil will be used (continued)

Scientific name ^a	Common name	Habit ^b	Seed count factor (seeds/lb) ^c	Proposed broadcast rate ^d		Intended tree and shrub density ^e (plants/acre)
				(seeds/ft ²) (pure live seed)	(lb/acre)	
<u>SEED-GROWN VEGETATION</u> (continued)						
FORBS						
<u>Aquilegia coerulea</u>	Colorado columbine	NPF	370,000	8	1	—
<u>Balsamorhiza sagittata</u>	Arrowleaf balsamroot	NPF	55,000	3	2	—
<u>Geranium richardsonii</u> or <u>G. fremontii</u>	Richardson's geranium	NPF	52,000	5	4	—
<u>Lupinus sericeus</u>	Silky lupine	NPF	13,000	3	10	—
<u>Vicia americana</u>	American vetch	NPF	41,000	5	5	—
				24	22	
				96	43	

^aIncluded species selected in consultation with Lynn M. Kunzler, Reclamation Biologist, Division of Oil, Gas, and Mining, State of Utah, October 26, 1983.

^bHabit codes: A = Annual, B = Biennial, F = Forb, G = Grass, GL = Grasslike (sedges and rushes), HS = Half-shrub (woody at base only), I = Introduced or Adventive, N = Native, P = Perennial, S = Shrub, T = Tree.

^cSource: Personal communication, Lynn M. Kunzler, October 28, 1983; from published references. Starred entries (*) are estimates. Remaining columns are calculated from seed weights and sowing rates (1 acre = 43,560 ft²).

^dRationale provided by Lynn M. Kunzler. First column (seeds/ft²) explained below:

Shrubs: Sow 1,000 x desired reclaimed density due to mortality rate for shrubs.

Grasses and forbs: Sow a total of 80 to 150 seeds per square foot for combined grasses and shrubs.

^eRounded to the nearest 50 or 100. Grass and forb densities are intentionally omitted.

TABLE 5. Master seed list for field trial studies

Scientific name	Common name	acres	Quantity per seed mix (pounds/acre) pure live seed				Quantity needed for field trial	
			1	2	3	4	Total acres pure live seed	Total pounds ^a pure live seed
SHRUBS								
<u>Amelanchier utahensis</u>	Utah serviceberry	—	10	10	—	—	.14	1.4
<u>Artemisia frigida</u>	Fringed sage	—	0.1	—	—	—	.13	<0.1
<u>Artemisia tridentata</u> var. <u>tridentata</u>	Big sage	0.2	—	—	—	—	.13	<0.1
<u>Artemisia tridentata</u> var. <u>vaseyana</u>	Mountain big sage	—	—	0.2	—	—	.01	<0.1
<u>Atriplex canescens</u>	Fourwing saltbush	6	—	—	—	—	.13	0.8
<u>Cercocarpus ledifolius</u>	Curleaf mountain mahogany	—	—	10	—	—	.01	0.1
<u>Chrysothamnus nauseosus</u> var. <u>albicaulis</u>	Whitestem rubber rabbitbrush	1	—	—	—	—	.13	0.1
<u>Ephedra viridis</u>	Green ephedra	—	10	—	—	—	.13	1.3
<u>Eurotia (Ceratooides)</u> <u>lanata</u>	Winterfat, white sage	6	5	—	—	—	.26	1.4
<u>Purshia tridentata</u>	Antelope bitterbrush	—	5	—	—	—	.13	0.7
<u>Rhus trilobata</u>	Squawbush, skunkbush sumac	—	—	1	—	—	.01	<0.1
<u>Sambucus caerulea</u>	Blue elderberry	—	—	1	—	—	.01	<0.1
<u>Symphoricarpos oreophilus</u>	Snowberry	—	—	4	—	—	.01	<0.1
		13.2	30.1	35.2	0			6.4

TABLE 5. Master seed list for field trial studies (continued)

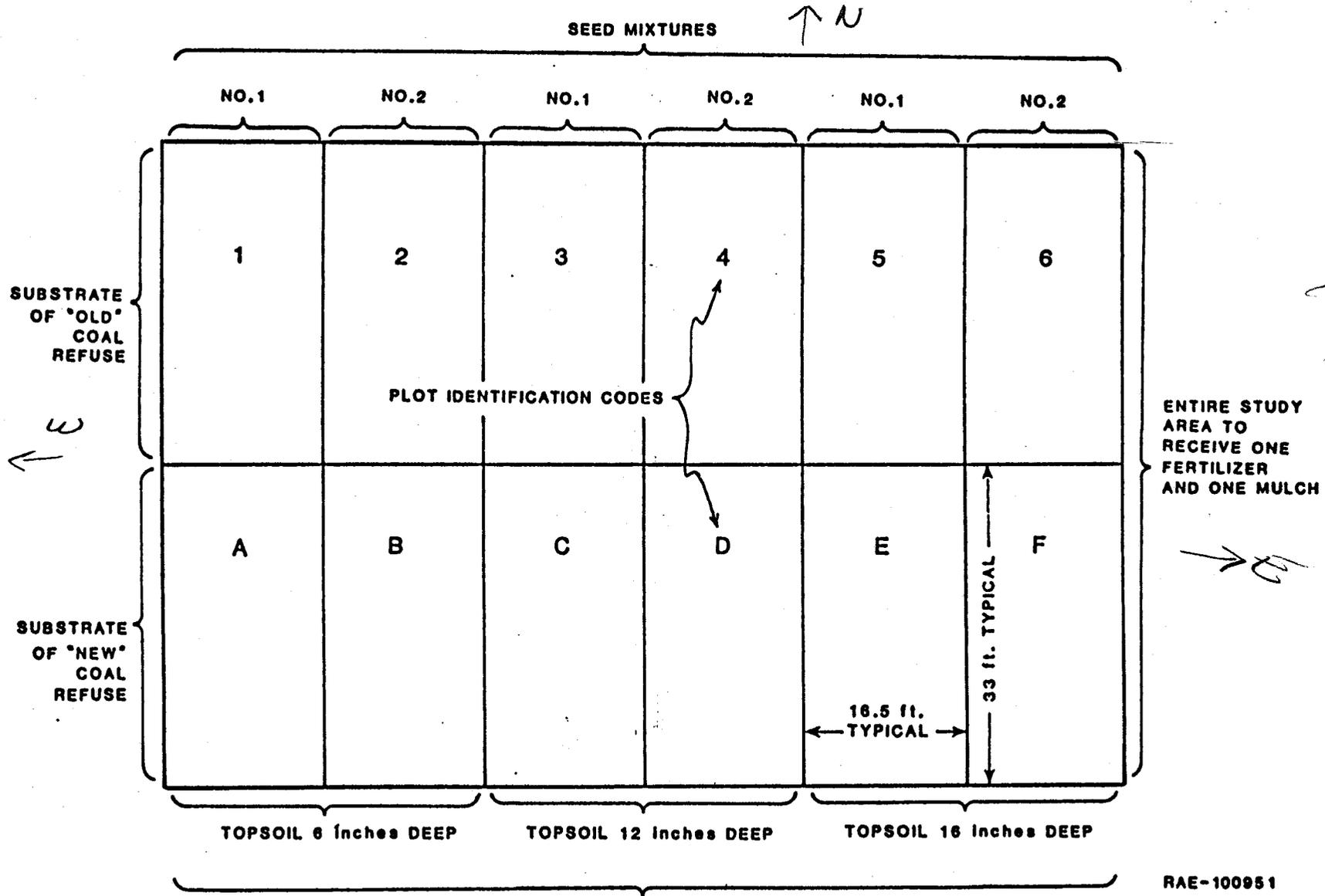
Scientific name	Common name	acres	Quantity per seed mix (pounds/acre) pure live seed				Quantity needed for field trial	
			1	2	3	4	Total acres	Total pounds ^a pure live seed
			.13	.13	.01	.02		
GRASSES								
<u>Agropyron dasystachyum</u>	Thickspike wheatgrass	—	4	—	4		0.15	0.6
<u>Agropyron smithii</u>	Western wheatgrass	5	—	—	4		0.15	0.7
<u>Agropyron spicatum</u>	Bluebunch wheatgrass	—	5	4	—		0.14	0.7
<u>Agropyron trachycaulum</u>	Slender wheatgrass	4	—	—	—		0.13	0.5
<u>Bromus carinatus</u> or <u>B. marginatus</u>	Mountain brome	—	—	5	—		.01	0.1
<u>Bromus ciliatus</u>	Fringed brome	—	—	—	4		.02	0.1
<u>Carex rossii</u> or other <u>C. as available</u>	Ross sedge	—	—	—	4.5		.02	0.1
<u>Dactylis glomerata</u>	Orchard grass	—	—	1	—		.01	<0.1
<u>Elymus cinereus</u>	Giant wildrye	5	5	5	—		0.27	1.4
<u>Festuca ovina</u> var. <u>duriuscula</u>	Hard fescue	—	—	1	—		.01	<0.1
<u>Juncus balticus</u>	Baltic rush	—	—	—	4		.02	0.1
<u>Oryzopsis hymenoides</u>	Indian ricegrass	3	3	3	—		0.27	0.8
<u>Phleum alpinum</u>	Timothy	—	—	0.3	0.3		.03	<0.1
<u>Poa pratensis</u>	Kentucky bluegrass	—	—	—	0.2		.02	<0.1
<u>Sitanian hystrix</u>	Bottlebrush squirreltail	—	2	—	—		0.13	0.3
<u>Sporobolus cryptandrus</u>	Sand dropseed	0.1	—	—	—		0.13	<0.1
<u>Stipe comata</u>	Needle-and-thread grass	—	3	—	—		0.13	0.4
			17.1	22.0	19.3	21.0		6.3

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TABLE 5. Master seed list for field trial studies (continued)

Scientific name	Common name	acres	Quantity per seed mix (pounds/acre) pure live seed				Quantity needed for field trial	
			1 .13	2 .13	3 .01	4 .02	Total acres pure live seed	Total pounds ^a
FORBS								
<u>Achillea millefolium</u>	Yarrow	—	0.1	—	—	—	0.13	<0.1
<u>Aquilegia coerulea</u>	Colorado columbine	—	—	—	—	1	.02	<0.1
<u>Artemisia ludoviciana</u>	Louisiana sagewort	—	0.1	—	—	—	0.13	<0.1
<u>Aster chilensis</u>	Pacific aster	0.2	—	—	—	—	0.13	<0.1
<u>Astragalus cicer</u>	Cicer milkvetch	—	4	—	—	—	0.13	0.5
<u>Balsamorhiza sagittata</u>	Arrowleaf balsamroot	—	—	—	—	2	.02	<0.1
<u>Cleome serrulata</u>	Rocky Mountain beeplant	5	—	—	—	—	0.13	0.7
<u>Geranium richardsonii</u> or <u>G. fremontii</u>	Richardson's geranium	—	—	—	—	4	.02	0.3
<u>Hedysarum boreale</u>	Northern sweetvetch	—	5	7	—	—	0.14	0.7
<u>Linum lewisii</u>	Blue flax	—	2	—	—	—	0.13	0.3
<u>Lupinus sericeus</u>	Silky lupine	—	—	—	—	10	.02	0.2
<u>Medicago sativa</u>	Ranger alfalfa	—	—	3	—	—	.01	<0.1
<u>Melilotus officinalis</u>	Yellow sweetclover	2	—	—	—	—	0.13	0.3
<u>Penstemon palmeri</u>	Palmer penstemon	1	—	—	—	—	0.13	0.1
<u>Sphaeralcea coccinea</u>	Scarlet globemallow	—	—	1	—	—	.01	<0.1
<u>Stanleya pinnata</u>	Desert prince's plume	5	—	—	—	—	0.13	0.7
<u>Vicia americana</u>	American vetch	—	—	—	—	5	.02	0.1
			13.2	11.2	11.0	22.0		4.4
			43.5	63.3	65.5	43.0		17.1

^aIt is required that additional seed be purchased as a contingency. This column shows the minimum requirement.

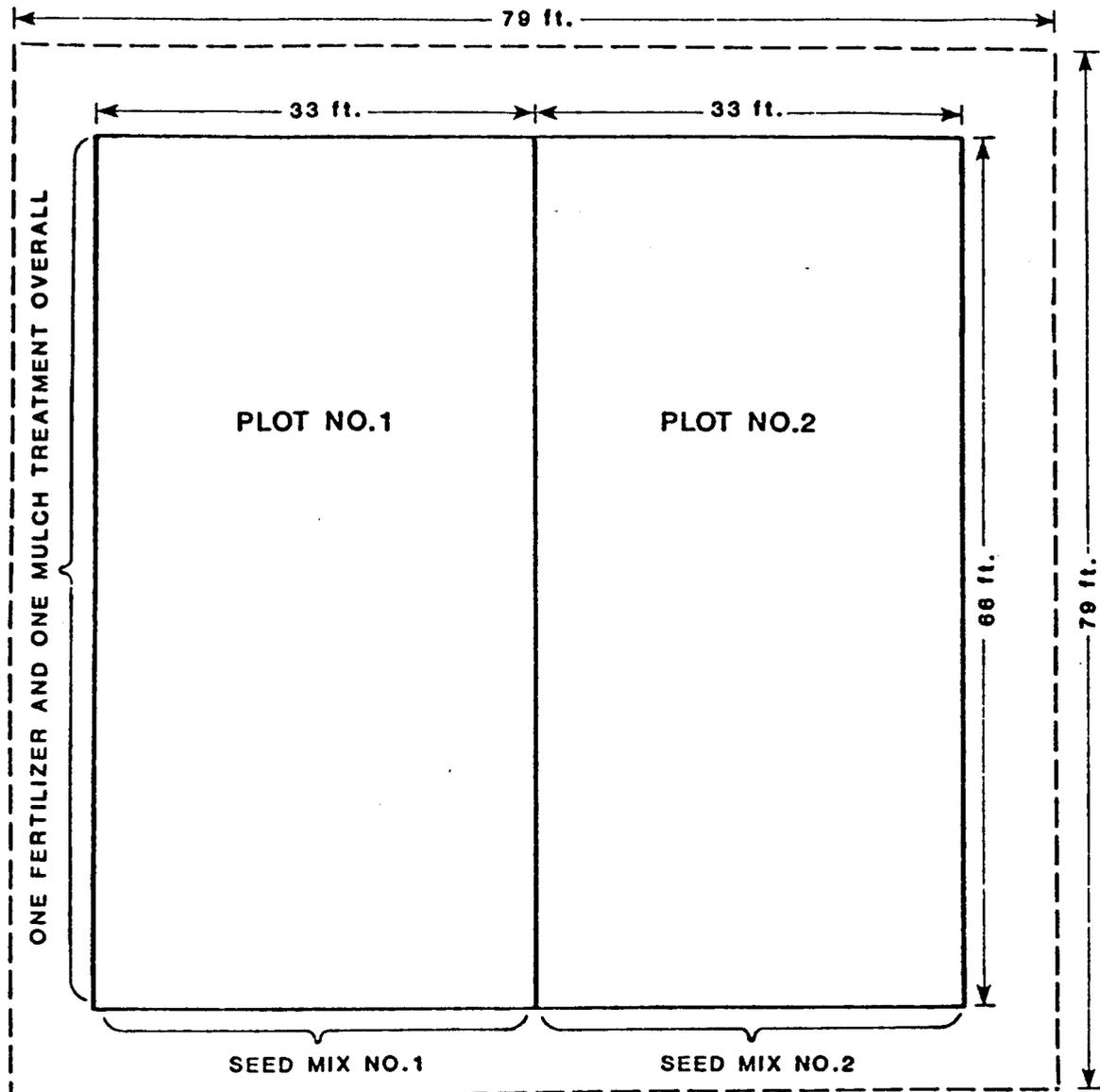


RAE-100951

TOTAL TOPSOIL REQUIRED $\cong 229 \text{ yd}^3$, TO BE OBTAINED FROM STUDY SITE NO.2

TOTAL STUDY AREA DIMENSIONS ARE 66x99 ft. (=0.16 acre)
STUDY SITE TO BE EXCAVATED SO ALL PLOTS ARE AT SAME SURFACE LEVEL AFTER TOPSOIL IS IN PLACE

FIGURE 1. LAYOUT OF "STUDY SITE NUMBER 1" TO BE LOCATED IN COAL REFUSE IMPOUNDMENT AREA.



LIMIT OF SOIL BORROW AREA- 0.14 ACRE. BORROW VOLUME IS
 79ft.x79ft.x1ft. DEEP \cong 231 yd³.

SOIL TO BE USED AT STUDY SITE NO.1 ON COAL REFUSE AREA

RAE-100952

FIGURE 2. LAYOUT OF "STUDY SITE NUMBER 2" TO BE LOCATED AT BORROW SITE IN SAGEBRUSH VEGETATION ZONE EAST OF COAL SLURRY IMPOUNDMENTS.

TABLE 6. List of plant species observed October 21, 1983 in sagebrush dominated alluvial fan area east and north of U.S. Fuel Co. slurry impoundments No. 5 and No. 2 near locations of four soil pits sampled on the same date.

Scientific Name	Common Name	Habit*
<u>TREES (3)</u>		
<u>Juniperus osteosperma</u>	Utah juniper	NT
<u>Pinus edulis</u>	Pinyon pine	NT
<u>Pinus monophylla</u>	Singleleaf pinyon pine	NT
<u>SHRUBS, VINES, AND CACTI (15)</u>		
<u>Artemisia frigida</u>	Fringed sagewort	NHS
<u>Artemisia nova</u>	Black sagebrush	NS
<u>Artemisia tridentata</u>	Big sagebrush	NS
<u>Berberis repens</u>	Oregon grape	NS
<u>Chrysothamnus nauseosus</u>	Rubber rabbitbrush	NS
<u>Chrysothamnus viscidiflorus</u> var. <u>lanceolatus</u>	Lanceleaf yellowbrush	NS
<u>Clematis ligusticifolia</u>	Western virgin's bower	NWV
<u>Eurotia (Ceratooides) lanata</u>	Winterfat, white sage	NHS
<u>Gutierrezia (Xanthocephalum)</u> <u>sarothrae</u>	Broom snakeweed	NHS
<u>Opuntia fragilis</u>	Brittle pricklypear	NS4S
<u>Opuntia polyacantha</u>	Plains pricklypear	NS4S
<u>Rhus trilobata</u>	Squawbush, skunkbush sumac	NS
<u>Rosa woodsii</u>	Wood's rose	NS
<u>Symphoricarpos oreophilus</u>	Snowberry	NS
<u>Yucca harrimaniae</u>	Harriman yucca	NS
<u>GRASSES (8)</u>		
<u>Agropyron smithii</u>	Bluestem wheatgrass	NPG
<u>Agropyron trachycaulum</u>	Slender wheatgrass	NPG
<u>Bouteloua gracilis</u>	Blue grama	NPG
<u>Bromus tectorum</u>	Cheatgrass	IAG
<u>Hordeum jubatum</u>	Foxtail barley	NPG
<u>Oryzopsis hymenoides</u>	Indian ricegrass	NPG
<u>Sitanian hystrix</u>	Bottlebrush squirreltail	NPG
<u>Sporobolus cryptandrus</u>	Sand dropseed	NPG
<u>FORBS (33)</u>		
<u>Allium sp.</u>	Wild onion	NPF
<u>Androsace occidentalis</u>	Western rockjasmine	NAF

TABLE 6. List of plant species observed October 21, 1983 in sagebrush dominated alluvial fan area east and north of U.S. Fuel Co. slurry impoundments No. 5 and No. 2 near locations of four soil pits sampled on the same date. (continued)

Scientific Name	Common Name	Habit*
<u>Arctium minus</u>	Burdock	IBF
<u>Aster chilensis</u>	Pacific aster	NPF
<u>Astragalus convallarius</u>	Timber poisonvetch	NPF
<u>Chenopodium album</u>	Lamb's quarter	IAF
<u>Cirsium spp. (2)</u>	Thistle	NBPF
<u>Cleome lutea</u>	Yellow beeplant	NAF
<u>Cleome serrulata</u>	Rocky mountain beeplant	NAF
<u>Cryptantha sp.</u>	Cryptantha	NAPF
<u>Cynoglossum vulgare</u>	Houndstongue	IBF
<u>Descurainea pinnata</u>	Tansymustard	NAF
<u>Echinopsilon (Bassia) hyssopifolium</u>	Smotherweed	IAF
<u>Eriogonum sp.</u>	Buckwheat	NAPF
<u>Grindelia squarrosa</u>	Curlycup gumweed	NBF
<u>Hedysarum boreale</u>	Northern sweetvetch	NPF
<u>Helianthus annuus</u>	Common sunflower	NAF
<u>Hymenoxys acaulis</u>	Stemless hymenoxys	NPF
<u>Ipomopsis (Gilia) aggregata</u>	Skyrocket gilia	NPF
<u>Kochia scoparia</u>	Belvedere summercypress	IAF
<u>Lactuca serriola</u>	Prickly lettuce	IBF
<u>Machaeranthera canescens</u>	Hoary tansyaster	NBF
<u>Marrubium vulgare</u>	Horehound	IPF
<u>Mentzelia sp.</u>	Blazingstar	NABPF
<u>Penstemon sp.</u>	Penstemon	NPF
<u>Phacelia sp.</u>	Phacelia	NAPF
<u>Salsola kali</u>	Russian thistle	IAF
<u>Sisymbrium altissimum</u>	Tumblemustard	IAF
<u>Solanum triflorum</u>	Cutleaf nightshade	NAF
<u>Solidago sparsiflora</u>	Goldenrod	NPF
<u>Sphaeralcea coccinea</u>	Scarlet globemallow	NPF
<u>Tragapogon dubius</u>	Yellow salsify	IBF

*Key to habit codes. "Habit" means the manner of growth of a plant, which encompasses its growth form (tree, shrub, grass, herbaceous forb, etc.), manner of overwintering (roots survive in perennials, seeds only survive in annuals), and the degree of indigeneity (i.e., native vs introduced or adventive).

The habit codes in this list have the following meanings:

A	Annual	P	Perennial
B	Biennial	S	Shrub
G	Grass	S4S	Succulent Shrub (cactus)
HS	Half-Shrub (woody at base only)	T	Tree
I	Introduced or adventive	WV	Woody Vine
N	Native		
F	Forb		

them for studies nor is disturbance very extensive either, compared to that at the coal slurry impoundment and that which will occur when borrow material is taken from nearby undisturbed borrow areas. Therefore the mine pad and riparian studies to be done will be less extensive, while still addressing the required needs of the decision-makers. In the entire permit area, all riparian habitats add up to about 170 acres. Most of this is undisturbed except at a few places where road crossings and road shoulders have intruded. These existing disturbances amount to no more than about 15 acres. All disturbed riparian habitat will be restored except for road crossings and railroad crossings and at the Hiawatha townsite. In the first case, the roads will be left in place. In the second case, the property does not belong to U.S. Fuel Company. An expanded discussion of mitigation of riparian habitat losses is found elsewhere in Chapter III under Aquatic and Riparian Habitat.

U.S. Fuel proposes to mitigate for permanently lost riparian habitat through replacement in kind on site.

Two field plot studies, corresponding to items 1 and 2 in the list of reclamation situations shown above, were designed to satisfy deficiencies noted in the ACR (Figures 1 and 2 relate to these plots). The experimental design of each is similar, though details differ due to different reclamation requirements. Each study site will occupy an area of 0.1 or 0.15 acres and will be 66 feet on a side and 66 or 99 feet long. These areas will be divided into separate treatment plots in an array as shown in Figures 1 and 2. The treatments and controls will be distributed into the array so as to provide two replicates of each different treatment combination. The treatments include soil depth, type of fertilizer, type of mulch, and seed mix. Each test site will be independent of the others and is ment to provide data only for that site. Each test site differs from the others in one or more fundamental ways while certain other factors remain common to both. For example, at the coal slurry impoundment site two soil depths will be tested against one seed mix. At the alluvial fan soil borrow site, one soil (the soil remaining after borrowing) will be tested against two seed mixes. Both sites will be fenced for protection against cattle, sheep and disturbance by any new mining construction or accidental equipment intrusion. The fence will be steel post and 6 inch square mesh hog-wire four feet high with two strands of barbed wire above the wire mesh at four and ten inches. A closing gate will be provided. The fence is to be two feet outside the perimeter of the study area.

Schedule

The study sites will be physically prepared during the first year of the approved permit term, beginning construction early enough to assure planting during the first year.

During January through May of the first year, necessary supplies will be ordered and received. These will include the seeds for the seed mixtures, fencing, hand tools, mulches, fertilizers, marking stakes (rebar), surveyor's

ribbon (or other material such as wire) for marking the plots, and other materials. Personnel and equipment will be scheduled for site construction. A truck, dozer, front-end loader, and work crew will be required to strip vegetation, haul borrow, and rough out sites. A small crew can be scheduled to smooth, level, rake, mark plots, construct fences, and finish all physical arrangements at the two sites. The same crew can physically prepare the smaller study plots at the mining pads and riparian areas to be tested.

In September and/or October of the first year the appropriate seeding, fertilizer, and mulch treatments will be applied. Protocols for these will be prepared in advance based on the study designs described here, as approved by DOGM. Seeds are to be broadcast, not drilled, at a uniform rate as given in the seed mixes. Pelletized or granular fertilizer is to be broadcast, not drilled. The hay mulch will be spread by hand and covered with staked-down mesh.

Study Designs

Plot layouts for the two larger studies are provided in Figures 1 and 2.

Trial seed mixture formulas are provided in Tables 1, 2, 3 and 4. A master list of all proposed revegetation species is provided in Table 5. In Tables 1, 2, 3, 4 and 5, which are the species list tables for seed mixtures 1, 2, 3 and 4 and a master list showing all four combined, the quantities of seeds shown in the "pounds per acre" and "total pounds" columns are "pure live seed" amounts. These numbers are formulated for planting by broadcasting. During actual reclamation work, on areas that are level enough, planting by drilling may be used. In that case, half the pound-per-acre seed rate shown in the tables will be used. This is because drilling results in a more uniform distribution and reliable covering of seeds by soil than does hand broadcasting followed by raking. Areas that will require hand broadcasting of seed will include the mine pads, any riparian areas, and steep slopes (greater than 8%). Drilling will be suitable at the coal slurry pond reclamation sites and on the substitute topsoil borrow areas after borrowing. Note that at study site No. 1 (coal slurry ponds), only seed mix No. 1 is used. At study site No. 2, seed mixes No. 1 and No. 2 are used. In each case, the seed mixtures are carefully formulated to provide suitable species for the expected conditions where they will be used. They are balanced between shrubs, forbs, and grasses. The intention in each mixture is to provide plants with good soil binding characteristics combined with good forage value for wildlife. It is intended that reclaimed areas be enhanced with respect to forage value rather than large shrub density. The sagebrush area where borrow material will be obtained, for example, presently has such large sagebrush plants at such high density that one cannot force a way through some areas on foot. This condition is accompanied by an almost complete lack of understory grass and forb species. A list of species observed in the vicinity of the soil test pits on the sagebrush dominated alluvial fan area proposed for a borrow site is provided in Table 6. Although cover for wildlife is abundant, the density and great size of these shrubs, some of which are over eight feet tall,

combine to produce a severe fire hazard. It is not particularly desired by range managers to promote an increase in such monoculture stands as this. For this reason some pinyon-juniper areas have been chained to release understory growth. Some sagebrush areas have been sprayed herbicidally or subjected to controlled burning for similar reasons. Pinyon-juniper and sagebrush monocultures exist over literally millions of acres in the western United States. Wildlife values will be enhanced by restoring some of these areas to vegetation types that contain a greater variety of shrubs and understory plants with higher forage value than sagebrush or pinyon-juniper affords. These considerations have been major guiding principles in formulating the proposed seed mixtures.

Seed mixtures No. 3 and No. 4 are intended for the smaller plot studies in South and Middle Forks at the mine pads and riparian areas, respectively. No studies are proposed for the North Fork area, which is difficult to access, is very limited in disturbance and does not represent much of a reclamation problem. The pads in South and Middle Forks will adequately test the worst case situations and will apply to reclamation of North Fork as well.

Twelve candidate sites for seed mixture testing areas are marked on maps of the mine pad areas, six in Middle Fork, (Nos. 1-6, Exhibit II-3) and six in South Fork (Nos. 7-12, Exhibit II-2). Soil samples have been collected from all 12 of these potential study plots and the laboratory analysis results are shown in Tables 7 and 8.

Study Site Number One - Coal Refuse Area

This field trial study site will be located on an east facing exposure in the coal refuse area just west of the railroad tracks and north of the coal loadout facility, as marked on Exhibit III-4. The study site will be an area of 66 X 99 feet (0.15 acre). One seed mixture (Number 1, see Table 1) will be tested. Three soil depths (6 inches, 12 inches and 16 inches) will be tested with the seed mixture. In addition, two types of substrates of coal refuse will be tested, "old" weathered material and "new" unweathered material. The layout of this field trial study site is shown in Figure 1.

The existing, weathered coal refuse surface is to be prepared before topsoil is hauled in, by excavating the surface to 6 inch, 12 inch, and 16 inch depths as shown on Figure 1. This is to be done to provide for a uniform level surface over the whole area when the soil is in place, even though three soil depths are being tested. The other side of the study area, to be used for testing reclamation success over "new" coal refuse, will be excavated to a depth of at least two feet below the corresponding bottoms of the 6, 12 and 16 inches of soil to be loaded in and graded to a common level surface. The excess coal refuse from the test plot excavations will be moved to another location in the coal refuse area well away from the study site.

Soil will be obtained from the soil borrow area designated "Area A" at the exact location where Study Site Number Two is to be constructed. The soil

TABLE 7
SOIL LABORATORY ANALYSES
KING IV, V, AND VI

Area	Sample	SP ^a	pH	ECe ^b	SAR	NA ^c	Ca ^c	Mg ^c	HCO ₃ ^c	OM	N	P ^c	K ^c	Texture ^c	MC ^c	AWC ^a
King IV & V Upper	1	27	7.5	.31	.06	176	46.2	15.6	.02	4.32	.08	1.84	10	SL	fr	.09-.10
King IV & V Upper	2	19	8.0	.43	.08	170	30.0	32.9	.01	8.49	.07	.43	20	L	fi	.09-.10
King IV & V Upper	3	22	7.3	.39	.08	180	13.6	4.3	.02	2.37	.02	.84	5	SL	fi	.13-.14
King IV & V Lower	4	29	7.6	1.00	2.27	725	70.8	17.5	.01	1.98	.04	.80	38	SL	fr	.13-.14
King IV & V Lower	5	25	7.6	.49	1.13	325	87.1	24.7	.01	1.76	.02	.19	18	SL	fi	.13-.14
King III & V Lower	6	22	7.4	.22	3.04	26	75.6	17.9	.01	8.24	.01	.38	16	LS	fr	.09-.10
King VI Upper	7	26	7.2	.16	.06	8	75.9	20.8	.02	9.94	.01	.22	10	SL	fr	.13-.14
King VI Upper	8	21	6.9	.47	.05	18	127.0	16.7	.02	1.53	.05	1.06	20	SL	fr	.13-.14
King VI Upper	9	20	8.0	.34	.06	219	18.5	4.9	.03	1.18	.02	.79	10	SCL	fr	.12-.13
King VI Lower	10	25	7.5	.49	.05	28	47.5	42.6	.01	2.28	.02	.10	14	SL	fr	.09-.10
King IV Lower	11	25	7.7	.32	.03	23	61.2	30.0	.01	2.12	.02	.05	13	SCL	fi	.13-.14
King VI Lower	12	25	7.0	.61	.06	128	75.1	16.8	.01	6.49	.02	.73	14	SL	fr	.13-.14

^aSP = Percentage of Water at Saturation

^bECE = Electrical Conductivity of Saturation Extract in mmhos/cm

^cSoluble in Saturation Extract in Parts Per Million

^dPercent

^eTexture: S = Sand, C = Clay, L = Loam

^fMoist Consistency: fr = Friable, fi = Firm

^gAWC = Available Water Capacity Inches/Inch

**TABLE 8
KING IV, V AND VI
CONCENTRATIONS OF BIOLOGICALLY ACTIVE TRACE METALS**

Pad	No.	Al (ppm)		B (ppm)		Cd (ppm)		Cu (ppm)		Fe (ppm)		Pb (ppm)		Mn (ppm)		Hg (ppb)		Se (ppm)		Zn (ppm)		pH	
King IV & V (Upper)	1	14.0	M	.05	L	.002	L	.077	L	25.8	M	<.01	L	.105	L	<1	L	.26	M	.394	L	8.1	F
	2	6.10	L	.37	L	<.001	L	.099	L	1.69	L	<.01	L	.026	L	<1	L	<.02	L	.296	L	8.8	P
	3	6.30	L	.04	L	<.001	L	.083	L	2.62	L	<.01	L	.012	L	<1	L	<.02	L	.379	L	8.7	P
King IV & V (Lower)	1	29.90	M	<.02	L	.003	L	.104	L	11.4	M	<.01	L	.344	L	<1	L	.32	M	.271	L	7.9	F
	2	1.75	L	.04	L	.001	L	.064	L	2.69	L	<.01	L	.443	L	<1	L	<.02	L	.180	L	7.7	G
	3	8.80	L	.15	L	.001	L	.087	L	4.61	L	<.01	L	.024	L	<1	L	<.02	L	.159	L	7.8	G
King VI (Upper)	1	1.92	L	.21	L	.001	L	.075	L	6.24	L	<.01	L	.021	L	<1	L	<.02	L	.031	L	7.6	G
	2	31.7	M	.11	L	.001	L	.062	L	16.4	M	<.01	L	.080	L	<1	L	.29	M	.421	L	8.3	F
	3	17.8	M	.24	L	.001	L	.068	L	5.14	L	<.01	L	.033	L	1	L	.13	M	.333	L	8.8	P
King VI (Lower)	1	.53	L	.50	L	.004	L	.036	L	.249	L	<.01	L	.006	L	<1	L	<.01	L	.002	L	8.1	G
	2	2.42	L	.32	L	.002	L	.059	L	3.43	L	<.01	L	.027	L	<1	L	<.02	L	.016	L	8.3	F
	3	5.28	L	.03	L	.001	L	.074	L	6.97	L	<.01	L	.042	L	<1	L	<.02	L	.036	L	8.0	F

Concentrations of trace metals:

L = Low concentrations, no toxicity to plants or animals

M = Moderate toxicity, very slight toxicity to plants, moderate to animals

H = High concentration, potential toxicity to plants and animals or acid-forming treatment needed

pH: G = Good pH range, no treatment required

F = Fair pH, limited treatment necessary

P = Poor pH, moderate treatment required with CaSO₄

volume will be about 229 cubic yards. The method of excavation will be described later.

When the soil is in place and has been smoothed and leveled, a pelletized fertilizer will be spread according to a prescription to be determined by soil tests.

Seed mixture Number 1 will then be applied to the test plot by broadcasting as shown on Figure 1.

Following the seeding operation, one mulch type (native hay or straw at the rate of one ton per acre) will be applied over the entire field trial area and anchored in place by mesh netting and staples.

The study site will be marked with permanent stakes to show where the different treatments are located, in accordance with Figure 1.

After seeding, fertilizing and mulching, the site will be fenced for protection against disturbance by animals or mining operations. The fence will be of steel posts and 4 or 6 inch square mesh hog wire (or equivalent) about four feet high, with two strands of barbed wire above the wire mesh at about 4 and 10 inches. A closing gate will be provided. The entire fence will be about two feet outside the perimeter of the study area.

Because of the close proximity of different treatments in the same test plot, edge effects will exist. These should be avoided during later data sampling. The monitoring protocol to be described in another section will specify that no sampling quadrats will be located within one foot of a plot boundary. The centerline of the long dimension where the "old" and "new" coal refuse substrates meet should also be avoided in data sampling, as also the entire perimeter. These excluded zones can be used as pathways by observers during data gathering.

Study Site Number Two - Topsoil Borrow Area

This study site will be located in Topsoil Borrow Area A. The study site will be an area of 66 by 66 feet (approximately 0.1 acre) marked out inside a larger area (79 by 79 feet) that has been cleared of vegetation and excavated to a depth of one foot. This excavation is the amount required to provide the necessary topsoil at Study Site Number One (about 230 cubic yards). The act of excavation corresponds to the actual disturbance that will occur during final reclamation. The field trial to be conducted on this borrow area is meant to test the revegetation methods to be used in final reclamation.

The soil surface to be tested is that remaining after borrowing. Two seed mixtures will be tested, Numbers 1 and 2, as listed in Tables 1 and 2. One fertilizer and one mulch will be used, as described for Site No. 1. Thus, the study area is a square 66 feet on a side, divided exactly in half for the two seed mixture tests. The layout of this study site is shown in Figure 2.

The surface, after the soil is borrowed, will be ripped, disked, or otherwise scarified to mitigate for the effects of heavy equipment compaction during borrowing. It will then be smoothed and the seed, fertilizer, and mulch applied as described for Study Area No. 1. This site will also be fenced as described for Study Site No.1.

Study Sites in the Mine Pad and Riparian Areas

Seed mixtures No. 3 and No. 4 are intended for the smaller plot studies in South and Middle Forks at the mine pads and riparian areas, respectively. No studies are proposed for the North Fork area, which is difficult to access, is very limited in disturbance, and does not represent much of a reclamation problem. The pads in South and Middle Forks will adequately test the worst case situations and will apply to reclamation of North Fork as well.

Twelve candidate sites for seed mixture testing are marked on maps of the mine pad areas, six in Middle Fork, (Nos. 1-6, Exhibit II-3) and six in South Fork (Nos. 7-12, Exhibit II-2). Soil samples have been collected from all 12 of these potential study plots. The laboratory analysis results are shown in Tables 7 and 8.

Of the 12 possible sites, only two will be used for field trial studies; one at each mine pad area. The preferred locations for these two study plots are Site No. 6 (Middle Fork) and Site No. 10 (South Fork). Each of these study sites will be an area 10 by 20 feet in dimension. The tested variables will be seed mixture No. 3 (see Table 3), a fertilizer and mulch. The plots will be fenced, protected, and monitored for success in the same way as is described for the large scale study plots.

The procedure at the study plots on the mine pads, utilizing seed mixture No. 3, will be a straight forward direct application of our proposed reclamation strategy on a small study area. No large areas are available for extensive studies.

This strategy seeks to avoid, as much as possible, the necessity to haul in large amounts of topsoil. Such haulage, if required, will necessitate the further disturbance of a new topsoil borrow site, leading to additional reclamation studies and actual restoration at that site. Rather, it is proposed that a field trial be made to test whether the existing pad surface can be made to support vegetative growth. This will be done by ripping, disking, and breaking up the existing surface to provide a friable surface material for planting. Soil amendments will be utilized.

Mulch will be used, native hay or straw will be tied down with staked mesh. Mulch will be applied at a rate of one ton per acre.

The field trials for seed mixture No. 4 (see Table 4), for riparian area, will be conducted at the site marked "Interim Revegetation Study Areas 1-8" on Exhibit III-5. This is an area of about 50 by 150 feet in extent located in

the riparian habitat. The study plots are to be located here because no other riparian area is available without introducing new disturbance. The study plot size will be 20 by 50 feet in extent and will be fenced, protected, and monitored for success the same way as described for the other study areas. The tested variables will be seed mixture No. 4, a fertilizer and a mulch.

Thus, a total of five soil test plot studies are proposed for the reclamation sites discussed in the introduction. Two are relatively extensive and three are limited by the availability of space in an active mining area.

Monitoring the Study Plots

After the study plots have all been constructed and seeded, the results of the study will be observed. The observation schedule is given in detail below. The measured parameters, called "plant responses", meaning responses to the various experimental treatments (soil depths, substrate, and seed mixture composition), will be the following: (a) survival density in years 2, 3, and 5 (year 1 is the first year of study plot construction and seeding); (b) percent cover in years 2, 3, and 5; (c) above-ground or standing biomass in year 5 only.

Data will be gathered in a manner suitable for later analysis by such techniques as analysis of variance followed by N-K pairwise comparison procedures, t-tests, or other techniques as needed. At the scheduled time for observation in July-August of the 2nd, 3rd, and 5th years, each of the treatment plots in the study areas will be sampled with 5 randomly located quadrats. Restriction against measuring within one foot of any plot boundary will be observed to avoid edge effects. The quadrats will be 1/2 meter X 1/2 meter = 1/4 square meter in size. The data to be recorded will include an estimate of percent cover by species and by non-living cover of rock, soil, and litter. All cover values shall add to 100 percent. Also, density counts by species of all living plant stems in the quadrats will be recorded. In the 5th year only, five quadrats in each plot will be clipped for productivity measurements. These clippings will be separated by growth form (shrub, grass, forb) and will be put in properly marked paper bags for transport to the laboratory. In the lab the clippings will be oven-dried at 105 deg. C for 24 hours and then weighed to the nearest 0.1 gram. Productivity will be calculated to reveal pounds per acre or kilograms per hectare of standing biomass.

Schedule

The study sites will be physically prepared during the first year of the approved permit term, beginning construction early enough to assure planting during the first year.

During January through May of the first year, necessary supplies will be ordered and received. These will include the seeds for the seed mixtures, fencing, hand tools, mulches, fertilizers, marking stakes (rebar), surveyor's

ribbon (or other material such as wire) for marking the plots, and other materials. Personnel and equipment will be scheduled for site construction. A truck, dozer, front-end loader, and work crew will be required to strip vegetation, haul borrow, and rough out sites. A small crew can be scheduled to smooth, level, rake, mark plots, construct fences, and finish all physical arrangements at the two sites. The same crew can physically prepare the smaller study plots at the mining pads and riparian areas to be tested.

During September and October of the first year the appropriate seeding, fertilizer, and mulch treatments will be applied. Seeds are to be broadcast, not drilled, at a uniform rate as given in the seed mixes. Pelletized or granular fertilizer is to be broadcast not drilled. The mulch treatment will be applied in a manner appropriate. The hay will be spread by hand and covered with staked down mesh.

The following table outlines the activities for a five year test plot study.

<u>Year</u>	<u>Month (s)</u>	<u>Activity</u>
1st	Jan-March	Order seed, fertilizers, mulches, hand tools, equipment. Schedule personnel and assemble all necessary protocols. Consult DOGM.
1st	June-Aug.	Prepare study sites physically, including layout, soil hauling, soil tilling, fertilizing, marking of treatment plots, fencing, etc.
1st	Sept.-Oct.	Seeding, Mulching
2nd	July-Aug.	Observe study plots by quadrat sampling, recording plant density and cover data by species and non-living cover of rock, soil and litter. All cover data is to add to 100 percent. Include ruderal and adventive species. Photographs will be taken. Weeds are not to be removed.
3rd	July-Aug.	Observe study plots by quadrat sampling for density and cover as before. Take photographs.
4th		No observations this year. Do physical maintenance of fences, etc. Take photographs.
5th	July-Aug.	Observe study plots by quadrat sampling methods for density and cover as before. Photograph. When quadrat studies are finished, not before, conduct productivity sampling by using clipped-quadrats method for standing biomass.

Year Month (s)

Activity

Separate clippings into shrub, grass, and forb groups per quadrat during collection. Oven dry clippings at 105 deg. C for 24 hours, then weigh clippings to nearest 0.1 gram per sample, and record all data on pre-designed data sheets that will facilitate later data analysis. Do data analysis and write report.

6th and
succeeding years

Monitor vegetation success in years 7, 9 and 10. Maintain integrity of study areas by fence maintenance; cleaning of wind-blown trash; prevention of destruction or disturbance from construction, cattle, or careless equipment operation. Maintain sites for future studies that could involve reseeding, reapplication of fertilizers, and/or simple sampling to document plant succession, natural reseeding, approach of stable climax conditions, survival and growth of shrub species, and others.

Application of Test Plot Studies

The results of monitoring will be evaluated each year soon after observations are taken. Each plant response will be tested. A report summarizing all observations will be prepared at the conclusion of the 5th year.

UNITED STATES FUEL COMPANY

VEGETATION TEST PLOTS

YEAR 2 PROGRESS REPORT

Hiawatha, Utah

by

Joseph M. Jarvis

Biologist

INTRODUCTION

A vegetation test plot program was submitted with the mine permit applications by U.S. Fuels to satisfy OSM regulations for a tested revegetation program. This revegetation program would be applied at mine shutdown for the reclamation of disturbed sites and material. The test plot program is to be monitored for five years to judge plant response to the various revegetation techniques tested. The complete details of the program are available in the OSM/DOGM mine permit applications. This progress report covers the 2nd year of monitoring. with subsequent reports due in year 3 (1986) and 5 (1988).

The test plot program was installed in 1984 with preparation of plot sites and seeding of various seed mix designs in the fall. 1983 and 1984 were "wet years" with above normal precipitation and below normal temperatures. The winter of 1985 started wet and cold but turned mild and dry by early spring. Spring was early, dry and mild with summer warm and dry. The only summer precipitation coming from heavy rain storms in July. The plots were read in August when soil conditions were dry. A succession of annual grasses and forbs had colonized the plots at lower elevations with a dense stand of living and dead plants. The plots in the canyons at higher elevations (8200') had produced vigorous stands of seeded species and some adventive species.

METHODS

Photo stations were established at each plot. Subplots in Study Sites 1 and 2 were also photographed. Each treatment in the plots or subplots were sampled with a 1/4 square meter quadrant at five random stations. Additional samples were taken if sampling error exceeded 10% except in the small canyon plots due to lack of space. Estimates of percent living and non-living cover were taken as were basal stem counts of all species in the quadrant. This provided the degree of cover, a total plant count per unit and species composition in the plots.

This data was collected and formatted to allow comparisons on a yearly basis and between treatments. The 2nd year data was not statistically analysed for differences in plant response to treatment.

Plots and subplots sampled:

Study Site #1
"old coal refuse substrate"
subplots 1,2,3,4,5 and 6

"new coal refuse substrate"
subplots A,B,C,D,E and F

Study Site #2
Plot #1
Plot #2

Middle Fork Plot

South Fork Plot

Riparian Plot

RESULTS

Study Site #1

The site was covered with a dense plant growth of living and dead annual grasses and forbs. The disturbance of the soil placed as topsoil on the coal refuse apparently provided an ideal growth environment for the adventive plants. This placed these "weedy species" in a strong competitive position and probably affected germination of seeded species in 1985 by shading the soil surface and depriving these desired species of soil moisture. The seeded species accounted for less than 1% of the plant species.

The adventive species were both early season and late season types indicating growth from spring moisture and later growth from the July moisture. The quick growth of these species on test plots is a situation repeatedly observed in test plot programs. This is generally due to the disturbance of the site in seedbed preparation providing ideal environmental conditions. These adventive species usually fade from the plant community in the test plots as seeded species become established and soil conditions stabilize.

The only differences between treatments, that was readily observable in the data, was the greater number of plants and plant cover in the old coal refuse substrate versus the new coal refuse substrate. Differences in plant response to treatments within the substrates was not detected.

Table I Transect Data

Subplot	Bare	Percent of		Cover	Basal Stems Per Quad
		Rock	Litter		
A. New Coal Refuse Substrate					
A	18	0	58	24	17.2
B	11	6	62	21	21.0
C	9	0	59	32	25.8
D	6	0	54	40	26.4
E	11	0	54	35	26.6
F	9	0	67	24	27.2
Means	10.7	1.0	59	29.3	24.0
B. Old Coal Refuse Substrate					
1	11	0	64	25	23.4
2	13	0	54	33	28.4
3	9	1	56	34	32.4
4	2	0	62	36	28.4
5	2	0	64	32	28.6
6	2	0	64	32	35.4
Means	6.5	0.2	60.7	32	29.4

Table II Species Composition

Species	Total # Plots	Total # Plants	Ave. # /Quad	Percent of Total Cover
A. New Coal refuse Substrate 30 Quads				
Salsola kali	30	524	17.5	72.3
Kochia scoparia	28	128	4.6	19.5
Chenopodium sp.	25	35	1.4	5.8
grass seedlings *	7	15	2.1	0.01
Ceratoides lanata *	5	11	2.2	0.01
Hilaria jamesii	2	7	2.0	0.01
Grindelia squarrosa	1	1	1.0	0.001
unknown forbs	1	1	1.0	0.001
B. Old Coal refuse Substrate 30 Quads				
Salsola kali	30	601	20.0	70.0
Kochia scoparia	30	241	8.0	25.1
Chenopodium sp.	23	34	1.5	3.6
Ceratoides lanata *	9	9	1.0	0.6
unknown forbs	3	3	1.0	0.6
grass seedlings *	1	1	1.0	0.001

* seeded species

Study Site #2

This site, where 12" of topsoil was removed, was also covered with a heavy growth of annual grasses and forbs. The disturbance to the soils and removal of established groundcover provided conditions ideal for adventive plant species. Some seeded species were evident but there was no discernable difference between the two seed mixes used here.

Table I Transect Data, 10 quadrants per seed mix

<u>Bare</u>	<u>Percent of</u>		<u>Cover</u>	<u>Basal Stems/Quadrant</u>
	<u>Rock</u>	<u>Litter</u>		
A. Seed Mix #1				
18.9	0	52.4	28.7	18.2
B. Seed Mix #2				
19.6	0	52.5	27.9	13.0

Table II Species Composition on Subplots

Species	Total # Plots	Total # Plants	Mean # /Quad	Percent of Total Cover
A. Seed Mix #1				
Salsola Kali	10	67	6.7	53.7
grass seedlings *	6	38	6.3	10.5
Linum lewisii	4	29	7.2	7.3
Kochia scoparia	4	13	3.2	7.0
Ceratoides lanata *	3	4	1.3	1.0
Convolvulus sp.	2	9	4.5	4.5
Melilotus officinalis *	2	5	2.5	6.3
Chrysothamnus naseosus *	2	5	2.5	1.7
Grindelia squarrosa	2	2	1.0	4.2
Chenopodium sp.	1	1	1.0	0.7
Astragulus sp.	1	1	1.0	0.7
Unknown forbs	6	8	1.3	2.4
B. Seed Mix #2				
Salsola kali	9	53	5.9	46.1
grass seedlings *	7	36	5.1	11.8
Kochia scoparia	3	10	3.3	9.7
Linum lewisii *	4	9	2.2	4.6
Chrysothamnus nauseosus*	4	5	1.2	2.1
Chenopodium sp.	4	4	1.0	3.1
Ceratoides lanata	3	4	1.3	2.6
Grindelia squarrosa	3	4	1.3	6.1
Melilotus officinalis *	2	2	1.0	1.5
Sphaeralcea coccinea	2	2	1.0	2.1
Erigeron sp.	1	2	2.0	1.5
Purshia tridentata *	1	1	1.0	0.5
Helianthus sp.	1	1	1.0	1.5
Unknown forbs	4	6	1.2	4.1

* seeded species

Canyon Plots

The three plots in the canyons produced good stands of the seeded species. Some of the grasses were in the flower stage during the field work period in August. The cover percentage was fairly consistent between quadrants. The riparian interseeding seeded cover was less than the other two plots but considering the conditions of shade and established plant cover it was moderately successful.

Table I Transect Data 5 quadrants

	Percent of				
Bare	Rock	Litter	Cover	Basal Stems per	Quadrant
A. Middle Fork					
2	3	42	53	74.5	
B. South Fork					
4	4	21	71	70.2	
C. Riparian					
41	11	34	14	32.0	

Table II Species Composition

Species	Total # Plots	Total # Plants	Mean # /Quad	Percent of Total Cover
A. Middle Fork				
grass seedlings *	5	284	56.8	91.3
Bromus sp. *	3	6	2.0	0.9
Avena fatua	1	2	2.0	0.9
Phleum alpinum *	1	2	2.0	0.9
Monolepis nuttallianus	1	2	2.0	0.9
Chenopodium sp.	1	1	1.0	0.5
unknown forbs	1	1	1.0	0.5
B. South Fork				
grass seedlings	5	278	55.6	64.8
Bromus sp. *	4	27	6.7	7.4
Phleum alpinum *	4	7	1.8	2.2
Cynoglossum officinale	2	11	5.5	2.7
Agropyron sp. *	2	7	3.5	2.2
Melilotus officinale *	2	5	2.5	1.4
Chenopodium album	2	3	1.5	1.4
Cleome serrulata	2	3	1.5	6.6
Chenopodium sp.	1	1	1.0	-
Salsola kali	1	1	1.0	1.4
Viguiera multiflora	1	1	1.0	0.5
unknown forbs	5	17	3.4	9.4
C. Riparian				
grass seedlings *	5	149	29.8	93.1
Poa sp. *	1	4	4.0	2.5
Lathyrus sp.	1	3	3.0	1.9
Mertensia sp.	1	2	2.0	1.2
Mahonia repens	1	1	1.0	0.6
Balsamorhiza sagittata *1	1	1	1.0	0.6

1985 PHOTOS

UNITED STATES FUEL COMPANY

VEGETATION TEST PLOTS

YEAR 3 PROGRESS REPORT

Hiawatha, Utah

by

Joseph M. Jarvis

Biologist

September, 1986

INTRODUCTION

A vegetation test plot program was submitted with the mine permit applications by U.S. Fuels to satisfy OSM regulations for a tested revegetation program. This progress report covers the 3rd year of the program or the results of the 2nd growing season. The results of the 1st growing season are contained in the 1985 progress report.

The test plot program was installed in 1984 with the preparation of the plot sites and the seeding of various seed mixes that fall. The 1985 growing season was generally "dry" and "mild". The soil was dry when the plots were measured in August for the first monitoring report. The precipitation in the 1986 growing season was "normal" but the summer was dry. The soil was dry when the first plots were read on August 20th but rain fell that afternoon and continued the next day saturating the soil.

METHODS

Photos were taken at each photo station established in 1985, the first year of monitoring. The various treatments were sampled by the methods explained in the 1985 progress report.

Plots and subplots sampled:

Study Site #1
"old coal refuse substrate"
subplots 1,2,3,4,5 and 6

"new coal refuse substrate"
subplots A,B,C,D,E and F

Study Site #2
Plot #1
Plot #2

Middle Fork Plot

South Fork Plot

Riparian Plot

RESULTS

Study Site #1

The site was covered with a dense dry growth of cheatgrass. The adventive "weedy species" so prominent in 1985 were now only a small part of the plant cover. The lack of summer moisture may have affected the growth of the warm season forbs or the increase in litter and cheatgrass may have altered environmental conditions at the soil surface to reduce germination success of these annuals. At this time it appears that the adventive forbs are fading from the plant community but have not yet been replaced by the seeded species.

The seeded species are present as immatures in thinly scattered stands. The presence of perennial grass seedlings and immature white sage plants indicates that the seeded species may yet establish an adequate ground cover on the plots. Certainly the dry summers of the 1985 and 86 growing seasons have been a hindrance to plant growth.

The meager amount of measurable plants in the subplots does not now allow for a comparison of results between subplots. Generally the data does support the assumption that plant growth is better on the old coal refuse substrate versus the new coal refuse substrate (Table I).

Table I Transect Data, 1986

Subplot	Bare	Percent of Rock	Litter	Cover	Basal Stems Per Quad
A. New Coal Refuse Substrate					
A	17*	0	80	3	3.2
B	0	0	95	4	6.2
C	2	0	96	2	2.8
D	6	1	85	8	12.4
E	1	0	98	0	0.4
F	1	0	99	0	0.0
Means	4.5	0.1	92.1	2.6	4.2
B. Old Coal Refuse Substrate					
1	12*	0	84	3	3.8
2	3	0	91	5	4.2
3	3	0	92	6	4.6
4	4	0	84	12	16.4
5	0	0	95	4	1.6
6	1	0	99	1	1.4
Means	3.8	0	90.8	5.1	5.3

* Coal fines, from adjacent refuse piles, have blown onto these two subplots producing bare areas with no vegetative growth.

Table II Species Composition, 1986

Species	Total # Plots	Total # Plants	Ave. # /Quad	Percent of Total Cover
A. New Coal Refuse Substrate		30 quads		
Elymus sp.	7	72	2.40	55
Agropyron sp.	1	1	0.03	1
grass seedlings	6	16	0.53	9
Kochia scoparia	4	13	0.43	13
Salsola kali	4	4	0.13	4
Ceratoides lanata	7	18	0.60	12
Atriplex canescens	1	1	0.03	2
Total Species	<u>7</u>			
B. Old Coal Refuse Substrate		30 quads		
Elymus sp.	5	53	1.76	28
Oryzopsis hymenoides	3	24	0.80	10
Agropyron sp.	3	3	0.10	3
Sitanion hystrix	2	5	0.16	3
grass seedlings	7	11	0.36	6
Grindelia squarrosa	5	13	0.43	28
Kochia scoparia	6	30	1.00	13
Salsola kali	2	2	0.06	1
Descuriana sp.	1	1	0.03	3
Chenopodium sp.	1	5	0.16	1
Total Species	<u>10</u>			

Study Site #2

This site, where 12" of topsoil was removed, has shown an increase in seeded species. The annual grasses and forbs are still present but are not dominant on the subplots as they were in 1985. The developing seeded plant cover has diversity as grasses, forbs and shrubs are all present on the sites. Seed Mix #1 appears at this time to be superior to Seed Mix #2.

Table I Transect Data, 10 quadrants per seed mix

<u>Bare</u>	<u>Percent of</u>		<u>Cover</u>	<u>Basal Stems/Quadrant</u>
	<u>Rock</u>	<u>Litter</u>		
A. Seed Mix #1				
15.4	0.4	65.0	19.2	29.4
B. Seed Mix #2				
12.7	0.0	75.3	12.3	21.6

Table II Species Composition on Subplots

Species	Total # Plots	Total # Plants	Mean /Quad	Percent of Total Cover
A. Seed Mix #1				
Agropyron sp. *	4	62	15.5	15.00
Elymus sp. *	1	27	27.0	14.00
Oryzopsis hymenoides *	1	2	2.0	1.00
Sitanion hystrix	1	17	17.0	4.00
grass seedlings	2	8	4.0	2.00
Grass Subtotal				<u>36.00</u>
Aster chilensis *	1	3	1.5	1.04
Astragalus cicer	2	10	5.0	3.64
Convolvulus sp.	1	4	4.0	1.04
Grindelia squarrosa	5	50	10.0	29.70
Linium lewissii	5	62	12.4	13.02
Melilotus officinalis *	1	6	6.0	5.21
Sphaeralcea coccinea	4	13	3.2	7.81
Forb Subtotal				<u>61.46</u>
Ceratoides lanata *	2	6	3.0	1.04
Chrysothamnus nauseosus *4	4	20	5.0	5.21
Purshia tridentata	1	3	3.0	0.52
Shrub Subtotal				<u>6.77</u>
<u>* seeded species</u>				<u>42.50</u>
B. Seed Mix #2				
Agropyron sp. *	6	76	12.7	20.32
Oryzopsis hymenoides *	2	7	3.5	1.62
Grass Subtotal				<u>21.94</u>
Astragalus cicer *	1	3	3.0	0.81
Cardaria sp.	2	2	1.0	2.44
Erigeron sp.	1	1	1.0	1.62
Grindelia squarrosa	4	13	3.2	19.70
Linium lewisii *	5	77	15.4	23.60
Melilotus officinalis *	1	5	5.0	5.69
Spharaelcea coccinea	1	1	1.0	tr.
Forb Subtotal				<u>51.68</u>
Ceratoides lanata *	1	5	5.0	5.24
Chrysothamnus nauseosus *7	7	26	3.7	21.14
Shrub Subtotal				<u>26.38</u>
<u>* seeded species</u>				<u>78.42</u>

Canyon Plots

The three plots have produced good stands of seeded grasses and forbs. Most of the species had flowered or were flowering during the field work in August. Generally grasses have increased on the plots and matured. Also species diversity has increased but total vegetative cover has decreased. This is probably due to the decrease in the total number of plants in the plots as evidenced by the reduction in basal stems per quadrant from 1985 (Table I).

Table I Transect Data, 5 quadrants

	Percent of				
Bare	Rock	Litter	Cover	Basal Stems/Quadrant	
A. Middle Fork					
12	2	53	33		64.60
B. South Fork					
7	6	50	37		59.80
C. Riparian					
30	5	20	45		24.60

Table II Species Composition

Species	Total # Plots	Total # Plants	Mean # /Quad	Percent of Total Cover
A. Middle Fork				
Agropyron spicatum *	2	27	13.5	6.60
Bromus marginatus *	2	34	17.0	12.00
Dactylis glomerata *	2	26	13.0	15.60
Elymus sp. *	5	46	9.2	14.40
Phleum alpinum *	4	114	57.0	31.80
grass seedlings	1	1	1.0	0.60
Grass Subtotal				<u>81.00</u>
Kochia scoparia	3	22	7.3	7.80
Monolepis nuttallianus	1	5	5.0	2.40
unknown forbs	2	3	1.5	1.80
Forb Subtotal				<u>12.00</u>
Populus tremuloides	2	7	3.5	4.80
B. South Fork				
Avena fatua	1	5	5.0	0.54
Bromus marginatus *	5	140	28.0	43.74
Dactylis glomerata *	4	72	18.0	29.16
Elymus sp. *	3	33	11.0	8.10
Phleum alpinum *	1	3	3.0	0.54
grass seedlings	1	6	6.0	0.54
Grass Subtotal				<u>82.62</u>
Melilotus officinalis	4	24	6.0	5.94
Viguiera multiflora	2	9	4.5	3.78
Forb Subtotal				<u>9.72</u>
Symphoricarpos oreophilus *	1	5	5.0	0.54
C. Riparian				
Agropyron smithii *	2	55	27.5	38.18
Bromus marginatus *	3	45	15.0	28.41
Dactylis glomerata *	1	3	3.0	1.33
Poa pratensis *	1	10	10.0	2.22
Grass Subtotal				<u>70.14</u>
Mertensia sp.	1	6	6.0	8.88
Mahonia repens	2	4	2.0	5.77
Melilotus officinalis	1	2	2.0	1.33
Forb Subtotal				<u>15.98</u>

* seeded species

1986 PHOTOS

UNITED STATES FUEL COMPANY

VEGETATION TEST PLOTS

YEAR 5 FINAL REPORT

Hiawatha, Utah

UNITED STATES FUEL COMPANY

VEGETATION TEST PLOTS

YEAR 5 FINAL REPORT

Hiawatha, Utah

Prepared for

United States Fuel Company
P.O. Box A
Hiawatha, Utah 84527

by

Joseph M. Jarvis

Biologist

January, 1989

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1.0 INTRODUCTION

A vegetation test plot program was submitted with the mine permit applications by U.S. Fuels to satisfy OSM regulations for a tested revegetation program. This final report covers the 5th year of the program, or the 4th growing season, and summarizes the results from the previous years. The results of the 1st and 2nd growing seasons are contained in the 1985 and 1986 progress reports respectively (Appendix 1&2). Under the plan originally submitted to the DOGM, the growth of the 3rd growing season (1987) was not to be measured.

The test plot program was installed in 1984 with the preparation of the plot sites and the seeding of various seed mixes that fall. The 1985 growing season was generally "dry" and "mild". The soil was dry when the plots were measured in August for the first monitoring report. The precipitation in the 1986 growing season was "normal" but the summer was dry. The soil was dry when the first plots were read on August 20th but rain fell that afternoon and continued the next day, saturating the soil. The 1988 year was considered a "drought" year, with little winter or spring moisture. There was scattered late summer storms, that provided some moisture late in the growing season.

2.0 METHODS

Photos were taken at each photo station established in 1985, the first year of monitoring. Thus, each photo station was photographed in the 1st(1985), 2nd(1986), and 4th(1988) growing seasons. The various treatments were sampled by the methods explained in the 1985 progress report. In 1988, the live, above-ground growth was clipped, air-dried, and weighed to obtain data on productivity.

Plots and subplots sampled:

Study Site #1

"old coal refuse substrate"

subplots 1,2,3,4,5 and 6

"new coal refuse substrate"

subplots A,B,C,D,E and F

Study Site #2

Plot #1

Plot #2

Canyon Plots

Middle Fork Plot

South Fork Plot

Riparian Plot

3.0 RESULTS

3.1 Study Site #1

The "drought" years of 1987 and 1988 have hindered plant growth and slowed the rate of succession. This site is slowly progressing from a plant cover of adventative species in the 1st growing season, through a cover of annual species, to a sparse cover of perennial species mixed with a few annual species. The establishment of mature perennial plants has greatly increased the plant cover. The presence of more perennial grass has also greatly increased the densities of basal stems, when compared to the 2nd seasons growth. See Table 3.1.1.

Table 3.1.1 Transect Data, 1988

Subplot	Bare	Percent of Rock	Litter	Cover	Productivity Dry Weight lbs/acre	Basal Stems Per Quad
A. New Coal Refuse Substrate						
A	17*	0	36	47	438	50.3
B	7	0	49	44	750	46.0
C	13	0	42	45	938	58.8
D	11	0	46	43	438	61.3
E	2	0	50	48	875	57.2
F	1	0	58	41	500	43.9
Means	8.5	0.0	46.8	44.7	656	53.0
B. Old Coal Refuse Substrate						
1	8*	0	48	44	688	55.7
2	7	0	50	43	1063	56.1
3	9	1	44	46	750	55.3
4	4	0	47	49	1125	67.0
5	0	1	22	77	625	40.8
6	3	1	41	55	1000	57.0
Means	5.2	0.5	42.0	52.3	875	55.4

* Coal fines, from adjacent refuse piles, have blown onto these two subplots producing bare areas with no vegetative growth.

The litter accumulation is slightly greater in the new substrate when compared with the old substrate. The percentage of plant cover and the productivity of the old substrate is greater than the new substrate, and is significant at the 5% level respectively. The densities of plant growth in each substratum is nearly equal, as judged by basal stems per unit area.

The differences in substrate were compared by separating the

applications of the two seed mixes and the topsoil depths. Generally the new substrate is superior where seed mix #1 was applied. However, with seed mix #2, the old substrate proves superior as a growing medium over the new substrate.

When the combined means of the seed mix applications are compared, the #2 seed mix is superior to the #1 seed mix in litter accumulation, productivity and plant stem density (litter and productivity at 5% level). Seed mix #1 is slightly superior in plant cover.

Table 3.1.2 Seed Mix and Substrate Comparisons

Subplot	Bare	Percent of Rock	Litter	Cover	Productivity Dry Weight lbs/acre	Basal Stems Per Quad
<u>Seed Mix #1-New Substrate</u>						
A	17*	0	36	47	438	50.3
C	13	0	42	45	938	58.8
E	2	0	50	48	875	57.2
Means	10.7	0	42.7	46.7	750	55.4
<u>Old Substrate</u>						
1	8*	0	48	44	688	55.7
3	9	1	44	46	750	55.3
5	0	1	22	77	625	40.8
Means	5.7	0.7	38	55.7	688	50.6
Combined Means	8.2	0.3	40.3	51.2	719	53.0
<u>Seed Mix #2-New Substrate</u>						
B	7	0	49	44	750	46.0
D	11	0	46	43	438	61.3
F	1	0	58	41	500	43.9
Means	6.3	0	51	42.7	563	50.4
<u>Old Substrate</u>						
2	7	0	50	43	1063	56.1
4	4	0	47	49	1125	67.0
6	3	1	41	55	1000	57.0
Means	4.7	0.3	46	49	1063	60.0
Combined Means	5.5	0.1	48.5	45.6	813	55.2

Table 3.1.3 compares the topsoil applications with the old and new substrates. There were three topsoil depths used in the

plot design, 6",12", and 18". Generally the old substrate is superior to the new substrate in plant growth despite the topsoil depths. The litter acumulation is greater on the new substrate. The increase in topsoil depth does not seem to change the differences between the old and new substrate.

When topsoil depth is considered, regardless of old or new substrates, the increase from 6" to 12" depths has the greatest affect on plant growth (productivity and basal stems). The 12" topsoil depth is sufficient to establish the best plant cover attainable on these types of substrates. The few repetitions in each plot do not allow for statistical testing.

Table 3.1.3 Topsoil Depths and Substrates

Subplot	Bare	Percent of Rock	Litter	Cover	Productivity Dry Weight lbs/acre	Basal Stems Per Quad
<u>6"-New Substrate</u>						
A	17*	0	36	47	438	50.3
B	7	0	49	44	750	46.0
Means	12	0	42.5	45.5	594	48.2
<u>6"-Old Substrate</u>						
1	8*	0	48	44	688	55.7
2	7	0	50	43	1063	56.1
Means	7.5	0	49	43.5	876	55.9
Combined Means	9.75	0	45.8	44.5	735	52.0
<u>12"-New Substrate</u>						
C	13	0	42	45	938	58.8
D	11	0	46	43	438	61.3
Means	12	0	44	44	688	60.0
<u>12"-Old Substrate</u>						
3	9	1	44	46	750	55.3
4	4	0	47	49	1125	67.0
Means	6.5	0.5	45.5	47.5	937	61.2
Combined Means	9.2	0.2	44.7	45.7	813	60.6
<u>18"-New Substrate</u>						
E	2	0	50	48	875	57.2
F	1	0	58	41	500	43.9
Means	1.5	0	54	44.5	688	50.6
<u>18"-Old Substrate</u>						
5	0	1	22	77	625	40.8
6	3	1	41	55	1000	57.0
Means	1.5	1	31.5	66	813	48.9
Combined Means	1.5	0.5	42.7	55.2	750	49.8

Table 3.1.4 Species Composition Test Site #1, 1988

Species	Total # Plots	Ave. # Stems/Quad	Percent of Total Cover
A. New Coal Refuse Substrate			
Agropyron smithii	3	3.59	3.00
Agropyron sp.	5	8.56	10.48
Agropyron cristatum	1	2.85	3.49
Bromus tectorum	6	26.25	57.08
Oryzopsis hymenoides	4	5.46	6.52
Stipa comata	1	0.40	0.70
Sitanion hystrix	1	1.25	0.47
Salsola kali	5	1.10	3.96
Astragalus ciceri	1	0.25	0.47
Linium lewisii	3	1.92	5.13
Grindelia squarrosa	4	0.47	4.67
Ceratoides lanata	4	0.48	2.80
Atriplex canescens	2	0.17	0.70
unknowns	1	0.25	0.47
Total Species	13		

7772/Acre
2752/Acre

B. Old Coal Refuse Substrate 30 quads			
Agropyron smithii	1	2.26	1.54
Agropyron spicatum	1	1.02	0.58
Agropyron sp.	5	16.26	21.23
Agropyron cristatum	2	3.92	3.47
Bromus tectorum	6	20.67	40.92
Oryzopsis hymenoides	3	4.39	2.51
Sitanion hystrix	1	1.11	0.19
Stipa comata	1	0.21	0.19
Astragalus ciceri	2	0.32	0.58
Grindelia squarrosa	4	1.20	11.19
Linium lewisii	2	1.47	3.86
Salsola kali	4	0.48	2.12
Artemisia tridentata	1	0.17	1.93
Ceratoides lanata	5	1.81	8.68
Chrysothamnus viscidiflorus	1	0.11	0.39
Total Species	15		

3.2 Study Site #2

This site, where 12" of topsoil was removed, has shown an increase in seeded species. The annual grasses have been replaced by perennial grasses and shrubs, the forbs are still a major part of the seeded communities. The developing seeded plant cover has diversity as grasses, forbs and shrubs are all present on the sites. Seed Mix #1 appears at this time to be superior to Seed Mix #2 (Table 3.2.1, cover and density at 5% level).

Table 3.2.1 Transect Data, 10 quadrants per seed mix

Bare	Percent of		Cover	Basal Stems/Quadrant
	Rock	Litter		
A. Seed Mix #1				
31.4	0.0	44.4	24.2	37.1
B. Seed Mix #2				
29.7	0.0	55.1	15.2	26.7

Table 3.2.2 Species Composition on Subplots, 1988

Species	Total # Plots	Total # Stems	Mean # /Quad	Percent of Total Cover
A. Seed Mix #1				
Agropyron trachycaulum*	7	134	19.1	25.61
Oryzopsis hymenoides *	4	39	9.8	7.43
Sitanion hystrix	1	17	17.0	4.00
grass seedlings	2	8	4.0	2.00
Grass Subtotal				<u>39.04</u>
Astragalus cicer	1	4	4.0	4.13
Lathyrus sp.	3	9	3.0	7.02
Linium lewissii	10	92	9.2	45.88
Sphaeralcea coccinea	3	3	1.0	1.65
Forb Subtotal				<u>58.78</u>
Ceratoides lanata *	1	2	2.0	1.23
Chrysothamnus nauseosus *4		22	5.5	5.37
Shrub Subtotal				<u>6.60</u>
<u>* seeded species</u>				<u>39.64</u>
Total # of Species	11			
B. Seed Mix #2				
Agropyron sp. *	4	73	18.5	17.76
Oryzopsis hymenoides *	3	8	2.4	3.29
Bromus tectorum	1	18	18.0	3.29
Grass Subtotal				<u>24.34</u>
Linium lewisii *	3	21	7.0	4.60
Melilotus officinalis *	1	1	1.0	0.66
Penstemon Palmeri	3	37	12.3	15.79
Forb Subtotal				<u>21.05</u>
Ceratoides lanata *	2	3	1.5	5.26
Chrysothamnus nauseosus *4		28	7.0	18.42
Chrysothamnus viscidiflorus	4	35	8.8	23.03
Shrub Subtotal				<u>46.71</u>
<u>* seeded species</u>				<u>49.99</u>
Total # of Species	9			

The percentage of seeded species is higher in the plant community established in the plot seeded with seed mix #2. However, the number of seeded species present in both plant

communities is similar (6 in #1, 7 in #2). The #1 seed mix community also has a greater total number of species than the #2 seed mix community. The percentage of grass is higher in the seed mix #1 plant community than the #2 mix, but the opposite is true for the shrub component of the respective seeded communities. Generally the distribution of the major plant groups is more even in the #2 seed mix community. There appears to have been some crossover of seeded species in each plot apparently due to proximity of plots and/or sloppiness of seeding efforts. This confuses the analysis and renders statistical analysis valueless.

3.3 Canyon Plots

The three plots have produced good stands of seeded grasses and forbs. Most of the species had flowered or were flowering during the field work in August. Generally grasses have increased on the plots and matured. Also species diversity has increased but total vegetative cover has decreased. This is probably due to the decrease in the total number of plants in the plots as evidenced by the reduction in basal stems per quadrant from 1985 and 1986 (Table 3.3.1).

Table 3.3.1 Transect Data, 1988 5 quadrants

Bare	Percent of Rock	Litter	Cover	Productivity lbs./acre	Basal Stems /Quadrant
A. Middle Fork 10	0	57	33	788	58.10
B. South Fork 9	7	42	42	1088	56.80
C. Riparian 14	1	52	33	375	21.00

The Middle Fork and South Fork plots have an excellent stand of seeded and seral plants. The amount of litter and production of forage is equal to that normally produced on adjacent indigenous plant communities. The amount of litter on the Riparian Plot has increased and bare ground has decreased. The low forage production is a result of the shading by the tree stand.

Table 3.3.2 Species Composition

Species	Total # Plots	Total # Plants	Mean # /Quad	Percent of Total Cover
A. Middle Fork				
Agropyron spicatum *	3	22	7.4	5.40
Bromus marginatus *	5	21	4.2	6.60
Dactylis glomerata *	5	53	10.6	52.40
Elymus sp. *	5	26	5.2	13.00
Phleum alpinum *	5	63	12.6	17.40
Grass Subtotal				<u>94.80</u>
Hedysarum boreale *	1	1	1.0	1.20
unknown forbs	1	2	2.0	1.20
Forb Subtotal				<u>2.40</u>
Symphoricarpos oreophilus *	1	1	1.0	<u>1.80</u>
B. South Fork				
Agropyron subsecundum	4	23	5.8	5.20
Bromus marginatus *	2	16	8.0	4.06
Dactylis glomerata *	5	112	22.4	45.50
Phleum alpinum *	4	29	7.3	19.80
Oryzopsis hymenoides *	4	54	13.5	9.00
Grass Subtotal				<u>83.56</u>
Cynoglossum officinale	1	1	1.0	2.36
Hedysarum boreale *	2	3	1.5	8.50
Viguiera multiflora	2	8	4.0	3.30
Unknown Forb	1	1	1.0	0.47
Forb Subtotal				<u>14.63</u>
Cercocarpus ledifolius *	1	1	1.0	0.47
Symphoricarpos oreophilus *	1	4	4.0	1.42
Shrub Subtotal				<u>1.89</u>
C. Riparian				
Agropyron smithii *	1	4	4.0	1.23
Bromus marginatus *	4	41	10.2	25.15
Dactylis glomerata *	3	43	14.3	22.70
Elymus sp. *	2	7	3.5	4.29
Phleum alpinum *	1	36	36.0	9.20
Grass Subtotal				<u>62.57</u>
Cynoglossum officinale	1	1	1.0	3.06
Hedysarum boreale	1	1	1.0	1.84
Mahonia repens	4	19	4.8	29.45
Forb Subtotal				<u>34.35</u>

Table 3.3.2 Con't.

Abies sp.	1	1	1.0	1.84
Populus tremuloides	1	1	1.0	1.23
Shrub Subtotal				<u>3.07</u>

The plant communities established in the South and Middle Forks are a grass/forb type with a very minor shrub component. The seeded grass species account for most of the grasses in the communities. The grasses in the Riparian seeded community are similar to those of the South and Middle Forks communities, even though a different seed mix was used in the Riparian plot.

4.0 Summary of Results

This section provides a summary of the change in the plots through the years and a comparison of seed mixtures and sites.

4.1 Study Site #1

Table 4.1.1 Species Composition Changes, 1985-1988

Species	Total # Plots			Percent of Total Cover		
	1985	1986	1988	1985	1986	1988
A. New Coal Refuse Substrate, 30 quads						
Agropyron smithii	-	-	3	-	-	3.00
Agropyron sp.	-	7	5	-	56.00	10.48
Agropyron cristatum	-	-	1	-	-	3.49
Bromus tectorum	-	-	6	-	-	57.08
Oryzopsis hymenoides	-	-	4	-	-	6.52
Stipa comata	-	-	1	-	-	0.70
Sitanion hystrix	2	-	1	0.01	-	0.47
grass seedlings	7	6	-	0.01	9.00	-
Astragalus ciceri	1	-	-	-	-	0.47
Chenopodium sp.	25	-	-	5.80	-	-
Grindelia squarrosa	1	-	5	tr	-	4.67
Kochia scoparia	28	4	-	19.50	13.00	-
Linium lewisii	-	-	3	-	-	5.13
Salsola kali	30	4	5	72.30	4.00	3.96
Ceratoides lanata	5	7	4	0.01	12.00	2.80
Atriplex canescens	-	1	2	-	2.00	0.70
unknowns	1	-	1	tr	-	0.47
B. Old Coal Refuse Substrate 30 quads						
Agropyron smithii	-	-	1	-	-	1.54
Agropyron spicatum	-	-	1	-	-	0.58
Agropyron sp.	-	3	5	-	3.00	21.23
Agropyron cristatum	-	5	2	-	28.00	3.47
Bromus tectorum	-	-	6	-	-	40.92
Oryzopsis hymenoides	-	3	3	-	10.00	2.51
Sitanion hystrix	-	2	1	-	3.00	0.19
Stipa comata	-	-	1	-	-	0.19
grass seedlings	1	7	-	tr	6.00	-
Astragalus ciceri	-	-	2	-	-	0.58
Chenopodium sp.	23	1	-	3.60	1.00	-
Descuriana sp.	-	1	-	-	3.00	-
Grindelia squarrosa	-	5	4	-	28.00	11.19
Linium lewisii	-	-	2	-	-	3.86
Kochia scoparia	30	6	-	25.10	13.00	-
Salsola kali	30	2	4	70.00	1.00	2.12
Artemisia tridentata	-	-	1	-	-	1.93
Ceratoides lanata	9	-	5	0.60	-	8.68
Chrysothamnus viscidiflorus	-	-	1	-	-	0.39
unknowns	3	-	-	0.60	-	-

The Chenopodium sp. and the Kochia scoparia were the early pioneers of these seeded disturbed sites. These plants quickly faded as the perennial seeded species, especially the grasses, began to become established and eventually dominate the new plant community. It was amazing that Bromus tectorum, an invader annual grass, did not become established until the 3rd or 4th growing season.

The Ceratoides lanata became the dominant species of seeded shrubs. The only seeded forbs to become established were the Linium lewisii and Astragalus ciceri. The seeded grass species that formed a dominant part of the plant community were the Agropyron spp. and the Oryzopsis hymenoides.

4.2 Study Site #2

Table 4.2.1 Species Composition Changes, 1985-1988

Species	Total # of Plots			Percent of Total Cover		
	1985	1986	1988	1985	1986	1988
A. Seed Mix #1						
Agropyron trachycaulum*	-	4	7	-	15.00	25.61
Oryzopsis hymenoides *	-	1	4	-	1.00	7.43
Sitanion hystrix	-	1	-	-	4.00	-
grass seedlings	6	2	2	10.50	2.00	2.00
Elymus sp.	-	1	-	-	14.00	-
Grass Subtotal				<u>10.50</u>	<u>36.00</u>	<u>35.04</u>
Aster chilensis *	-	1	-	-	1.04	-
Astragalus cicer	1	2	1	0.70	3.64	4.13
Chenopodium sp.	1	-	-	0.70	-	-
Convolvulus sp.	1	1	-	4.50	1.04	-
Grindelia squarrosa	2	5	-	4.20	29.70	-
Kochia scoparia	4	-	-	7.00	-	-
Lathyrus sp.	-	-	3	-	-	7.02
Linium lewisii	4	5	10	7.30	13.02	45.88
Melilotus officinalis *	2	1	-	6.30	5.21	-
Salsola kali	10	-	-	53.70	-	-
Sphaeralcea coccinea	-	4	3	-	7.81	1.65
Forb Subtotals				<u>84.40</u>	<u>61.46</u>	<u>58.68</u>
Ceratoides lanata *	3	2	1	1.00	1.04	1.23
Chrysothamnus						
nauseosus *	2	4	4	1.70	5.21	5.37
Purshia tridentata	-	1	-	-	0.52	-
Shrub Subtotals				<u>2.70</u>	<u>6.77</u>	<u>6.60</u>
<u>* seeded species</u>				<u>9.00</u>	<u>42.50</u>	<u>39.64</u>
B. Seed Mix #2						
Agropyron sp. *	-	6	4	-	20.32	17.76
Oryzopsis hymenoides *	-	2	3	-	1.62	3.29
Bromus tectorum	-	-	1	-	-	3.29
grass seedlings	7	-	-	11.80	-	-
Grass Subtotal				<u>11.80</u>	<u>21.94</u>	<u>24.34</u>
Astragalus cicer *	-	1	-	-	0.81	-
Cardaria sp.	-	2	-	-	2.44	-
Chenopodium sp.	4	-	-	3.10	-	-
Erigeron sp.	1	1	-	1.50	1.62	-
Grindelia squarrosa	3	4	-	6.10	19.70	-
Helianthus sp.	1	-	-	1.50	-	-
Kochia scoparia	3	-	-	9.70	-	-
Linium lewisii *	4	5	3	4.60	23.60	4.60
Melilotus officinalis *	2	1	1	1.50	5.69	0.66

Table 4.2.1 Con't.

Penstemon Palmeri	-	-	3	-	-	15.79
Salsola kali	9	-	-	46.10	-	-
Spharaelcea coccinea	2	1	-	2.10	tr.	-
Forb Subtotal				<u>76.20</u>	<u>51.68</u>	<u>21.05</u>
Ceratoides lanata *	3	1	2	2.60	5.24	5.26
Chrysothamnus nauseosus *4		7	4	2.10	21.14	18.42
Chrysothamnus viscidiflorus	-	-	4	-	-	23.03
Purshia tridentata *	1	-	-	0.50	-	-
Shrub Subtotal				<u>5.20</u>	<u>26.38</u>	<u>46.71</u>
<u>* seeded species</u>				<u>11.30</u>	<u>78.42</u>	<u>49.99</u>

The amount of differences, in bare ground, between the two seed mixes is negligible. Most of the basic difference is in a greater litter occurrence in Seed Mix #2, and a greater plant cover in Seed Mix #1.

The first years' growth in both plots was dominated by adventative species, similar to those found at Study Site #1. However, by the second year of growth the seeded species and other perennials had largely replaced the adventative species. By the fourth year of growth, the seeded species accounted for 40-50% of the plant cover.

The plant cover in the Seed Mix #1 plot is composed mostly of grasses and forbs, while that in Seed Mix #2 has a greater amount of shrubs. The comparisons of the two seed mixes is not clear due to an apparent mixing of seeded species from one plot to another. The proximity has allowed the seed mixes to cross from one plot to another, either at seeding or during subsequent seed production by the seeded species. Both plots have very similar appearances.

4.3 Canyon Plots

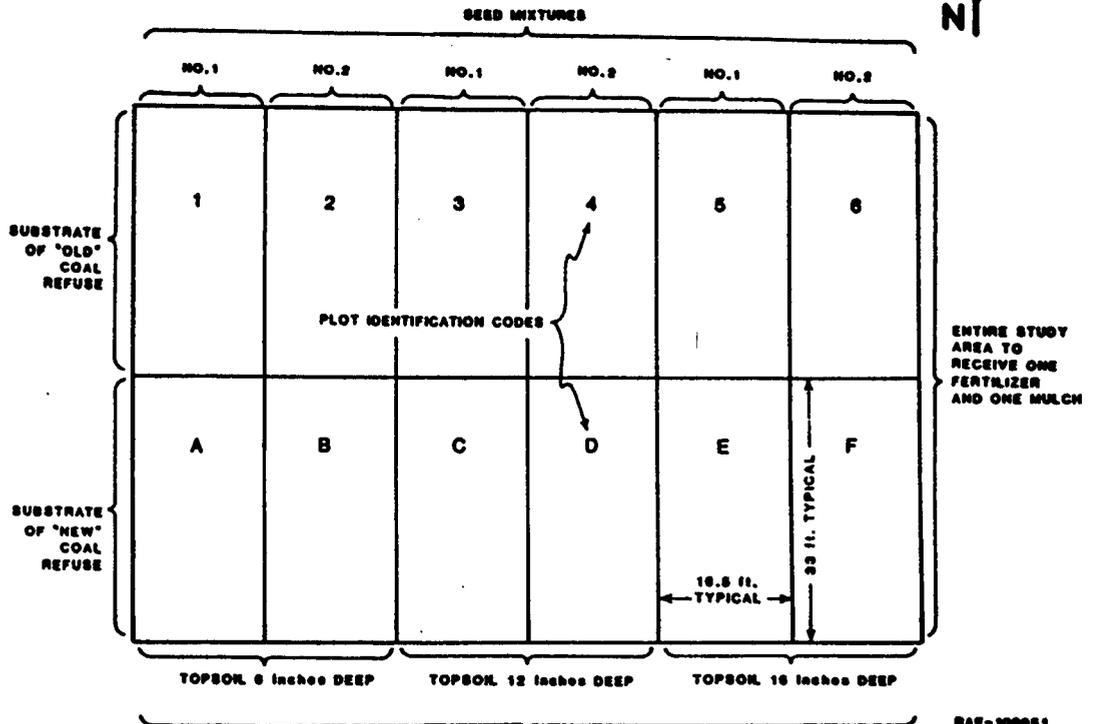
Table 4.3.1 Species Composition Changes, 1985-1988

Species	Total # of Plots			Percent of Total Cover		
	1985	1986	1988	1985	1986	1988
A. Middle Fork						
Avena fatua	1	-	-	0.90	-	-
Agropyron spicatum *	-	2	3	-	6.60	5.40
Bromus marginatus *	3	5	5	0.90	12.00	6.60
Dactylis glomerata *	-	4	5	-	15.60	52.40
Elymus sp. *	-	3	5	-	14.40	13.00
Phleum alpinum *	1	4	5	0.90	31.80	17.40
grass seedling *	5	1	-	91.30	0.60	-
Grass Subtotal				<u>94.00</u>	<u>81.00</u>	<u>94.80</u>
Chenopodium sp.	1	-	-	0.50	-	-
Hedysarum boreale *	-	-	1	-	-	1.20
Kochia scoparia	-	3	-	-	7.80	-
Monolepsis nuttallianus	1	1	-	0.90	2.40	-
unknown forbs	1	2	1	0.50	1.80	1.20
Forb Subtotal				<u>1.90</u>	<u>12.00</u>	<u>2.40</u>
Symphoricarpos *						
oreophilus	-	-	1	-	-	1.80
Populus tremuloides	-	2	-	-	4.80	-
Shrub Subtotal				-	<u>4.80</u>	<u>1.80</u>
* seeded species				<u>93.10</u>	<u>81.00</u>	<u>97.80</u>
B. South Fork						
Avena fatua	-	1	-	-	0.54	-
Agropyron subsecundum	2	1	4	2.20	0.54	5.20
Bromus marginatus *	4	5	2	7.40	43.74	4.06
Dactylis glomerata *	-	4	5	-	29.16	45.50
Phleum alpinum *	4	1	5	2.20	0.54	19.80
Oryzopsis hymenoides *	-	-	4	-	-	9.00
grass seedlings *	5	1	-	64.80	0.54	-
Grass Subtotal				<u>76.60</u>	<u>82.62</u>	<u>83.56</u>
Cleome serrulata	2	-	-	6.60	-	-
Chenopodium album	2	-	-	1.40	-	-
Chenopodium sp.	1	-	-	tr.	-	-
Cynoglossum officinale	2	-	1	2.70	-	2.36
Hedysarum boreale *	-	-	2	-	-	8.50
Melilotus officinale	2	4	-	1.40	5.94	-
Salsola kali	1	-	-	1.40	-	-
Viguiera multiflora	1	2	2	0.50	3.78	3.30
Unknown Forb	5	-	1	9.40	-	0.47
Forb Subtotal				<u>23.40</u>	<u>9.72</u>	<u>14.63</u>
Cercocarpus ledifolius* -	-	-	1	-	-	0.47
Symphoricarpos						

Table 4.3.1 Con't.

oreophilus *	-	1	1	-	0.54	1.42
Shrub Subtotal				-	<u>0.54</u>	<u>1.89</u>
* seeded species				<u>74.40</u>	<u>74.52</u>	<u>88.75</u>
C. Riparian						
Agropyron smithii *	-	2	1	-	38.18	1.23
Bromus ciliatus *	-	3	4	-	28.41	25.15
Dactylis glomerata	-	1	3	-	1.33	22.70
Elymus sp.	-	-	2	-	-	4.29
Phleum alpinum *	-	-	1	-	-	9.20
Poa pratensis *	1	1	-	2.50	2.22	-
grass seedlings *	5	-	-	93.10	-	-
Grass Subtotal				<u>95.60</u>	<u>70.14</u>	<u>62.57</u>
Balsamorhiza sagitta *	1	-	-	0.60	-	-
Cynoglossum officinale	-	-	1	-	-	3.06
Hedysarum boreale	-	-	1	-	-	1.84
Vicia americana *	1	-	-	1.90	-	-
Mahonia repens	1	2	4	0.60	5.77	29.45
Melilotus officinale	-	1	-	-	1.33	-
Mertensia sp.	1	1	-	1.20	8.88	-
Forb Subtotal				<u>4.30</u>	<u>15.98</u>	<u>34.35</u>
Abies sp.	-	-	1	-	-	1.84
Populus tremuloides	-	-	1	-	-	1.23
Shrub Subtotal				-	-	<u>3.07</u>
* seeded species				<u>98.10</u>	<u>68.81</u>	<u>35.88</u>

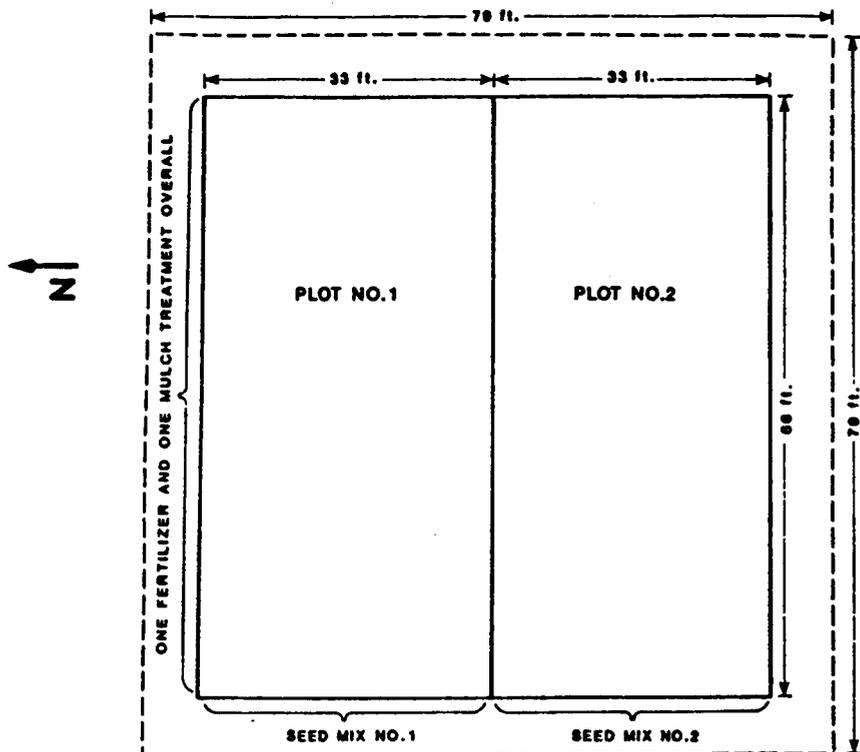
The seeded grasses and forbs did very well in the Middle and South Fork plots, establishing a good ground cover. The seeded shrub species were not evident in these plots. In the Riparian Plot, the seeded species initially provided much of the ground cover. However, with time other native species, common to riparian communities, colonized the plot and became co-dominant with the seeded species.



TOTAL TOPSOIL REQUIRED $\approx 229 \text{ yd}^3$, TO BE OBTAINED FROM STUDY SITE NO.2

TOTAL STUDY AREA DIMENSIONS ARE 66x88 ft. (≈ 0.18 acre)
 STUDY SITE TO BE EXCAVATED SO ALL PLOTS ARE AT SAME SURFACE LEVEL AFTER TOPSOIL IS IN PLACE

FIGURE IX-1. LAYOUT OF "STUDY SITE NUMBER 1" TO BE LOCATED IN COAL REFUSE IMPOUNDMENT AREA.



LIMIT OF SOIL BORROW AREA- 0.14 ACRE. BORROW VOLUME IS
 $70 \text{ ft.} \times 70 \text{ ft.} \times 1 \text{ ft. DEEP} \approx 231 \text{ yd}^3$.

SOIL TO BE USED AT STUDY SITE NO.1 ON COAL REFUSE AREA

RAE-100852

FIGURE IX-2. LAYOUT OF "STUDY SITE NUMBER 2" TO BE LOCATED AT BORROW SITE IN SAGEBRUSH VEGETATION ZONE EAST OF COAL SLURRY IMPOUNDMENTS.

1988 PHOTOS

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CHAPTER IV APPENDICES

Appendix IV-1	Cultural Resource Inventory Of Middle Fork Surface Facilities
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R614-301-400 LAND USE AND AIR QUALITY

R614-301-410 LAND USE

R614-301-411 ENVIRONMENTAL DESCRIPTION

411.100 PREMINING LAND-USE INFORMATION

U.S. Fuel Company has been operating coal mines in the Hiawatha area since the early part of the century. Land use has remained relatively unchanged in the various topographies on the property over the years and is not expected to change significantly in the future. The land use picture is still and will remain primarily wildlife habitat and limited grazing. U.S. Fuel Company mining operations are located in the narrow canyons that lead to the top of the Wasatch Plateau, therefore, no cropland or prime farmland is within the mine area. Control measures needed to mitigate impacts shall include steps necessary to protect ground and surface water, soil resources, vegetation, wildlife and air quality.

A description of the condition and capability of the land within the permit area, excluding Forest Service land, is given by the Soil Conservation Service in the publication Soil Survey of Carbon Area, Utah dated June, 1988. This publication describes soil resources and gives estimates of rangeland and woodland understory production, recreational development, wildlife habitat and water management as they relate to soils. A statement of the condition of rangeland and forestland within the Forest Service boundaries of the permit area is given in Chapter II on page 9 of Appendix II-2.

411.110 USES OF THE LAND EXISTING AT TIME OF FILING

The uses of the land existing at the time of the filing of the permit application were coal mining, wildlife habitat, livestock grazing and outdoor recreation. Exhibit IV-4 shows existing livestock range sites. Exhibit IV-5 shows locations of existing and abandoned mine sites.

The mine plan area contains habitat for numerous wildlife species. The varied topography and diversity of vegetative environments ranging from semi-desert shrubs to high mountain forests provide a variety of life zones for game and nongame animals. The mine plan area and surrounding lands contain both summer and winter range for big game animals and are included in deer management area numbers 33 and 34, and elk management area number 21. See Exhibits III-1 and III-2.

There are no developed recreation sites in the area, though dispersed recreation such as camping, hiking, sightseeing and especially big game hunting have been and are increasingly prevalent.

The upper reaches of Miller Creek and Cedar Creek are municipal water sheds, providing domestic water for the town of Hiawatha, industrial water for mining and coal processing, and agricultural water for irrigating farm lands further downstream. Stream flow, depending on seasonal variations, is from 0.1 to 4 cubic feet per second for Miller Careek and 0.8 to 4.5 cubic feet per second for Cedar Creek.

Some oil and gas exploration has been done in the past and most likely will continue due to increased demand. Although there are no oil or gas wells in the mine plan area, several have been drilled on adjacent lands. The potential for oil and gas discovery in this area is high with estimated reserves for the Gentry Mountain area averaging 28 billion cubic feet of gas and 12 billion barrels of oil.⁴

411.120

CAPABILITY OF LAND TO SUPPORT A VARIETY OF USES

Regional land use consists primarily of mining, grazing, recreation, and forestry related activities. No developed recreation sites exist in the area. There is some dispersed recreation associated with camping, hiking, sightseeing and big game hunting in the fall.

Land use in the mine plan area has remained pretty much unchanged since the early part of this century. These uses include livestock grazing, logging, mining, wildlife habitat, watershed, dispersed recreation and oil and gas exploration.

The first significant use of the land was for livestock grazing. In the 1880's the Miller Brothers ranged large herds of cattle and sheep on the Wasatch Plateau and surrounding lowlands from Scofield to the Colorado River. Their headquarters were at the Millerton Ranch (now owned by U.S. Fuel Company) on Miller-Creek approximately four miles east of Hiawatha. The ranch and mountain rangelands are still being used though at a lesser intensity.

Some logging had been done in this area in earlier days. Historical accounts note that a saw mill was located near the forks of Miller Creek around the turn of the century. Since that time, and into the early 1930's logging intensified somewhat due to the need for mine props for roof support in coal mines which began operating around 1909. Very little logging has been done in recenat years since better quality and less expensive mine props can be shipped from the Uinta Basin.

In the Manti-LaSal National Forest, of which part of the mine plan is included, the Forest Service estimates standard component sawtimber volumes of 10,000 board feet per acre for conifers and 5,300 board feet for aspen.² An extensive timber survey was performed by the Forest Service in 1929 in connection with mine prop logging on U.S. Fuel Company property near Hiawatha. The survey notes that there were no even aged stands of timber except aspen. "The coniferous species are all adapted to growing under considerable shade and consequently have developed all age stands".³ The following data derived from the survey is included as a guide to existing conditions since little logging or unnatural changes have occurred since that time.

TIMBER SPECIES DISTRIBUTION - HIAWATHA AREA 1929

<u>FOREST TYPES</u>	<u>ACRES</u>	<u>PERCENT OF TOTAL AREA</u>
60% or more Douglas fir with alpine fir, white fir and spruce	1,651	7
60% or more white and alpine fir with Douglas fir and spruce	1,538	6
Varying mixtures of alpine and subalpine species	241	1
60% or more Aspen often nearly pure but also with conifers	2,069	11
Pinyon-Juniper, Grassland-Brush scattered or stunted spruce-fir	13,707	75

AGE DISTRIBUTION (CONIFERS ONLY)

	<u>AGE</u>	<u>DIAMETER</u>	<u>PERCENT OF TIMBERED AREA</u>
Saplings	0 - 40 years	Under 4"	0.5
Poles	40 - 80 years	4" to 8"	9.0
Intermediate	80 to 160 years	8" to 12"	39.0
Mature	120 to 160 years	Over 12"	14.0
Overmature	Over 160 years	Over 12"	15.0

Oil and gas ownership on the property is comprised of fee and federal lands. In the past, two oil and gas wells were drilled in the proximity of the property but both resulted in dry holes. There is currently no oil and gas production on the United States Fuel Company property. Federal oil and gas leases on the property are as detailed in Table IV-1.

411.130 LAND USE CLASSIFICATIONS UNDER LOCAL LAW

The mine plan and surrounding areas are classified as recreation, forestry, grazing and mining lands under local county zoning ordinances. Due to rugged topography however there are no croplands in the area.

411.140 CULTURAL AND HISTORICAL RESOURCES INFORMATION

A site search conducted by Utah's Division of State History located no known archaeological or cultural sites. Sites have been identified in the area but none are located on the property. See Attachment IV-1. In the event any paleontological remains are discovered during mining operations, U.S. Fuel Company will notify the Division of State History.

Compliance with E011593 and the National Historic Preservation Act

U.S. Fuel contracted with Brigham Young University (B.Y.U.) through Asa Nielsen of the Department of Anthropology to conduct a field survey necessary for compliance with E011593. This survey was conducted at the Middle Fork mine yard area where a new portal breakout was proposed. This comprises about 0.5 acre and is attached directly on its south boundary to the King IV mine yard. No artifacts or sites were located here. Refer to Appendix IV-1. An archaeological field survey was also conducted in the vicinity of the King VI mine. No cultural resources of any significance were encountered in this area either. See Appendix IV-2.

No new disturbance under the term of this permit is projected at this time. Any new construction will be done on presently disturbed areas and no survey will be required.

U.S. Fuel Company commits to maintaining a file of historical information pertaining to the town of Hiawatha. The file will attempt to collect available information on the history of Hiawatha.



SCOTT M. MATHESON
GOVERNOR



STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

March 3, 1980

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVINT SMITH DIRECTOR
307 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801/533-5755

Mr. Robert Eccli
Mine Engineer
United States Fuel Company
Hiwatha, Utah 84527

Dear Mr. Eccli:

As requested by your letter of February 22, 1980, a site search was completed of the area located on the map furnished by your office. The search located no known archeological or cultural sites. There are a number of known sites in the area, but none are located on your property. Also enclosed is a copy of 36 CFR 800 and a list of surveyors as requested.

If our office can be of further help on advise, please contact me.

Sincerely,

Jim Dykman
Compliance Administrator

JLD:re

Enclosure:

TABLE IV-1

FEDERAL OIL AND GAS LEASES IN THE MINE PERMIT AREA

	<u>LeaseNumber</u>
Township 15 South, Range 7 East	
Sections 13: S $\frac{1}{2}$	U-17537
24: N $\frac{1}{2}$, SW $\frac{1}{4}$, N $\frac{1}{2}$ SE $\frac{1}{4}$, SW $\frac{1}{4}$ SE $\frac{1}{4}$	U-17534
25: W $\frac{1}{2}$, W $\frac{1}{2}$ E $\frac{1}{2}$	U-17535
36: SE $\frac{1}{4}$, E $\frac{1}{2}$ NE $\frac{1}{4}$	U-21236
36: W $\frac{1}{2}$ NE $\frac{1}{4}$	U-17535
Township 15 South Range 8 East	
Sections 31: S $\frac{1}{2}$	U-42783
34: S $\frac{1}{2}$ SE $\frac{1}{4}$	U-31707
35: SE $\frac{1}{4}$ SE $\frac{1}{4}$	U-31707
Township 16 South, Range 7 East	
Sections 1: SE $\frac{1}{4}$	U-36982
12: All	U-38968
13: All	U-23270
Township 16 South, Range 8 East	
Sections 3: E $\frac{1}{2}$	U-21129
9: NE $\frac{1}{4}$ NE $\frac{1}{4}$, NE $\frac{1}{4}$ SE $\frac{1}{4}$	U-22011
9: SE $\frac{1}{4}$ NE $\frac{1}{4}$	U-42784
10: N $\frac{1}{2}$, N $\frac{1}{2}$ S $\frac{1}{2}$	U-14454
11: N $\frac{1}{2}$, N $\frac{1}{2}$ SE $\frac{1}{4}$, NW $\frac{1}{4}$ SW $\frac{1}{4}$	U-14454
15: SW $\frac{1}{4}$ NW $\frac{1}{4}$, NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$, E $\frac{1}{2}$ SE $\frac{1}{4}$, W $\frac{1}{2}$ SE $\frac{1}{4}$	U-34988
19: S $\frac{1}{2}$ N $\frac{1}{2}$, SE $\frac{1}{4}$, SW $\frac{1}{4}$	U-23794
20: SE $\frac{1}{4}$ NW $\frac{1}{4}$, NW $\frac{1}{4}$ SW $\frac{1}{4}$, E $\frac{1}{2}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$, SW $\frac{1}{4}$ SW $\frac{1}{4}$	U-23794
21: SE $\frac{1}{4}$ SW $\frac{1}{4}$, S $\frac{1}{2}$ SE $\frac{1}{4}$	U-23852
21: NE $\frac{1}{4}$ SE $\frac{1}{4}$	U-42784
22: SE $\frac{1}{4}$	U-17416
22: SW $\frac{1}{4}$, W $\frac{1}{2}$ NE $\frac{1}{4}$, S $\frac{1}{2}$ NW $\frac{1}{4}$, NE $\frac{1}{4}$ NW $\frac{1}{4}$	U-14455
23: SE $\frac{1}{4}$	U-19013
23: N $\frac{1}{2}$ NW $\frac{1}{4}$, SW $\frac{1}{4}$ SW $\frac{1}{4}$	U-17416
23: NE $\frac{1}{4}$, S $\frac{1}{2}$ NW $\frac{1}{4}$, N $\frac{1}{2}$ SW $\frac{1}{4}$, SE $\frac{1}{4}$ SW $\frac{1}{4}$	U-14454
27: SE $\frac{1}{4}$	U-17416
28: NE $\frac{1}{4}$ NW $\frac{1}{4}$, NW $\frac{1}{4}$ SE $\frac{1}{4}$, SW $\frac{1}{4}$ SW $\frac{1}{4}$	U-26309
28: NE $\frac{1}{4}$, E $\frac{1}{2}$ SE $\frac{1}{4}$, SW $\frac{1}{4}$ SE $\frac{1}{4}$, SE $\frac{1}{4}$ SW $\frac{1}{4}$, N $\frac{1}{2}$ SW $\frac{1}{4}$, S $\frac{1}{2}$ NW $\frac{1}{4}$, NW $\frac{1}{4}$ NW $\frac{1}{4}$	U-20763
29: SE $\frac{1}{4}$ SE $\frac{1}{4}$	U-45422
29: SW $\frac{1}{4}$ SE $\frac{1}{4}$, SW $\frac{1}{4}$ SW $\frac{1}{4}$, SE $\frac{1}{4}$ NW $\frac{1}{4}$	U-26309
29: NW $\frac{1}{4}$ SE $\frac{1}{4}$, SW $\frac{1}{4}$ NE $\frac{1}{4}$, SE $\frac{1}{4}$ SW $\frac{1}{4}$, N $\frac{1}{2}$ SW $\frac{1}{4}$, N $\frac{1}{2}$ NW $\frac{1}{4}$, SW $\frac{1}{4}$ NW $\frac{1}{4}$	U-20763
30: All except SE $\frac{1}{4}$ NE $\frac{1}{4}$	U-23794
33: SE $\frac{1}{4}$ NW $\frac{1}{4}$, SE $\frac{1}{4}$ SW $\frac{1}{4}$	U-26309
33: E $\frac{1}{2}$, N $\frac{1}{2}$ NW $\frac{1}{4}$, SW $\frac{1}{4}$ NW $\frac{1}{4}$, NE $\frac{1}{4}$ SW $\frac{1}{4}$, W $\frac{1}{2}$ SW $\frac{1}{4}$	U-20763
34: N $\frac{1}{2}$ SE $\frac{1}{4}$	U-34988
34: W $\frac{1}{2}$, NE $\frac{1}{4}$, SE $\frac{1}{4}$ SE $\frac{1}{4}$	U-14455

411.141 CULTURAL AND HISTORIC RESOURCES MAPS

Not applicable see 411.140.

411.142 COORDINATION WITH STATE HISTORIC PRESERVATION OFFICER

Prior to the initiation of any new ground disturbance, U.S. Fuel Company will consult with OSM, the Utah Division of Oil, Gas and Mining and the State Historical Preservation Organization as to the need for a cultural resource inventory to be conducted on the area to be disturbed. If an inventory is required, all cultural resources will be properly evaluated in terms of the National Register of Historic Places eligibility criteria. Appropriate impact mitigation measures will be developed, in consultation with the appropriate agencies, when if any such significant sites to be affected are discovered.

411.143 IDENTIFICATION OF HISTORIC AND ARCHEOLOGICAL RESOURCES

See 411.142

411.144 PROTECTION OF HISTORIC OR ARCHEOLOGICAL PROPERTIES

See 411.142

411.200 PREVIOUS MINING ACTIVITY

Coal mining in this area began just after the turn of the century. During that time, the Consolidated Fuel Company, the Blackhawk Coal Company and the Castle Valley Coal Company opened mines in the canyons west of Hiawatha and Mohrland. Early mining was almost exclusively in the Hiawatha seam which has been the predominate coal producing seam in the area. The United States Fuel Company acquired the properties of the above mentioned companies in 1915 and since then has mined in the Hiawatha seam, the A seam (0 to 60 feet above the Hiawatha seam) and the B seam (50 to 120 feet above the Hiawatha). Eight significant mines have developed since the beginning of mining in this area. Five of these have been abandoned, one is currently operating and two are currently inactive. See Exhibit IV-5. Coal extraction has been entirely by the room and pillar mining method. Mining has continued uninterrupted for a period of over 80 years with a total production of over 50 million tons.

R614-301-412 RECLAMATION PLAN

412.100 POSTMINING LAND-USE PLAN

After the recoverable coal reserves have been extracted from the United States Fuel Company property it is expected and anticipated that the current status of the existing land use area will remain unchanged. Mining in this immediate area has been ongoing since the turn of the century without any significant disruptions to existing land use.

The postmining land use of the equipment storage yard east of Slurry Pond No. 5 will be for wildlife use and grazing.

The postmining land use for the railroad corridor will be dictated by the railroad and its activities.

The equipment storage yard south of the mine office building will be dedicated to the town of Hiawatha for use as municipal vehicle storage and equipment and maintenance facilities. An agreement has been drawn up between U. S. Fuel Company and the town of Hiawatha for the maintenance and repair of the roads leading to municipal and culinary water supplies. See attachment IV-2.

The Soil Conservation Service, at the request of U.S. Fuel Company, compiled a grazing plan for the mine property area. This plan identifies five range types and addresses soils, vegetation and productivity. The plan is given in Appendix IV-3. The range site locations are shown on Exhibit IV-4.

412.200 LAND OWNER OR SURFACE MANAGER COMMENTS

Surface land status of the mine plan area is a combination of fee lands on the eastern side and the Manti-LaSal National Forest lands on the western portion.

Ownership of the surface is detailed on Exhibit IV-1 with the subsurface ownership detailed on Exhibit IV-2. Specific legal descriptions of property control are provided in Chapter I, Table I-1.

Surface managing authorities consist of two separate and distinct agencies. United States Fuel Company fee lands are bordered on the east, southeast and northeast by the Bureau of Land Management, with the United States Forest Service Manti-LaSal National Forest bordering the fee lands on the west, southwest and northwest. Federal surface control is illustrated on Exhibit IV-1.

Utility corridors traversing the eastern edge of the United States Fuel Company property consist of two Utah Power & Light Company transmission lines. The first transmission

ATTACHMENT IV-2

AGREEMENT

THIS AGREEMENT, entered into as of this 8 th day of February, 1984, by and between UNITED STATES FUEL COMPANY and the TOWN OF HIAWATHA.

United States Fuel Company is the owner of access roads and related drainage control structures serving coal mine facilities in the Left, Middle and Right forks of Miller Creek Canyon in Carbon County, Utah. In accordance with regulations pertaining to Surface Effects of Underground Coal Mining Activities, specifically UMC 784.15 and UMC 817.133 (Postmining Land Use), U.S. Fuel Company proposes to retain these roads upon final reclamation of mine facilities.

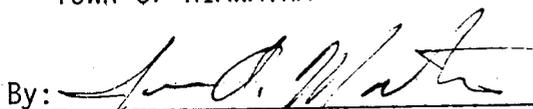
In consideration of access necessary for maintenance and repair of vital municipal and culinary water supply systems, U.S. Fuel Company proposes to grant these roads to the town of Hiawatha following final reclamation of mine facilities. The roads as well as the town water supply systems are located within the boundaries of the incorporated town of Hiawatha.

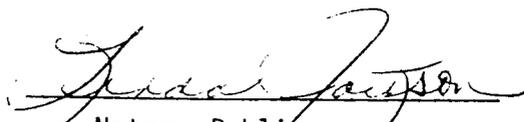
The town of Hiawatha agrees to accept and maintain the roads and related drainage structures in compliance with maintenance standards existing at the time of transferal.

UNITED STATES FUEL COMPANY

By: 
Vice President and General Manager

TOWN OF HIAWATHA

By: 
Mayor


Notary Public
5-21-84

line is a 340 KV north-south line connecting Huntington to Provo, Utah. The second transmission line is a 45 KV north-south line connecting into a substation southeast of the town of Hiawatha that supplies electricity to the mine and town. The Utah Railway Company holds title to a railroad corridor bisecting the eastern portion of the property.

Special use permits and leases are limited primarily to grazing leases issued by the Bureau of Land Management and the United States Forest Service Manti-LaSal National Forest region.

The only coal leases on the property are federal leases which are listed below:

SL-069985
 SL-025431
 U-026583,058261 (combined)
 U-51923

These leases are confined mainly to the western portion of the property and are illustrated on Exhibit IV-2. Table I-1 in Chapter I gives the legal description and land area of each lease. Comments and stipulations relating to these federal lands are made a part of each lease document. Appendix IV-4 gives a listing of these comments and stipulations.

Mineral ownership in the area is comprised of fee and federal lands. Coal is the only valuable commodity mined in the area.

412.300 SUITABILITY AND COMPATIBILITY

Plans for final fills and surface regrading operations for each disturbed site are discussed in Chapter V. Materials to be utilized for final reclamation have all proven to be of a quality suitable for reclamation purposes. See Chapter II, (Soil Resources) and the five year vegetation test plot study given in Appendix III-5.

R614-301-420 AIR QUALITY

421 COMPLIANCE WITH CLEAN AIR ACT

Coal mining and reclamation operations at U.S. Fuel Company's properties are conducted in compliance with the Clean Air Act and the Utah State Department of Health Air Conservation Regulations. All new and previously existing potential sources of air pollution are inspected on a regular basis by the Utah Bureau of Air Quality.

422 COORDINATION AND COMPLIANCE WITH UTAH BUREAU OF AIR QUALITY

All new installations which could be a source of air pollution constructed after the implementation of the Clean Air Act have been reviewed by and received approval orders from the Utah Bureau of Air Quality. U.S. Fuel submits annual emission inventory reports which include the rate and period of emissions, specific plant sources of pollution, composition of contaminants and types and efficiencies of control equipment.

423 AIR POLLUTION CONTROL PLAN

U.S. Fuel Company does not project production rates exceeding 1,000,000 tons of coal per year during the term of this permit, therefore, no air quality monitoring program is required.

Fugitive dust is controlled by enclosed facilities, conveyor belt covers, transfer chute covers and watering of unpaved haul roads.

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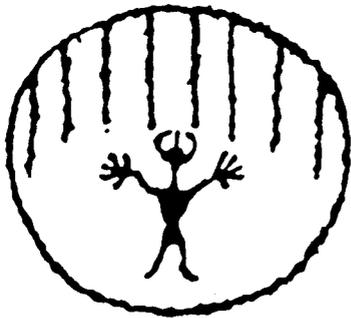
FOOTNOTES

1. Cook, Moreau and Peterson, Soil and Water Conservation Plan For U.S. Fuel Company, Price River Conservation District, USDA Soil Conservation Service, May, 1979.
2. U.S. Forest Service, Intermountain Region, 1979, Land Management Plan, Ferron-Price Planning Unit, Manti-LaSal National Forest, Price, Utah, 1979, page 28.
3. Clayton W. Scribner, Timber Survey, Hiawatha Compartment of Manti Working Circle, Manti National Forest, Nov. 1929, page 28.
4. Forest Service, OP. CIT., p. 165.

APPENDIX IV-1

CULTURAL RESOURCE INVENTORY
OF
MIDDLE FORK SURFACE FACILITIES

Nov. 4, 1983



BRIGHAM YOUNG UNIVERSITY
DEPARTMENT OF ANTHROPOLOGY
TECHNICAL SERIES NO. 83-60

A CULTURAL RESOURCE INVENTORY OF MILLER CREEK
SURFACE FACILITIES IN CARBON COUNTY FOR U.S. FUELS

by
Dean Schleisman and Asa S. Nielson

Cultural Resource Management Services
A. S. Nielson, Principal Investigator
Department of Anthropology
Brigham Young University
Provo, Utah 84602

prepared for
Ford, Bacon and Davis, Inc.
Salt Lake City, Utah

4 November 1983

ABSTRACT

CRMS/BYU has completed a three-acre survey for expansion of U.S. Fuels mine facilities in Carbon County, Utah. No cultural resource materials were observed within the survey area, and CRMS recommends to the Utah State Historic Preservation Office that a cultural resource clearance be granted to Ford, Bacon and Davis, Inc. for this project.

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A CULTURAL RESOURCE INVENTORY OF MILLER CREEK SURFACE FACILITIES IN CARBON COUNTY FOR U.S. FUELS

INTRODUCTION

On 2 November 1983 Dean Schleisman, of the Cultural Resource Management Services (CRMS), Brigham Young University, conducted a cultural resource inventory of about 3 acres in Carbon County, Utah, for U.S. Fuels. The inventory area is the proposed location for new surface mine facilities for the expanding U.S. Fuels mine near Hiawatha, Utah. The work was requested by Dr. Jack Elder, of Ford, Bacon and Davis Inc., mine consultants for U.S. Fuels. The survey area is entirely on private land, hence no Federal or State permits were requested. Survey conditions were ideal and ground visibility excellent. The report was prepared by Dean Schleisman and Asa S. Nielson, and Ted Duffin processed the manuscript.

LOCATION

The proposed mine facility (Figure 1) is located about 2.7 miles due west of Hiawatha, Carbon County, Utah. It is in the upper portion of the Middle Fork of Miller Creek, in the SW1/4 NW1/4 NW1/4 of Section 29, T15S R8E (Hiawatha Quadrangle, Utah, 7.5-minute series topographic). Access to the area is by an existing road leading past the existing Hiawatha Mine.

ENVIRONMENT

The survey area is part of the Wasatch Plateau Subsection of the Basin and Range-Colorado Plateau Transition (Stokes 1977). This area is characterized by deeply entrenched east-to-west canyons which empty into the Mancos Shale Lowlands. Miller Creek has cut its way through successive layers of Cretaceous Black Hawk and Price River Formations, and Paleocene North Horn Formation (Hintze 1980). The mine area is predominantly Black Hawk Formation covered with a thin veneer of talus and colluvial soil. The canyon bottom has in excess of one meter of Recent alluvial deposits of sandy, rocky stream clays.

Flora observed was restricted to big sage, mountain mahogany, pinyon, scrub oak, broom grass and cactus. No fauna were directly observed in the survey area. However, tracks of mule deer and rabbit were observed.

PREVIOUS RESEARCH

Overviews of the culture history of the area are available elsewhere and need not be repeated in detail here. In addition, Ford, Bacon and Davis Inc. is in the process of negotiating a complete overview of the Hiawatha area in addition to proposed additional survey next Spring. Records searches at the Utah Division of State History revealed no known cultural resources in the proposed mine facility area. Consultation with the State and National Registers of Historic Places also revealed no known National Register sites within the survey boundaries.

SURVEY METHODS

The survey was accomplished by completing several parallel transects back and forth over the area of proposed disturbance. Much of the surface is dominated by a moderate hill slope. All possible overhangs, level areas or other potential areas were examined.

SURVEY RESULTS

No cultural resource sites or isolated artifacts were noted during the inventory. The historic Hiawatha Mine is about 300 m due east, but will not be impacted by the new mine facilities. No significant cultural resources will be directly impacted; therefore, CRMS recommends to the Utah State Historic Preservation Office that a cultural resource clearance be granted for this phase of the project, with the following restrictions:

1. that personnel and equipment associated with the development be restricted to those areas cleared for the project;
2. that personnel associated with the project refrain from collecting or otherwise disturbing cultural materials which may be encountered during development; and
3. that should unreported cultural materials be encountered during development, activities in the affected area(s) should cease immediately and the Utah State Historic Preservation Office notified prior to resuming such activities.

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1980 Geologic Map of Utah. Utah Geological and Mineral Survey. Salt Lake City.

Stokes, William Lee

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APPENDIX IV-2

ARCHAEOLOGICAL RECONNAISSANCE OF A PROPOSED
COAL FACILITY AT THE KING VI MINE

April 17, 1981

UTAH ARCHAEOLOGICAL RESEARCH CORPORATION • 87 E. CENTER, SUITE 103 • SPANISH FORK, UTAH 84660 • (801) 798-7061
FIELD OFFICE: P.O. BOX 1147 • MONTICELLO, UTAH 84535

SUBJECT: Archaeological Reconnaissance of A Proposed Coal Facility
At The King #6 Mine, United Fuel Company, Hiawatha, Utah

AUTHOR: Clayton W. Cook
Staff Archaeologist

DATE: April 17, 1981

PROJECT: USF-81-1

PERMIT: #80-Ut-137

PREPARED FOR:

Mr. Robert Eccli
United States Fuel Co.
P.O. Box A
Hiawatha, Utah 84527

Mr. Chuck Jahne
Sharonsteel Mining Division
19th Floor, University Club Building
136 East South Temple
Salt Lake City, Utah 84111

Dr. David B. Madsen
Utah State Archaeologist
300 South Rio Grande
Salt Lake City, Utah 84101

ARCHAEOLOGICAL RECONNAISSANCE OF A PROPOSED COAL FACILITY
AT THE KING #6 MINE, UNITED FUEL COMPANY, HAIWATHA, UTAH

INTRODUCTION

On April 14, 1981 Utah Archaeological Research Corporation was contacted by United States Fuel Company of Hiawatha, Utah to conduct a cultural survey of a proposed coal facility in the south fork of Miller Creek. The project area is privately owned and the legal description is as follows (see attached map):

Township 15 South, Range 8 East, Section 32 S $\frac{1}{2}$, NE $\frac{1}{4}$

UTM Zone 12, Easting 496000, Northing 469750

The project consists of building a coal conveyor just to the north of an existing road, a truck load-out and turn around, and a sedimentation pond. The conveyor will be approx. 3000 feet long and will carry the coal from the mine to the load-out. The project will disturb approx. 3 acres of area. The field work was conducted by Clayton Cook, UTARC Staff Archaeologist on April 15, 1981.

ENVIRONMENTAL SETTING

The project is located in a east trending canyon which washes off the east face of the Wasatch Plateau and into the Castle Valley Area; the creek is known as the South Fork of Miller Creek. The project area is 2 $\frac{1}{2}$ miles east of the present town of Hiawatha. The project is located in the Montane Vegetational Zone. The area has about 80% vegetational coverage with 20% sage, 40% conifers (Abies concolor, Pseudotsuga menziesii, etc.) and 40% miscellaneous grasses

and forbes. Sediments in the area are basically colluvial. Faunal observed consisted of deer and various small rodents. The land has been utilized mostly for mining since 1915. Before the 1900's, there was some stock ranging in the area.

HISTORICAL SETTING

Coal mining has long been an important part of Carbon County's economical base and has been responsible for the founding of several small communities in the county, including Hiawatha. The first large mines to be opened on the east front of the Wasatch Plateau were opened from 1909 to 1911 in Miller and Cedar Creek Canyons. These operations were soon consolidated into one operation known as King Mine.

The Consolidated Fuel Company organized in 1907 was the first to mine in the area. It built the old Southern Utah Railroad from Price to Hiawatha and opened the mine known as West Hiawatha. A year later the railroad was extended up Cedar Creek Canyon to the Mohrland Mine which was owned and operated by the Castle Valley Coal Company. In 1911, the Blackhawk Coal Company opened the Black Hawk Mine on the mountainside approximately 1000 feet above the present town of Hiawatha. The United States Fuel Company was organized in 1915, and in 1916 commenced operation by taking over the properties owned by the Consolidated Fuel Company, Castle Valley Coal Company, Black Hawk Coal Company, and the Panther Coal Company at Hiener, Utah. The King Coal operations at Hiawatha, owned and operated by United States Fuel, are the longest continuously operated mines in Utah.

In 1948, the King #3 Mine was opened in the South Fork of Miller Creek. The #3 Mine operated until 1975, when it was shut down. Operations at #3, consisted of the portal and vent shaft, showers and office, shop buildings and stock pile.

The proposed operation of King #6, is to reopen the King #3 Mine. This will be accomplished by opening a new portal and bypassing the old #3 portal. Many of the existing buildings will be renovated and reused. The conveyor, as mentioned, will carry the coal to the new load-out facility. These are the only operations which will be constructed on areas that were not previously disturbed by construction of King #3.

FILE SEARCH

A file search was conducted at the Utah State SHPO Office and at the State Bureau of Land Management Office prior to entering the field. No cultural resources have been recorded in Section 32 in past work. However, sites have been recorded in Sections 10, 11, 23, 24, 25, and 26 of the same Township and Range. Most of these sections are on ridge tops and not in steep walled canyons such as Section 32. There could possibly have been some aboriginal hunting activity in the area but, no evidence has been encountered as of yet.

METHODOLOGY

Field Survey of the proposed construction was conducted by walking parallel transects spaced at 10 foot intervals across the area where the sedimentation pond and turn around will be constructed. A corridor of

approximately 100 feet was walked along the proposed location of the conveyor. This way all areas of potential impact were thoroughly checked for cultural resources.

RESULTS AND RECOMMENDATIONS

Two existing structures will be torn down during the construction of the turn around and load-out. These structures consist of one powder magazine and one cap magazine. These buildings were built in the late 1940's. They are not considered to be significant because they are not unusual or unique in their construction or function.

No cultural resources of any significance were encountered in the area of the proposed construction. Therefore, clearance is recommended with the stipulation that if buried resources are encountered during construction, work be stopped and a qualified archaeologist be contacted to determine their significance.

"Reference Cited"

Thirty Years of Coal Mining - Pamphlet Published by The United States Fuel Company, Salt Lake City, Utah 1946.



View looking East - Conveyor will run along,
and to the left of, the existing road.

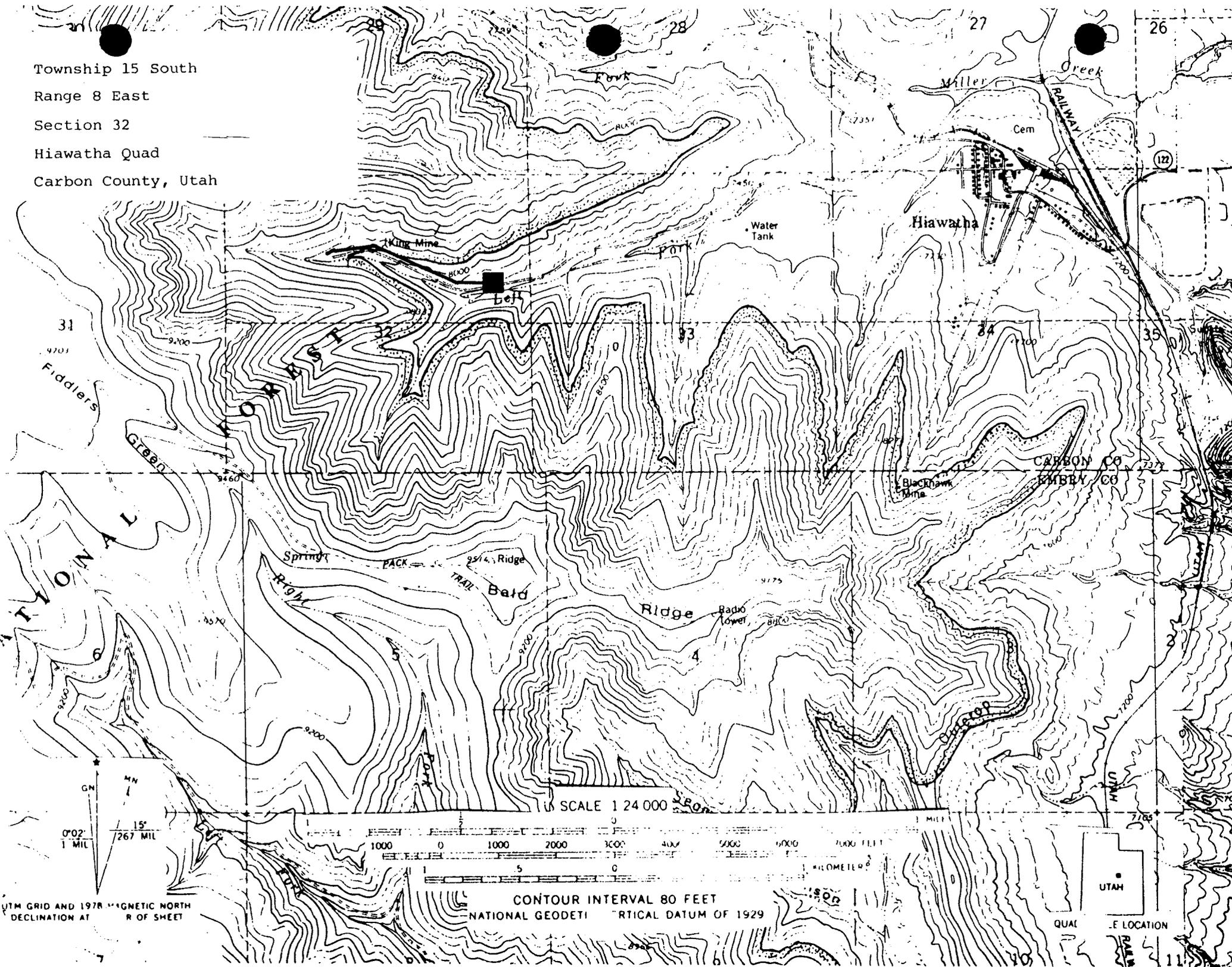


View of proposed turn around and load-out looking NW.



View looking SE of proposed sedimentation pond location.

Township 15 South
Range 8 East
Section 32
Hiawatha Quad
Carbon County, Utah



UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24,000
CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

UTAH
LOCAL LOCATION

APPENDIX IV-3

LIVESTOCK GRAZING PLAN FOR U.S. FUEL CO.

May 16, 1979

RECORD OF COOPERATOR'S DECISIONS
AND PROGRESS IN APPLICATION

APPROVED BY _____ & _____
DATE 5-79

FIELD NO.	PLANNED		APPLIED		LAND USE AND TREATMENT
	AMOUNT	YEAR	AMOUNT	MONTH AND YEAR	
1,2,3	12,800	1979			<p>Range 12,800 acres</p> <p><u>Proper Grazing use</u></p> <p>Graze at an intensity which will maintain enough to cover to protect soil and maintain or improve the quality and quantity of desirable vegetation. (rule of thumb: take half and leave half and both halves will get bigger.) see job sheet #1 for proper use of key species.</p>
1-3	12,800	1979			<p><u>Planned Grazing System</u></p> <p>See job Sheet No. 2 use either alternate #1 which is a rest rotation system or alternate #2 which is a deferred rotation grazing system.</p>
1-3	5 each	1979-1980			<p><u>Water Development</u></p> <p>Ponds will be made & springs will be maintained and developed where needed.</p>
1-3			2 mi.	1977	<p><u>Fencing</u></p> <p>Fences will be constructed where needed to better control and distribute livestock.</p>

Job Sheet #1
PROPER GRAZING USE

OPERATOR U.S. Fuel

NG	ACRES	SPECIES OF GRAZING ANIMAL	SEASON OF USE	LOCATION OF KEY GRAZING AREA	KEY PLANT(S) FOR JUDGING PROPER GRAZING USE	PLANNED USE OF KEY SPECIES AT END OF GRAZING PERIOD	ESTIMATED USE OF KEY SPECIES BY WEIGHT				
							1979	1980	1981	1982	1983
		Cattle	Sum.	High Mt. Loam Range Site South	Little & Tall	Not to exceed					
				side of unit	Native bluegrass	50%					
		Cattle	Sum.	Mt. Shallow Loam (Sec. 30)	Little & Tall	50%					
					Native bluegrass						
		Cattle	Sum.	Mt. Shallow (Sec. 30)	Little & Tall	50%					
					Native bluegrass						
		Cattle	Sum.	Mt. Shallow Loam (Sec. 31)	Little & Tall	50%					
					Native bluegrass						
		Cattle	Sum.	Section 17	Bluebunch	50%					
		Cattle	Sum.	Mt. Shallow Loam	Bluebunch	50%					

Conservationist Assisting with Planning

Initials of Conservationist
Assisting with Application

Gary D Moran 5/16/79
NAME AND DATE

Dates of Application Checks

Job Sheet # 2

ALTERNATE #1 Rest Rotation

	<u>Graze</u>	<u>Rest</u>
Year 1	1&2	3
Year 2	2&3	1
Year 3	3&1	2
Year 4	1&2	3
Year 5	2&3	1
Year 6	3&1	2

Use Job Sheet #1 as a guide to change pastures with livestock.

ALTERNATE #2 Rotation Deferred

Year 1	1,2&3
Year 2	3,2,&1
Year 3	2,1,&3 if needed

Use the use factor on the key plants as an indicator as listed in Job Sheet #1 to rotate pastures.

<u>Site & Woodland Site</u>	<u>Acres</u>	<u>Prod</u>	<u>Total Herbage</u>	<u>% Utilization</u>	<u>Available Forage</u>	<u>Proper use %</u>	<u>Useable Forage</u>	<u>Aums</u>	<u>Potential Aums</u>
Mtn. Loam	735	1000	735000	35	257250	50	128625	160	800
en Grass	735	1000	735000	40	294000	50	147000	183	500
Shallow Loam	1475	11000	1622500	25	405625	50	202812	253	500
uce Fir	240	700						25	
s Will	735	-						-	
Stony Loam	980	1200	1176000	35	411600	50	205800	257	550
Total	4900							853	2350
Mtn. Loam	325	1000	325000	30	975000	50	48750	60	350
en Grass	630	1000	650000	40	260000	50	130000	162	480
Shallow Loam	975	1100	1072500	25	268125	50	134062	167	335
Stony Loam	325							24	
uce Fir	1950							-	
and Shallow Loam PJ	1300	700	910000	35	318500	50	159250	199	
Total	6500							843	1715
Mtn. Loam	280	1200	336000	75	252000	50	126000	157	300
en Grass	350	1200	420000	70	294000	50	147000	183	260
Shallow Loam	490	1100	539000	30	161700	50	80850	101	170
uce Fir	140							24	
ss Will	140							-	
Total	1400							441	730
Total								2137	4795

Difference

2650

Possible stocking Rate of 400 - 425 head for 5 months but,
would try 300 - 350 for a season or two.

RANGE SITE DESCRIPTIONS

HIGH MOUNTAIN LOAM (ASPEN)

This site occurs in a rainfall belt of 22 inches or greater. Fifty percent or more of this comes during the growing season. The soils are medium textured and deep. The infiltration rate and the waterholding capacity are good. An over-story of aspens identifies this site.

Mountain and nodding brome grass, blue wildrye, bearded and slender wheatgrass, peavine, butterweed and aspen make up the bulk of the potential plant community. Potential production for this site ranges from 2750-4000 pounds per acre.

HIGH MOUNTAIN LOAM

This site occurs in association with your High Mountain Loam (Aspen) site but does not have aspen on it. The soils making up this site are medium textured. Infiltration rates and waterholding capacity are good. This site occurs in a rainfall belt of greater than 22 inches. Potential production can reach 2700 pounds in favorable years.

Bearded and slender wheatgrass, mountain brome, columbia needlegrass, big sagebrush, snowberry and oakbrush make up the bulk of the potential plant community.

MOUNTAIN STONY LOAM

Medium textured soils make up this site. The soil profile has 50% or more of stones. Although the site is in a favorable rainfall belt (16-22 inches) the stoniness limits the waterholding capacity. This affects total production. Deep rooted plants are a "natural" for this site as moisture percolates deep.

Mountain mahogany, bitterbrush, sagebrush, and blue-bunch wheatgrass make up the bulk of the potential plant community. Potential production ranges from 750 to 2000 pounds per acre.

MOUNTAIN SHALLOW LOAM

This site occurs in a rainfall belt from 16 to 22 inches. Fifty percent or more comes during the growing season. Soils in this site are stony or cobbly, shallow and well drained.

**MOUNTAIN SHALLOW
LOAM (Continued)**

Bluebunch wheatgrass, Indian ricegrass, Great Basin wildrye, prairie junegrass, balsamroot, native bluegrass, bitterbrush, and big sagebrush are potential plants for the bulk of the production. Potential production for the site is 750-1500 pounds depending on how favorable the year.

**UPLAND LOAM
(PINON-JUNIPER)**

This is a woodland range site as pinon-juniper dominates the site. Soils making up the site are medium textured, have a good infiltration rate and store all the moisture that normally falls. The site occurs in the 12-16 inch rainfall belt.

Potential production for the site is 950-2600 pounds per acre. Pinon-juniper, bluebunch wheatgrass, Indian ricegrass, sandberg and western wheatgrass yield the bulk of the production.

**UPLAND STONY
HILLS (JUNIPER)
(Summer Precipitation)**

Soils of this site are stony, cobbly and shallow. Waterholding capacity is limited by the shallow depth and the high percentage of stone in the soil. The site occurs in the 12-16 inch rainfall belt.

Juniper, Indian ricegrass, needle-and-thread, blue grama, sedge and yellowbrush make up the bulk of the potential plant community.

**UPLAND STONY
LOAM (PINON-
JUNIPER)**

This is a pinon-juniper tree site. The soils are medium textured and occur in the 12-16 inch rainfall belt. Limited rainfall as well as a high percentage of stones in the soil limits production.

Fifty percent of the total production can be expected from pinon and juniper. Other potential plants for the site are bluebunch wheatgrass, needle-and-thread, bluegrasses, bitterbrush, big and black sagebrush.

CLASS VIII LAND

Land that is too steep, barren, or inaccessible to livestock.

ASPEN GRASS ECOSYSTEM

Soils Soils are deep, well-drained - surface layers being loam, silt loam as clay loam and in places stony, gravelly cobbly or very cobbly. Intake rate is moderate to rapid and water movement through the soil is good. Water holding capacity is high (ten to fourteen inches in a six foot profile.)

Potential Native Plant Community

Overstory - Quaking Aspen - 40
Understory Grass - 60
Shrub - 610
Forb - 20 30

Density

Overstory - 25-70%
Understory - 80%

Grainy Value

Potential forage value rating 60%
heavy weight of desirable species

Important Species

Columbia Needlegrass
Mountain Brome
Letterman's Needlegrass
Western Wheatgrass
Slender Wheatgrass
Lupine
Aspen Peavine
American Vetch

ENGELMANN SPRUCE WOODLAND SUITABILITY GROUP

Vegetation	Overstory - Engleman Spruce Understory - Mountain Brome and Brand of forbs.
Productive Capacity	Site Class VI site index (unavailable) Productive Rating low for Engelmann Spruce
Soils	Extremely Stony Loam
Hazards and Limitations	High percentage of Rock, steep slopes.
Yield Data	unavailable

13. HIGH MOUNTAIN LOAM

Topography

This site occurs on gently sloping to very steep mountain slopes. On this site slope range from 20 to 60%. It will be found primarily on north and east exposures.

Soils

The soils are deep, well-drained soils. Infiltration and inturmal water movement are good. The soil has a high water holding capacity ranging from about 10 to 14.5 inches in a six foot profile. Amount of stone, cobble or gravel is variable throughout the profile but is less than 50%.

Potential Native Plant Community

Grass - 45
Shrubs - 30
Forbs - 25%

Potential Production

1300 pounds in unfavorable years to
2700 pounds in favorable years.

Density

A potential density of herbage cover
by ocular estimate is 70 to 75%

Important Plants

Mountain Prome
Slender Wheatgrass
Bullgrass
Western Wheatgrass
Letterman's Needlegrass
Columbia Needlegrass
Lupine
Tall Larkspur
Big Sagebrush

38. MOUNTAIN SHALLOW LOAM

Physiographic Factors

This site will be found on steep mountain slopes ranging from 30 to 65%. On this site it will be found primarily on south and west exposures, and ridge tops. Elevation 7500 to 9000 feet.

Soils

The soils are stony or cobbly and shallow over bedrock (10 to 20 inches) They are well drained. Water intake rate is moderate to slow. Water holding capacity is low due to the shallow depth and rock fragment content. It ranges from 1.5 to 3.0 inches with a water supplying capacity of 5 to 8 inches.

Potential Native Plant Community

Grass - 50%
Shrubs - 45%
Forbs - 5%

Potential Production

600 pounds in unfavorable years to 1700 pounds in favorable years.

Density

Potential density of herbage by ocular estimation is 45 to 50%

Important Plants

Letterman's Needlegrass
Longtongue Nuttongrass
Big Sagebrush
Bullgrass
Mountain Snowberry

43. MOUNTAIN STONY LOAM

Physiographic Features	This site will occur on all exposures but primarily on the north and east slopes. The slopes will vary from 30 to 60%. Elevation ranges from 7000 to 9000 feet.
Soils	The soils are deep well-drained and very gravelly, very stony or very cobbly over 50% by volume throughout the profile. Infiltration and internal water movement are good. Water holding capacity is moderate due to the high contents of rock fragments.
Potential Native Plant Community	Grass - 65 - 75% Shrubs - 15 - 20% Forbs - 5 - 10 %
Potential Production	1000 pounds per acre in unfavorable years to 2500 pounds in favorable years.
Density	Potential density by ocular estimate, overstory 10 - 20%, understory 40 to 45%.
Important Plants	Bullgrass Muttongrass Letterman's Needlegrass Lupine Rig Sagebrush Mountain Snowberry <i>MOUNTAIN MARGARIT</i> <i>BITTER ROOT</i>

APPENDIX IV-4

COMMENTS AND STIPULATIONS RELATING TO
FEDERAL LEASE LANDS

PART II. TERMS AND CONDITIONS

Sec. 1.(a) RENTAL RATE - Lessee shall pay lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate of \$3.00 for each lease year.

(b) RENTAL CREDITS - Rental shall not be credited against either production or advance royalties for any year.

Sec. 2.(a) PRODUCTION ROYALTIES - The royalty shall be 8 percent of the value of the coal as set forth in the regulations. Royalties are due to lessor the final day of the months succeeding the calendar month in which the royalty obligation accrues.

(b) ADVANCE ROYALTIES - Upon request by the lessee, the authorized officer may accept for a total of not more than 10 years, the payment of advance royalties in lieu of continued operation, consistent with the regulations. The advance royalty shall be based on a percent of the value of a minimum number of tons determined in the manner established by the advance royalty regulations in effect at the time the lessee requests approval to pay advance royalties in lieu of continued operation.

Sec. 3. BONDS - Lessee shall maintain in the proper office a lease bond in the amount of \$5,000. The authorized officer may require an increase in this amount when additional coverage is determined appropriate.

Sec. 4. DILIGENCE - This lease is subject to the conditions of diligent development and continued operation, except that these conditions are excused when operations under the lease are interrupted by strikes, the elements, or casualties not attributable to the lessee. The lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the

regulations in existence at the time of the suspension. Lessee's failure to produce coal in commercial quantities at the end of 10 years shall terminate the lease. Lessee shall submit an operation and reclamation plan pursuant to Section 7 of the Act not later than 3 years after lease issuance.

The lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, *inter alia*, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

Sec. 5. LOGICAL MINING UNIT (LMU) - Either upon approval by the lessor of the lessee's application or at the direction of the lessor, this lease shall become a LMU or part of a LMU, subject to the provisions set forth in the regulations.

The stipulations established in a LMU approval in effect at the time of LMU approval will supersede the relevant inconsistent terms of this lease so long as the lease remains committed to the LMU. If the LMU of which this lease is a part is dissolved, the lease shall then be subject to the lease terms which would have been applied if the lease had not been included in an LMU.

Sec. 6. DOCUMENTS, EVIDENCE AND INSPECTION - At such times and in such form as lessor may prescribe, lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

Lessee shall keep open at all times for the inspection of any duly authorized officer of lessor, the leased premises and all surface and underground improvements, works, machinery, ore stockpiles, equipment, and all books, accounts, maps,

and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall allow lessor access to and copying of documents reasonably necessary to verify lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Act (5 U.S.C. 552).

Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS - Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation to any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and to other land uses or users. Lessee shall take measures deemed necessary by lessor to accomplish the intent of this lease term. Such measures may include, but are not limited to, modification to proposed siting or design of facilities, timing of operations, and specification of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other

mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits, not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 8. PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY - Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergencies; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither lessee nor lessee's subcontractors shall maintain segregated facilities.

Sec. 9.(a) TRANSFERS

This lease may be transferred in whole or in part to any person, association, or corporation qualified to hold such lease interest.

This lease may be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

This lease may only be transferred in whole or in part to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest must be approved in accordance with the regulations.

(b) RELINQUISHMENT - The lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon lessor's acceptance of the relinquishment, lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 10. DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC. - At such time as all portions of this lease are returned to lessor, lessee shall deliver up to lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the

leased lands beyond 180 days, or approved extension thereof, shall become the property of the lessor, but lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the lessor. If the surface is owned by third parties, lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by lessee's activity or activities incidental thereto, and reclaim access roads or trails.

Sec. 11. PROCEEDINGS IN CASE OF DEFAULT - If lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Sec. 12. HEIRS AND SUCCESSORS - IN-INTEREST - Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 13. INDEMNIFICATION - Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the lessee's activities and operations under this lease.

Sec. 14. SPECIAL STATUTES - This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151 - 1175); the Clean Air Act (42 U.S.C. 1857 et seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.).

Sec. 15. SPECIAL STIPULATIONS -

The Regulatory Authority shall mean the State Regulatory Authority pursuant to a cooperative agreement approved under 30 CFR Part 745 or in the absence of a cooperative agreement, Office of Surface Mining. The Authorized Officer shall mean the State Director, Bureau of Land Management. The Authorized Officer of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. Surface Management Agency for private surface is the Bureau of Land Management.

The Authorized Officers, of the Bureau of Land Management, Office of Surface Mining (Regulatory Authority), and the Surface Management Agency (Forest Service) respectively, shall coordinate, as practical, regulation of mining operations and associated activities on the lease area.

1. In accordance with Sec. 523(b) of the "Surface Mining Control and Reclamation Act of 1977", surface mining and reclamation operations conducted on this lease are to conform with the requirements of this act and are subject to compliance with Office of Surface Mining regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c) and final determination of suitability for mining. The United States Government does not warrant that the entire tract will be susceptible to mining.

2. Federal Regulations 43 CFR 3400 pertaining to Coal Management make provisions for the Surface Management Agency, the surface of which is under the jurisdiction of any federal agency other than the Department of Interior, to consent to leasing and to prescribe conditions to insure the use and protection of the lands. All or part of this lease contain lands the surface of which are managed by the United States Department of Agriculture, Forest Service - Manti-LaSal National Forest.

The following stipulations pertain to the lessee responsibility for mining operations and the lease area and on adjacent areas as may be specifically designated on National Forest System Lands.

3. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the Lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the Lessee, prior to disturbance, shall immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the Lessee.

4. If there is reason to believe that threatened or endangered (T&E) species of plants or animals, or migratory species of high Federal interest occur in the area, the Lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. A listing of migratory birds of high Federal interest in Federal coal producing regions is published by the U.S. Fish and Wildlife Service, Migratory Bird Management Office, Washington, D.C. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the Lessee.

5. The Lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data is adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the inter-relationship of the geology, topography, surface hydrology, vegetation, and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

6. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100 yards from public roads.

7. The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of the access road, are factors which will determine the ultimate size of the surface area utilized for the mine. A site specific environmental analysis will be prepared for each new mine site development and for major modifications to existing developments to examine alternatives and mitigate conflicts.

8. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed, to reduce visual impacts, and where possible achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural lands forms and vegetative landscape features will be avoided.

9. The Lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

10. The Lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), Lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

11. Except at specifically approved locations, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The Lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

12. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specific approved locations.

13. If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

14. The coal contained within, and authorized for mining under this lease shall be extracted only by underground mining methods.

15. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

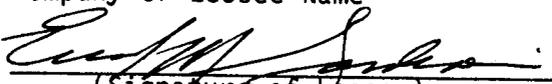
16. In order to protect big game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other critical wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specified periods of the year.

17. Support facilities, structures, equipment, and similar developments will be removed from the lease area within two years after the final termination of use of such facilities. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages re-established, and the areas returned to a premining land use.

18. The Lessee, at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged disturbed or displaced land monuments (section corners, 1/4 corners, etc.)

their accessories and appendages (witness trees, bearing trees, etc.) or restore them to their original condition and location, or at other locations that meet the requirements of the land net. This work shall be conducted at the expense of the Lessee, by a professional land surveyor registered in the State of Utah, and to the standards and guidelines found in the Manual of Surveying Instructions, United States Department of the Interior.

19. The Lessee at their expense will be responsible to replace any surface water identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses.

<hr/>	
	The United States of America
<u>U. S. Fuel Co.</u>	By
Company or Lessee Name	
<u></u>	ROBERT LOPEZ
(Signature of Lessee)	(Signing Officer)
<u>Vice Pres of Coal Mgmt.</u>	Chief, Minerals
(Title)	Adjudication Section
<u>May 24, 1985</u>	(Title)
(Date)	SEP 05 1985
	(Date)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statement or representations as to any matter within its jurisdiction.

This form does not constitute an information collection as defined by 44 U.S.C. 3502 and therefore does not require OMB approval.

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