1988
VEGETATION MONITORING
REPORT

UTAH POWER AND LIGHT COMPANY

MINING DIVISION
PERMITTING AND COMPLIANCE
HUNTINGTON, UTAH 84528

PREPARED BY:

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SCOPE

The following is a report of vegetation monitoring and revegetation work which occurred at the coal mine properties operated by the Utah Power and Light Company - Mining Division. The report discusses activities completed during 1988 at the Deer Creek, Cottonwood/Wilberg and Des-Bee-Dove mine properties.

1988 VEGETATION MONITORING REPORT

INTRODUCTION

A general description of the Utah Power & Light Company coal mine properties can be found in the 1987 Vegetation Monitoring Report.

Monitoring during 1988 included qualitative surveys at areas of interim revegetation and quantitative sampling at final revegetation sites. The areas monitored are those identified in the 1987 report.

Additional interim revegetation work was completed in 1988. This is discussed later in this report.

METHODS

Qualitative surveys involved site visits at each interim revegetation area. Observations were made to assess the general conditions of each area. Items of concern were noted i.e. erosion, insect or animal damage, etc.

Quantitative sampling, at the final reclamation sites and associated reference areas, included cover, frequency and woody plant density. Cover estimates were made using occular methods with meter square quadrats.

Species composition and relative frequency were

also assessed from the quadrats. The quadrats were randomly located throughout the areas.

Density of woody plant species was recorded using the point-quarter method as described in the Division's Guidelines. Sample points were randomly placed at the sites. The area at each point was divided into quarters based on lines in the four (4) cardinal directions, (N-S, E-W).

Statistical adequacy for sample size for cover and density was determined by the following formula:

$$n_{min} = t^2 s^2 / (d\bar{x})^2$$

Where: n_{min} = minimum sample size,

t = t - value for a 1-tailed test,

s = standard deviation

d = allowable change in sample mean (10%),

$\bar{x}$ = sample mean.

Sample sizes were tested at the 90 percent confidence level with a 10 percent error of the mean.

Shrub density was determined by the following equations:

$$A_j = \left(\frac{\Sigma Y_i}{4}\right)^2$$

$$D = 43{,}560 \div \frac{\Sigma A_j}{n}$$

Where: Y_i = distance from point to nearest plant in the i^{th} quarter.

A_j = mean area/plant at the j^{th} point.

n = sample size (number of points sampled).

D = plants/acre.

Shrub composition based on density was determined by the following formula:

$$C_i = S_i / T;\ T = \Sigma S_i = (4)n;\ D_i = (C_i)(D)$$

Where: C_i = shrub composition for i^{th} species,

S_i = total individuals of the i^{th} species,

T = total number of shrubs sampled,

D_i = density of i^{th} species,

D = total shrub density.

A students t-test of sample means was used to compare the final reclamation sites and the reference areas.

RESULTS

Interim Revegetation Monitoring

Cottonwood/Wilberg - 9th East Road

General appearance of site is good. Vegetation is well established. Evidence of deer and lagomorph activity was observed, but no serious impact has resulted.

Cottonwood/Wilberg - 4th East Road

Vegetation establishment is excellent. Some evidence of grazing evident, but no serious impact has occurred. Some impact resulting from foot traffic has occurred. This will be monitored to

determine if impact is detrimental.

Cottonwood/Wilberg - Waste Rock Sites

Vegetation establishment is good in most areas. Much evidence of grazing by deer and rabbits. Vegetation in some areas is sparse. Soil sampling will be conducted in these areas, in 1989, if vegetation has not improved.

Cottonwood Fan Portal Area - Subsoil Storage

Vegetation establishment is excellent. Site is in very good condition.

Cottonwood Fan Portal Area - Topsoil Storage

Excellent vegetation establishment. Straw bales in need of replacement at toe of topsoil pile.

Des-Bee-Dove - Beehive Substation

General appearance of site is good. Some erosion occurring. This will be monitored.

Des-Bee-Dove - Bathhouse Slope

Area generally appears in good condition. Some evidence of deer and rabbit grazing.

Des-Bee-Dove - Material Yard Slope

Good vegetation establishment. Evidence of deer and rabbit grazing. This will be monitored. Erosion occurring along half-round culvert needs to be repaired.

Des-Bee-Dove - Haul Road Bench

Vegetation establishment is fair. Many "weed"

species present. Extremely difficult site to achieve revegetation (mancos shale). Evidence of deer activity. Erosion occurring at several locations will be monitored.

Des-Bee-Dove - Sediment Pond Area

Vegetation establishment is fair. Evidence of deer and rabbit activity present. Chuckars have been observed on the site. No detrimental impacts.

Deer Creek - Deer Canyon

Site is in good condition. Vegetation establishment is good. Evidence of deer use but no serious impact has occurred.

Deer Creek - Pipeline

General appearance is good. Vegetation establishment is good. Much evidence of deer use, particularly at northern portion of area.

Final Revegetation Monitoring

Cottonwood Fan Portal - Reclaimed Slope (see Tables 1-3)

The site is in excellent condition with vegetation well established. Total living cover is 29.26 percent with total cover of 55.28 percent. Production is estimated at 1658 lbs/acre dried weight. Vegetation consists primarily of grasses

and shrubs. Woody plant density is estimated at 1139 plants/acre. Evidence of use of the area by deer, rabbits and livestock is present but no adverse impacts have occurred.

Cottonwood Fan Portal - Reference Area (see Tables 4-6)

The reference area appears to be in good condition. Total living cover is 22.38 percent with total cover at 56.60 percent. Production is estimated at 1060 lbs/acre. Woody plant density is estimated at 1170 plants/acre. Evidence of deer use is present but no serious impact has occurred. No impact from mans activities is evident. A comparison of the reclaimed slope and the reference area appears to indicate that revegetation standards of success have been achieved (Table 7).

Cottonwood/Wilberg Mine - Reclaimed Fan Road (Tables 8-10)

The site is in excellent condition. Vegetation is well established and vigorous. Total living cover is 39.87 percent with total cover at 76.23 percent. Production is estimated at 1785 lbs/acre dried weight. Vegetative cover is composed primarily of forbs (46.29%) and shrubs (30.76%) with grasses comprising 22.94 percent. Woody plant density is estimated at 7723 plants/acre.

Evidence of use by wildlife is present but no detrimental impacts are occurring.

Cottonwood/Wilberg Mine - Reference Area (Tables 11-13)

The mine reference area appears in good condition. Total living cover is 28.66 percent with total cover at 62.60 percent. Production is estimated at 1193 lbs/acre dried weight. Woody plant density is estimated to be 1181 plants/acre. Use of the area by deer is evidenced but no serious impact is resulting.

A comparison of the reclaimed road and the mine reference area indicates that revegetation success standards have been achieved (Table 14).

Copies of the vegetation monitoring field notes can be found in the Appendix.

Interim Revegetation (1988)

Additional interim revegetation work was completed during 1988 at various locations (see accompanying maps). This work was completed in November. The areas were hydroseeded using the methods, seed mixes and fertilizer application rates described in the MRPs.

Infrared Aerial Photography

Infrared aerial photographs were taken September 30, 1987. The entire mine property was covered. Additional photography will be conducted once during each permit period (5 years) during mining. The information is available at the Mining Division offices in Huntington, Utah.

TABLES

TABLE 1

COTTONWOOD FAN PORTAL
RECLAIMED SLOPE
COVER AND COMPOSITION

	MEAN COVER (%)	STANDARD DEVIATION	SAMPLE SIZE
COVER			
Total Living Cover (1)	29.26	14.75	50
Litter	13.94	11.78	50
Rock	12.08	9.35	50
Bare Ground	44.72	22.23	50
COMPOSITION			
Grasses	84.81	25.10	50
Forbs	3.00	11.36	50
Shrubs/Trees	12.19	23.31	50

(1) Sample size insures 90% accuracy within 10% of true mean.

TABLE 2

COTTONWOOD FAN PORTAL
RECLAIMED SLOPE
COVER BY SPECIES

SPECIES	MEAN COVER%	STANDARD DEVIATION	RELATIVE FREQUENCY	SAMPLE SIZE
GRASSES				
Agropyron cristatum	4.06	3.75	86.00	50
Elymus cinereus	13.68	9.95	90.00	50
Agropyron spp.	6.22	4.96	96.00	50
Oryzopsis hymenoides	0.08	0.34	12.00	50
Bromus inermis	0.12	0.59	12.00	50
FORBS				
Hedysarum boreale	0.02	0.14	6.00	50
Tragopogon spp.	-	-	2.00	50
Melilotus officinalis	-	-	4.00	50
Aster chilensis	1.50	6.09	10.00	50
Salsola kali	-	-	4.00	50
Halogeton glomeratus	-	-	4.00	50
SHRUBS/TREES				
Atriplex canescens	1.26	4.91	12.00	50
Atriplex confertifolia	0.36	2.55	4.00	50
Artemisia tridentata	1.92	5.70	20.00	50
Chrysothamnus viscidiflorus	0.04	0.28	4.00	50

TABLE 3

COTTONWOOD FAN PORTAL
RECLAIMED SLOPE
WOODY PLANT DENSITY

SPECIES	COMPOSITION, %	DENSITY, #/ACRE(1)
Artemesia tridentata	66	752
Atriplex canescens	15	171
Atriplex confertifolia	10	114
Chrysothamnus viscidiflorus	9	102
TOTAL	100	1139

(1) Sample size insures 90% accuracy within 10% of the true mean.

TABLE 4

COTTONWOOD FAN PORTAL
REFERENCE AREA
COVER AND COMPOSITION

	MEAN COVER (%)	STANDARD DEVIATION	SAMPLE SIZE
COVER			
Total Living Cover (1)	22.38	10.77	40
Litter	15.15	13.04	40
Rock	19.07	12.11	40
Bare Ground	43.40	16.68	40
COMPOSITION			
Grasses	84.91	20.35	40
Forbs	0.66	2.38	40
Shrubs/Trees	14.43	20.39	40

(1) Sample size insures 90% accuracy within 10% of true mean.

TABLE 5

COTTONWOOD FAN PORTAL
REFERENCE AREA
COVER BY SPECIES

SPECIES	MEAN COVER%	STANDARD DEVIATION	RELATIVE FREQUENCY	SAMPLE SIZE
GRASSES				
Elymus salinus	18.02	10.13	100.00	40
Agropyron spp.	0.95	2.19	17.50	40
Oryzopsis hymenoides	0.32	0.69	32.50	40
FORBS				
Aster spp.	0.15	0.53	20.00	40
Galium spp.	-	-	12.50	40
Cryptantha spp.	-	-	12.50	40
Cirsium spp.	0.10	0.63	2.50	40
SHRUBS/TREES				
Berberis repens	0.75	1.68	32.50	40
Chrysothamnus viscidiflorus	1.53	4.93	15.00	40
Eriogonum corymbosum	0.13	0.56	10.00	40
Amelanchier alnifolia	0.28	1.26	5.00	40
Ephedra viridis	0.10	0.50	5.00	40
Atriplex confertifolia	0.05	0.32	2.50	40

TABLE 6

COTTONWOOD FAN PORTAL
REFERENCE AREA
WOODY PLANT DENSITY

SPECIES	COMPOSITION, %	DENSITY, #/ACRE(1)
Chrysothamnus viscidiflorus	34	398
Berberis repens	21	246
Amelanchier alnifolia	12	140
Ephedra viridis	11	128
Pinus edulis	9	105
Juniperus scopulorum	4	47
Eriogonum corymbosum	4	47
Atriplex confertifolia	4	47
Rosa woodsii	1	12
TOTAL	100	1170

(1) Sample size insures 90% accuracy within 10% of the true mean.

TABLE 7

COTTONWOOD/WILBERG MINE
COTTONWOOD FAN PORTAL
COMPARISON OF REFERENCE AREA AND RECLAIMED SLOPE

TOTAL LIVING COVER

	REFERENCE AREA	RECLAIMED SLOPE
Mean Percent Cover ($\bar{x}$)	22.38	29.26
Variance (s^2)	115.93	217.58
Sample Size (n)	40	50
n_{min}	39.35	42.95

Assumed t = 1.665; Two tail test at 90% confidence with df = 88,

$$df = (n_1 + n_2 - 2)$$

$$t = \bar{x}_1 - \bar{x}_2 \Big/ \sqrt{\frac{s^2}{n_1}1 - \frac{s^2}{n_2}2}$$

$$t = 5.710$$

Significant difference if calculated t ≥ 1.665.

WOODY PLANT DENSITY

	REFERENCE AREA	RECLAIMED SLOPE
Density, #/acre	1170	1139
Mean area per plant	37.22	38.24
Sample size	40	35
n_{max}	40	40
n_{min}	50.66	32.82

The woody plant distribution in the reference is highly variable. The maximum number of samples recommended by DOGM Guidelines (40) is not sufficient to account for the variability.

TABLE 8

COTTONWOOD/WILBERG MINE
RECLAIMED FAN ROAD
COVER AND COMPOSITION

	MEAN COVER %	STANDARD DEVIATION	SAMPLE SIZE
COVER			
Total Living Cover (1)	39.87	16.31	30
Litter	16.87	11.92	30
Rock	17.50	14.62	30
Bare Ground	23.77	17.14	30
COMPOSITION			
Grasses	22.94	20.38	30
Forbs	46.29	36.51	30
Shrubs/Trees	30.76	37.04	30

(1) Sample size insures 90% accuracy within 10% of true mean.

TABLE 9

COTTONWOOD/WILBERG MINE
RECLAIMED FAN ROAD
COVER BY SPECIES

SPECIES	MEAN COVER %	STANDARD DEVIATION	RELATIVE FREQUENCY	SAMPLE SIZE
GRASSES				
Elymus salinus	5.37	5.22	86.67	30
Oryzopsis hymenoides	0.90	1.92	26.67	30
Elymus cinereus	0.50	1.38	13.33	30
Agropyron smithii	0.47	1.25	20.00	30
Agropyron dasystacium	0.36	1.50	10.00	30
Bromus spp.	0.13	0.43	10.00	30
Agropyron cristatum	0.13	0.73	3.33	30
Sitanion hystrix	0.06	0.36	6.67	30
FORBS				
Aster chilensis	16.70	17.19	73.33	30
Linum lewisii	0.90	1.40	70.00	30
Machaeranthera canescens	0.27	1.05	20.00	30
Erodium cicutarium	0.13	0.57	6.67	30
Cirsium spp.	-	-	6.67	30
Salsola kali	-	-	6.67	30
Hedysarum boreale	-	-	3.33	30
Tragopogon spp.	-	-	3.33	30
SHRUBS/TREES				
Chrysothamnus viscidiflorus	11.30	18.19	60.00	30
Atriplex confertifolia	2.37	7.32	16.67	30
Eriogonum corymbosum	0.17	0.91	6.67	30
Ribes spp.	0.10	0.55	3.33	30
Artemisia tridentata	-	-	3.33	30

TABLE 10

COTTONWOOD/WILBERG MINE
RECLAIMED FAN ROAD
WOODY PLANT DENSITY

SPECIES	COMPOSITION, %	DENSITY, #/ACRE(1)
Chrysothamnus viscidiflorus	81	6256
Eriogonum corymbosum	10	772
Atriplex confertifolia	9	695
TOTAL	100	7723

(1) Sample size insures 90% accuracy within 10% of true mean.

TABLE 11

COTTONWOOD/WILBERG MINE
REFERENCE AREA
COVER AND COMPOSITION

	MEAN COVER %	STANDARD DEVIATION	SAMPLE SIZE
COVER			
Total Living Cover (1)	28.66	11.85	35
Litter	19.51	15.66	35
Rock	14.43	12.02	35
Bare Ground	37.40	17.63	35
COMPOSITION			
Grasses	55.13	25.14	35
Forbs	11.80	15.71	35
Shrubs/Trees	33.07	26.62	35

(1) Sample size insures 90% accuracy within 10% of true mean.

TABLE 12

COTTONWOOD/WILBERG MINE
REFERENCE AREA
COVER BY SPECIES

SPECIES	MEAN COVER %	STANDARD DEVIATION	RELATIVE FREQUENCY	SAMPLE SIZE
GRASSES				
Elymus salinus	14.17	8.88	97.10	35
Oryzopsis hymenoides	0.60	1.42	22.90	35
Agropyron spicatum	0.31	0.96	14.30	35
FORBS				
Hedysarum occidentale	1.69	3.94	20.00	35
Galium spp.	0.74	1.62	31.40	35
Machaeranthera canescens	0.23	0.60	17.10	35
Aster spp.	0.08	0.37	14.30	35
Penstemon spp.	0.08	0.28	14.30	35
SHRUBS/TREES				
Chrysothamnus viscidiflorus	3.31	6.12	34.30	35
Pinus edulis	2.46	4.46	31.40	35
Amelanchier alnifolia	1.80	4.71	37.10	35
Eriogonum corymbosum	1.49	3.28	25.70	35
Pseudotsuga menziesii	1.26	4.55	11.40	35
Juniperus osteosperma	0.23	0.97	5.70	35
Atriplex confertifolia	0.20	0.68	8.60	35

TABLE 13

COTTONWOOD/WILBERG MINE
REFERENCE AREA
WOODY PLANT DENSITY

SPECIES	COMPOSITION, %	DENSITY #/ACRE(1)
Amelanchier alnifolia	34	406
Pinus edulis	28	325
Chrysothamnus viscidiflorus	11	133
Gutierrezia sarothrae	5	59
Leptodactylon spp.	4	52
Atriplex confertifolia	4	44
Pseudotsuga menziesii	4	44
Abies concolor	3	37
Pinus flexilis	2	30
Eriogonum corymbosum	2	22
Artemisia tridentata	1	15
Ribes spp.	1	7
Physocarpus spp.	1	7
TOTAL	100	1181

TABLE 14

COTTONWOOD/WILBERG MINE-
RECLAIMED FAN ROAD
COMPARISON OF REFERENCE AREA AND RECLAIMED ROAD

TOTAL LIVING COVER

	REFERENCE AREA	RECLAIMED ROAD
Mean Percent Cover ($\bar{x}$)	28.66	39.87
Variance (s^2)	140.41	265.91
Sample Size (n)	35	30
n_{min}	29.32	28.71

Assumed t = 1.670; Two tail test at 90% confidence with df = 63,

$$df = (n_1 + n_2 - 2)$$

$$t = \bar{x}_1 - \bar{x}_2 \Big/ \sqrt{\frac{s^2}{n_1}1 - \frac{s^2}{n_2}2}$$

$$t = 5.091$$

Significant difference if calculated $t \geq 1.670$.

WOODY PLANT DENSITY

	REFERENCE AREA	RECLAIMED ROAD
Density, #/acre	1181	7723
Mean area per plant	36.89	5.64
Sample size	40	20
n_{min}	39.80	18.13

APPENDIX

VEGETATION SAMPLING

LOCATION: Cottonwood Fan Portal / Reclaimed Slope DATE: 9-24-[illegible]

SLOPE: _____ EXPOSURE: _____ SAMPLER: [illegible] Pg 1

RECORDER: [illegible]

	SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X̄/S	VAR FREQ
GRASSES	Agropyron cristatum	9	7	5	–	–	4	5	10	5	18	2	–	–	7	–	3	5	7	3	4		
	Elymus cinereus	11	9	25	30	35	25	15	35	25	28	7	–	–	13	8	12	13	18	12	22		
	Agropyron sp.	10	–	–	2	4	3	10	5	3	15	12	4	4	12	5	18	23	4	5	12		
	Oryzopsis hymenoides		–	–	–	T	–	–	–	–	–	–	T	T	–	–	–	–	–	–	–		
	Bromus inermis																	–	–				
FORBS	Helyspermum boreale	1						T															
	Tragopogon sp.	T																					
	Melilotis officinale								T														
	Aster chilensis											1											
SHRUBS/TREES	Atriplex canescens							5							2					8			
	Artemisia tridentata																1						

																							VAR = 189.80
TOTAL LIVING COVER	31	16	30	22	34	32	35	50	33	61	22	4	4	34	13	34	41	29	28	38	30.30 / 13.78	n_{min} = 36-46
LITTER	20	3	10	10	30	8	45	12	15	12	10	4	12	20	9	27	13	12	22	25		
BARE GROUND	34	76	40	49	28	35	19	28	37	20	50	10	69	35	71	26	40	50	27	9		
ROCK	15	5	20	9	3	25	1	10	15	7	18	22	15	11	7	12	6	9	23	28		
GRASSES	96.8	100	100	100	100	100	85.7	100	100	100	95.5	100	100	94.1	100	97.1	100	100	71.4	100		
FORBS	3.2	0	0	0	0	0	0	0	0	0	4.5	0	0	0	0	0	0	0	0	0		
SHRUBS/TREES	0	0	0	0	0	0	14.3	0	0	0	0	0	0	5.9	0	2.9	0	0	28.6	0		

NOTES:

$n_{min} = \frac{(t)^2 (var)}{[(.1)\bar{x}]^2}$

VEGETATION SAMPLING

LOCATION: COTTONWOOD FAN PORTAL / RECLAIMED SLOPE DATE: 9-25-81

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP RECORDER: VP Pg-2

	SPECIES	SAMPLE NUMBERS 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	$\bar{X}$/s	VAR FREQ
GRASSES	Ag cr	5	3	T	T	1	2	-	3	5	1	7	1	T	11	-	5	2	3	1	3		
	El ci	11	8	T	4	-	14	18	9	25	30	8	-	T	8	-	26	7	14	17	9		
	Ag sp.	1	15	1	9	2	4	2	12	9	8	4	2	2	3	5	3	9	4	3	1		
	Oryzopsis hymenoides	-	-	T	1	-	-	1	-	-	-	-	-	-	-			-	-	-	-		
	Bromus inermis	-	-			-		-	-		-	-	T		-	-	-	T	-	-	1		
FORBS	He loo				T																		
	Tr sp.																						
	Me of				T																		
	As ch	20				T																	
	Salsoli kali	T																					
	Halogeton glomerata																				T		
SHRUBS/TREES	At ca				T									21							27		
	Ar tr	8	3	2					3							24	21		25				
	Chrysothamnus sp.				M	T																	
	Atriplex confertifolia						E	T												18			
			-																				

TOTAL LIVING COVER	45	29	3	14	3	20	21	27	39	39	19	3	23	22	29	56	18	46	39	41	28.525/14.326	VAR 205.23
LITTER	45	8	1	5	2	5	3	9	13	4	5	1	40	3	22	29	10	11	32	42		
BARE GROUND	6	61	81	71	75	37	36	57	21	30	70	88	26	66	24	13	70	31	25	8		
ROCK	4	2	15	10	20	38	40	7	29	27	6	8	11	9	25	4	2	12	4	9		
GRASSES	37.8	89.7	33.3	100	100	100	100	88.9	100	100	100	100	8.7	100	17.2	61.8	100	45.7	53.8	34.1		
FORBS	44.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
SHRUBS/TREES	17.8	10.3	66.7	0	0	0	0	11.1	0	0	0	0	91.3	0	82.8	38.2	0	54.3	46.2	65.9		

NOTES:

$$n_{min} = \frac{(1.304)^2 (205.23)}{(2.852)^2}$$

VEGETATION SAMPLING

LOCATION: Cottonwood Fan Portal / Reclaimed Slope DATE: Sept 26, 86

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP RECORDER: VP

Pg 3

	SPECIES	SAMPLE NUMBERS 41	42	43	44	45	46	47	48	49	50	11	12	13	14	15	16	17	18	19	20	X̄ / S	VAR / FREQ
GRASSES	Ag cr	3	7	7	4	11	3	5	4	11	1											4.00 / 3.75	14.10 / 10 80.0
	El ci	19	21	17	2	6	21	11	27	7	2											13.60 / 9.95	98.92 / 10 90.0
	Ag sp.	4	13	9	2	3	5	7	7	8	3											6.22 / 4.96	24.62 / 10 90.0
	Or hy	-	2	-	-	-	-	-	-	-	-											0.09 / 0.34	0.12 / 6 12.0
	Br in	-	-	-	-	4	1	-	T		-											0.12 / 0.59	0.35 / 10 12.0
FORBS	He bo																					0.02 / 0.14	0.02 / 3 6.0
	Tr sp.																						1 2.0
	Me of																						2 4.0
	As ch			33				21			-											1.50 / 6.09	37.11 / 5 10.0
	Sa ka										T												2 4.0
	Ha gl							T			T												2 4.0
SHRUBS/TREES	At ca																					1.26 / 4.91	24.16 / 10 12.0
	Ar tr					6					3											1.92 / 5.70	32.44 / 10 20.0
	Ch sp.				2																	0.04 / 0.28	0.08 / 2 4.0
	At co																					0.36 / 2.55	6.48 / 2 4.0
	TOTAL LIVING COVER	26	43	66	10	30	30	44	38	26	9											29.26 / 14.75	VAR = 217.5
	LITTER	14	11	8	3	7	20	4	16	3	2											13.94 / 11.78	VAR = 138.7
	BARE GROUND	42	41	19	79	58	47	49	42	68	82											44.72 / 22.23	VAR = 494.35
	ROCK	18	5	7	8	5	3	3	4	3	7											12.08 / 9.35	VAR = 87.42
	GRASSES	100	100	50.0	80.0	80.0	100.0	52.3	100.0	100.0	66.7											84.81 / 25.10	VAR = 630.00
	FORBS	0	0	50.0	0	0	0	47.7	•	•	0											3.00 / 11.36	VAR = 129.1
	SHRUBS/TREES	0	0	0	20.0	20.0	0	0	•	•	33.3											12.19 / 23.31	VAR = 543.1

n_{min} = 42.95

NOTES:

VEGETATION SAMPLING
DENSITY

LOCATION: Cottonwood Fan Portal Reclaimed Slope DATE: Sept. 29, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE (FT)	HEIGHT (IN)	~~DBH~~ ΣY_i	A_j $(\frac{\Sigma Y_i}{4})^2$
1	1	Artr	10.6	12		
1	2	Artr	6.6	12		
1	3	Atco	2.1	6		
1	4	Artr	7.7	24	27	45.56
2	1	Atco	9.2	~~29~~ 19		
2	2	Artr	6.3	12		
2	3	Artr	13.8	~~13~~ 15		
2	4	Artr	0.3	12	29.6	54.76
3	1	Artr	2.0	30		
3	2	Artr	3.0	36		
3	3	Atco	4.3	36		
3	4	Artr	3.6	30	12.9	10.40
4	1	Artr	4.6	36		
4	2	Artr	6.7	48		
4	3	Chvi	1.2	12		
4	4	Artr	4.3	36	16.8	17.64

VEGETATION SAMPLING
DENSITY

LOCATION: Grand Fan Portal / Reclaimed Slope DATE: 9-24-YY

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	~~DBH~~ ΣY_i	$(\frac{\Sigma Y_i}{4})^2$ A_j
1	1	Artr	9.0	24		
1	2	Atca	6.7	40		
1	3	Artr	5.6	24		
1	4	Artr	3.3	26	24.6	37.82
2	1	Atca	7.0	36		
2	2	Artr	3.8	36		
2	3	Atca	17.0	48		
2	4	Ch.vi	0.9	18	28.7	51.48
3	1	Atco	1.8	6		
3	2	Atca	3.7	48		
3	3	Atco	11.6	12		
3	4	Atca	5.5	12	22.6	31.92
4	1	Atco	1.9	9		
4	2	Atca	11.6	40		
4	3	Artr	7.5	30		
4	4	Artr	6.0	30	29.0	52.56

VEGETATION SAMPLING DENSITY

LOCATION: Cttnwd - Fan Portal Reclaimed Slope DATE: 9-24-88

SLOPE: ______ EXPOSURE: ______ SAMPLER: MP RECORDER: MP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	~~DBH~~ ΣY_i	$(\frac{\Sigma Y_i}{4})^2$ A_j
1	1	Atca	7.7	36		
1	2	Atco	11.2	7		
1	3	Ltir	5.6	15		
1	4	Artr	9.0	48	33.5	70.14
2	1	Artr	6.7	30		
2	2	Artr	6.7	30		
2	3	Ch vi	5.7	6		
2	4	Atco	6.5	12	25.8	41.60
3	1	Ch vi	7.5	45		
3	2	Artr	5.2	36		
3	3	Artr	5.3	36		
3	4	Atca	9.0	40	27	45.56
4	1	Artr	4.2	18		
4	2	Artr	5.6	24		
4	3	Artr	10.7	24		
4	4	Ch vi	3.8	30	24.3	36.90

VEGETATION SAMPLING
DENSITY

LOCATION: CWEP Rec. Slope DATE: 9-24-81

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP
RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH ΣY_i	$(\frac{\Sigma Y_i}{4})^2 = A_i$
13 1	1	Ar tr	12.4	15		
13 1	2	Ar tr	3.3	24		
13 1	3	Ar tr	9.7	12		
13 1	4	Ar tr	5.1	12	30.5	58.14
14 2	1	Ar tr	4.7	30		
14 2	2	Ar tr	6.7	16		
14 2	3	Ar tr	10.2	24		
14 2	4	Ar tr	3.8	12	25.4	40.32
15 3	1	At ca	3.2	36		
15 3	2	Ar tr	3.0	30		
15 3	3	At co	3.9	12		
15 3	4	Ar tr	3.6	6	13.7	11.73
16 4	1	At ca	7.7	18		
16 4	2	Ar tr	3.9	12		
16 4	3	At ca	2.9	20		
16 4	4	At ca	1.3	24	15.8	15.60

VEGETATION SAMPLING
DENSITY

LOCATION: GNWD Fan Patch / Rec ~~Area~~ Slope DATE: 9-24-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	~~DBH~~ Σy_i	$\left(\frac{\Sigma y_i}{4}\right)^2 = A_i$
1	1	Artr	8.1	12		
1	2	Artr	11-7	20		
1	3	Atc2	2.6	8		
1	4	Artr	1.8	16	24.2	36.60
2	1	Artr	1-1	30		
2	2	Artr	11-1	12		
2	3	Artr	5.6	12		
2	4	Artr	10-4	20	28.2	49.70
3	1	Atco	10-4	12		
3	2	Artr	5.1	6		
3	3	Artr	5.6	10		
3	4	Atc2	11-9	24	33	68.06
4	1	Chvi	6.9	15		
4	2	~~Atr~~ Artr	2.8	30		
4	3	Artr	1.8	16		
4	4	Artr	5.9	12	17.4	18.92

VEGETATION SAMPLING DENSITY

LOCATION: Runoff Rec. Slope DATE: 9.25 (

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH ΣY_i	$\left(\frac{\Sigma Y_i}{4}\right)^2 = A_j$
21	1	Ar tr	2.1	24		
21	2	At co	6.1	18		
21	3	Ar tr	10.0	6		
21	4	Ar tr	4.5	6	22.7	32.21
22	1	Ar tr	2.8	15		
22	2	Ar tr	4.9	10		
22	3	At. co	3.9	6		
22	4	At co	3.3	24	14.9	13.88
23	1	At co	5.0	18		
23	2	Ch. ~~sp~~ vi	6.2	5		
23	3	At co.	1.3	8		
23	4	Ar tr	3.9	6	16.4	16.81
24	1	Ar tr	9.0	20		
24	2	Ar tr	1.2	12		
24	3	At co	2.9	10		
24	4	Ar tr	7.8	12	20.9	27.30

VEGETATION SAMPLING
DENSITY

LOCATION: CWFP Rec. Slope DATE: 9-25-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	~~DBH~~ Σ Aj	Aj
1	1	Artr	9.4	24		
1	2	Artr	7.9	18		
1	3	Artr	5.0	12		
1	4	Artr	1.2	12	23.5	34.52
2	1	Artr	9.7	30		
2	2	Artr	7.6	24		
2	3	Artr	2.5	24		
2	4	Artr	8.3	15	28.1	49.35
3	1	Artr	4.6	20		
3	2	Artr	12.5	16		
3	3	Artr	3.4	24		
3	4	Atco	5.1	12	25.6	40.96
4	1	Artr	4.3	30		
4	2	Atco	10.5	36		
4	3	Artr	5.2	10		
4	4	Artr	8.4	12	28.4	50.41

VEGETATION SAMPLING
DENSITY

LOCATION: CwFP Rec. Loop DATE: 9-25-[illegible]

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP
RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	~~DBH~~ ΣY_i	A_j
129	1	Artr	5.5	?		
129	2	Artr	5.9	24		
129	3	Artr	1.7	12		
129	4	Artr	2.5	12	15.6	15.21
230	1	Artr	2.7	18		
230	2	Artr	4.4	30		
230	3	Artr	7.5	10		
230	4	Artr	11.6	18	26.2	42.90
31	1	Atco	6.5	6		
31	2	Artr	2.5	20		
31	3	Ch ~~sp~~ vi	3.5	16		
31	4	Atco	5.0	10	17.5	19.14
432	1	Ch ~~sp~~ vi	3.0	24		
432	2	Artr	10.5	15		
432	3	Artr	7.0	40		
432	4	Artr	5.2	36	25.7	41.28

VEGETATION SAMPLING
DENSITY

Pg 9

LOCATION: Ctrwd Fan Portal
Rec. Slope

DATE: 9-25-88

SLOPE: ________ EXPOSURE: ________ SAMPLER: VP
RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH Σy_i	A_j
133	1	Artr	13.0	28		
133	2	Artr	7.3	20		
133	3	Artr	3.2	8		
133	4	Artr	2.7	12	26.2	42.90
234	1	Artr	9.8	6		
234	2	Atco	1.3	8		
234	3	Chspvi	3.5	16		
234	4	Chspvi	2.8	12	27.4	46.92
35	1	Chspvi	8.6	28		
35	2	Artr	4.3	20		
35	3	Artr	12.2	16		
35	4	Artr	8.2	24	33.3	69.31
436	1					
436	2					
436	3					
436	4					

VEGETATION SAMPLING

LOCATION: Cottonwood/Wilberg Mine / Old Fan Road (Reclaimed) DATE: OCT. 8, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: _____

RECORDER: _____

	SPECIES	SAMPLE NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X / S	IAR FREQ
GRASSES	El sp.	13	10		1	6	9	7	1	6			7	11	3	2	2	4	2	1	4		
	Br sp.			1													1						
	Or hy	3				1								5	2						1		
	Ag sm															6		1	-				
	Er ci																		1				
FORBS	Li le	7	2			1	T	1	1	T	1	1	1		T		T	1		T			
	Maca		T		T		T					T											
	Asch						5	12	55	2		19	38	1	T	26	49	26	24	33	30		
	Ci sp.							T									T						
	Tr sp.								T														
	He bo														T								
	Sa ka																		T				
	Er co		T								5												
SHRUBS	Ch sp.		26	75	60	30	20	4	1	21	23	4		11	13	2				1			
	Atco				19										3						1		
	Ri sp.							3															

TOTAL LIVING COVER	23	38	76	80	38	34	27	58	29	29	24	46	26	21	36	52	32	27	35	36		
LITTER	2	20	15	17	35	13	22	16	9	4	7	13	17	7	27	23	7	38	2	9		
BARE GROUND	51	25	2	2	4	16	42	15	38	50	60	4	38	51	26	9	55	32	5	39		
ROCK	18	17	7	1	23	37	9	11	24	17	9	37	19	21	11	16	6	3	58	16		
GRASSES	69.6	26.3	1.3	1.2	18.4	26.5	25.9	1.7	20.7	-	-	15.2	53.8	23.8	22.2	5.8	15.6	7.4	2.9	13.9		
FORBS	30.4	5.3	-	-	2.6	14.7	48.2	96.6	6.9	3.4	83.3	84.8	3.9	-	72.2	94.2	84.9	92.6	94.2	83.3		
SHRUBS	-	68.4	98.7	98.8	79.0	58.8	25.9	1.7	72.9	96.6	16.7	-	42.3	76.2	5.6	-	-	-	2.9	2.8		

NOTES:

VEGETATION SAMPLING

LOCATION: Ctrwd / Wilbury Mine Old Fan Road DATE: Oct. 8, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: _____

RECORDER: _____

	SPECIES	SAMPLE NUMBERS 21	22	23	24	25	26	27	28	29	30	31	32	13	14	15	16	17	18	19	20	$\bar{X}$ / S	S^2 FREQ.
GRASSES	El sa	2	2	16	4	2	2		18	11	15											5.37 / 5.22	27.27 3.6-67
	Br sp.				2																	0.13 / 0.43	0.19 10.0
	Or hy	3						7			7											0.90 / 1.92	3.68 26.67
	Ag sm		2	3	1	1																0.47 / 1.25	1.57 20.00
	El ci		5			2		3		5												0.50 / 1.38	1.91 13.33
	Si hy		2		T																	.06 / 0.36	.13 6.67
	Ag da					1			2	8												0.36 / 1.50	2.24 10.00
	Ag cr								4													0.13 / 0.73	0.53 3.33
FORBS	Erci							3														0.13 / 0.57	0.33 6.67
	Li le			1	1	2	3		2	1	1											0.90 / 1.40	1.96 70.00
	Ma ca							5		3												0.27 / 1.05	1.10 20.00
	Asch	18	16	11	27	52			21	4	32											16.7 / 17.19	295.53 73.33
	Ci sp.																					—	6.67
	Tr sp.																					—	3.33
	Hebo																					—	3.33
	Saka	T																				—	6.67
SHRUBS	Erco																					0.17 / 0.91	0.83 6.67
	Ch sp.			9		6	28				5											11.3 / 18.19	330.84 60.00
	At co						34	14														2.37 / 7.32	53.62 16.67
	Ri sp.																					0.10 / 0.55	0.30 3.33
	Ar tr				T																	—	3.33
	TOTAL LIVING COVER	23	27	40	35	66	67	32	97	32	60											39.87 / 16.31	265.91
	LITTER	9	6	21	27	8	9	52	21	37	13											16.87 / 11.92	142.12
	BARE GROUND	39	10	8	29	17	17	12	19	27	25											23.77 / 17.14	293.70
	ROCK	29	57	31	9	9	7	4	13	4	2											17.50 / 14.62	213.84
	GRASSES	21.7	40.7	47.5	20.0	9.1	3.0	31.5	51.1	75.0	36.7											22.94 / 20.38	415.39
	FORBS	78.3	59.3	30.0	80.0	81.8	4.5	65.0	48.9	25.0	55.0											46.29 / 36.5	1333.25
	SHRUBS	—	—	22.5	—	9.1	92.5	43.7	—	—	8.3											30.76 / 37.04	1371.79

NOTES:

$n_{min} = \frac{(1.311)^2 (265.91)}{(3.99)^2}$

VEGETATION SAMPLING
DENSITY

LOCATION: COTTONWOOD/WILLOWS, OLD FAN ROAD (RECLAIMED) DATE: OCT. 9, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE (ft)	HEIGHT (in)	DBH	ΣV_i	A_j $(\frac{\Sigma V_i}{6})^2$
1	1	Ch ~~sp~~ Vi	3.3	24			
1	2	"	3.2	30			
1	3	"	1.4	6			
1	4	"	1.5	18		9.4	5.52
2	1	"	2.5	4			
2	2	"	1.0	6			
2	3	"	1.2	9			
2	4	"	3.5	9		8.2	4.20
3	1	"	1.3	4			
3	2	Er co	3.0	9			
3	3	Ch vi	1.8	12			
3	4	"	1.3	6		7.4	3.42
4	1	"	2.5	30			
4	2	"	0.8	20			
4	3	"	3.5	24			
4	4	"	4.1	24		10.9	7.42

VEGETATION SAMPLING
DENSITY

5.2

LOCATION: CONWD/WILBORN OLD FAN ROAD DATE: Oct. 9, 1984

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Chvi	2.5	18		
1	2	"	1-3	12		
1	3	Erco	2.5	14		
1	4	Chvi	2-3	15		8.6 4.62
2	1	"	1.5	30		
2	2	Alco	2.8	15		
2	3	Chvi	1.9	24		
2	4	"	2.0	28		8.2 4.20
3	1	"	2.3	30		
3	2	"	2.5	16		
3	3	Erco	1.8	19		
3	4	Chvi	1.8	12		8.4 4.41
4	1	"	2.3	24		
4	2	"	1.5	10		
4	3	"	3.0	10		
4	4	"	2.8	30		9.6 5.76

VEGETATION SAMPLING
DENSITY

LOCATION: Grand/Wilshire OLD FAN ROAD (REC) DATE: 10-9-84

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Chvi	2.8	15		
1	2	"	3.2	6		
1	3	"	3.9	12		
1	4	"	1.0	16		10.9 7.42
2	1	"	3.0	16		
2	2	"	4.3	6		
2	3	"	2.8	6		
2	4	Erco	1.9	6		12.0 9.00
3	1	Chvi	1.8	15		
3	2	"	2.5	15		
3	3	"	3.4	6		
3	4	"	1.9	9		9.6 5.76
4	1	"	3.6	24		
4	2	"	1.7	6		
4	3	"	1.3	20		
4	4	"	1.7	~~6~~		8.3 4.30

VEGETATION SAMPLING
DENSITY

LOCATION: GRAND/WILDERNESS OLD FAT ROAD (ROC) DATE: 10-9-12

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Chvi	3.1	9		
1	2	Erco	4.3	6		
1	3	Erco	4.2	12		
1	4	Chvi	0.9	20		12.5 9.76
2	1	"	3.5	24		
2	2	Erco	2.4	6		
2	3	Chvi	2.3	3		
2	4	"	1.9	9		10.1 6.38
3	1	"	2.4	6		
3	2	"	2.2	6		
3	3	"	2.0	3		
3	4	"	1.1	9		8.3 4.30
4	1	"	2.1	6		
4	2	"	2.5	16		
4	3	Atco	1.9	9		
4	4	Atco	1.4	6		7.9 3.90

VEGETATION SAMPLING. DENSITY

LOCATION: Ctrwd/wilberg Old Pen Road (Rec) DATE: 10-9-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Chvi	1.9	3		
1	2	Atco	1.7	9		
1	3	Chvi	1.6	3		
1	4	Chvi	2.4	9		7.6 3.61
2	1	Erco	3.4	9		
2	2	Chvi	1.1	12		
2	3	"	2.0	18		
2	4	Atco	2.6	24		9.1 5.18
3	1	Atco	3.1	24		
3	2	Atco	2.2	18		
3	3	Chvi	2.4	9		
3	4	"	3.4	28		11.1 7.70
4	1	"	3.4	9		
4	2	"	1.9	12		
4	3	"	2.0	15		
4	4	"	2.5	6		9.8 6.00

$n = 20$ $n-1 = 19$ $n_{min} = \frac{(1.328)^2(3.27)}{(.560)^2}$ $\frac{\Sigma A_i}{n} = \bar{X} = 5.64$

VEGETATION SAMPLING

LOCATION: Wildlife Reference Area DATE: Oct. 1, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP Pg. 1

RECORDER: VP

	SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	$\bar{x}$ % Cover / s	FREQ.
GRASSES	Elymus salinus	9	11	21	8	7	14	13	19	15	9	7	11	14	15	20	21	11	13	15			
	Oryzopsis hymenoides	1							6	1	4					3							
	Agropyron sp.			1		1									2		5						
FORBS	Galium sp.	1		2					3				1		1	1				6			
	Penstemon sp.	1														1			1				
	Aster sp.		1				T								T								
	Ma cd										2			1	2		-	T	1				
	He oc										6	5						14					
SHRUBS/TREES	Chrysothamnus sp.								2					9	6	5	25		3		11		
	Am al	2	T				1	T		2	14		T			2				2			
	Al co	2											2			3							
	Ps me			6			9																
	Juniperus sp.			5																			
	Pinus edulis				5					4		18					9			5	13		
	Eriogonum corymb.	-			7	2					5				2						6		

TOTAL LIVING COVER	16	12	35	20	10	24	13	30	22	40	30	14	24	28	35	60	25	18	22	30	25.7 / 11.60	VAR = 134.64, n_{min} = 35.95
LITTER	7	18	18	5	73	11	21	8	12	12	16	26	8	3	34	18	41	51	9	17		
BARE GROUND	71	44	40	65	10	61	52	25	51	40	26	25	41	64	26	13	19	22	6	38		
ROCK	6	26	7	10	7	4	14	37	15	8	28	35	27	5	5	9	9	9	57	15		
COMPOSITION (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
GRASSES	62.5	91.7	62.9	40.0	80	58.3	100	83.3	72.7	32.5	23.3	78.6	58.3	60.7	65.7	43.3	44	72.2	63.6	-			
FORBS	12.5	8.3	5.7	-	-	-	-	10	-	20	16.7	7.1	4.2	10.7	5.7	41.7	56	11.1	21.4	-			
SHRUBS/TREES	25	-	31.4	60	20	41.7	-	6.7	27.3	47.5	60	14.3	37.5	28.6	28.6	15	-	16.7	25.0	100.0			

NOTES: Hoary Aster = Ma c2 Atriplex confertifol. = At co

Hedysarum occidentali var. canone = He oc Ps me = Doug Fir

$n_{min} = \frac{(1.328)^2 (134.64)}{(2.57)^2}$ $n_{min} = \frac{(t^2)(var)}{(d)^2}$

VEGETATION SAMPLING

LOCATION: Wilberg Ref. Area DATE: Oct 2 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP Pg. 2

RECORDER: VP

	SPECIES	SAMPLE NUMBERS 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		
GRASSES	El sa	19	34	9	28	7	11	5	13	23	4	9	42	R	7	2						14.37/8.88	VAR = 78.85 FREQ = 97.1
	Or hy	1		4											1							0.60/1.42	VAR = 2.01 FREQ = 22.9
	Ag sp.									2					1							0.31/0.96	VAR = 0.93 FREQ = 14.3
FORBS	Ga. sp.	1	1			1						2										0.74/1.62	VAR = 2.61 FREQ = 31.4
	Pe sp.						T							T								0.08/0.28	VAR = 0.08 FREQ = 14.3
	As sp.					2				T												0.08/0.37	VAR = 0.14 FREQ = 14.3
	Mo co	2																				0.23/0.60	VAR = 0.36 FREQ = 17.1
	He oc	5					8					5			16							1.69/3.94	VAR = 15.52 FREQ = 20.0
SHRUBS/TREES	Ch sp.			9		8			21	12						5						3.31/6.12	VAR = 37.40 FREQ = 34.3
	Am al									5				1	12	12						1.80/4.71	VAR = 22.16 FREQ = 37.1
	At co																					0.20/0.68	VAR = 0.46 FREQ = 8.6
	Ps me				4									25								1.26/4.55	VAR = 20.67 FREQ = 11.4
	Ju sp.				3																	0.23/0.97	VAR = 0.95 FREQ = 5.7
	Pi ed			10						3	7	3			9							2.46/4.46	VAR = 19.90 FREQ = 31.4
	Er co	1		6				15	6													1.49/3.28	VAR = 10.79 FREQ = 25.7
	TOTAL LIVING COVER	29	40	40	35	24	19	20	40	45	11	19	42	45	45	35						28.66/11.85	VAR = 140.41 n_{min} = 29.92
	LITTER	33	38	11	21	8	20	7	9	10	22	15	46	18	10	1						19.54/15.66	VAR = 245.32
	BARE GROUND	22	19	41	34	35	55	57	31	25	59	58	10	30	40	54						37.48/17.63	VAR = 310.95
	ROCK	16	3	8	10	33	6	16	20	20	8	8	2	7	5	10						14.43/12.02	VAR = 144.56
	% COMPOSITION	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100							
	GRASSES	69	97.5	32.5	80	29.2	57.9	25	32.5	55.6	36.4	47.4	100	42.2	17.8	22.9						55.13/25.14	VAR = 632.14
	FORBS	27.6	2.5	—	—	37.5	42.1	—	—	—	—	36.8	—	—	35.5	—						11.80/15.71	VAR = 246.85
	SHRUBS/TREES	3.4	—	67.5	20	33.3	—	75	67.5	44.4	63.6	15.8	—	57.8	46.7	77.1						33.07/26.62	VAR = 708.48

NOTES:

$n = 35$ $n_{min} = \frac{(1.307)^2 (140.41)}{(5)^2} = 29.92$

VEGETATION SAMPLING
DENSITY

LOCATION: CTNWR/Willow Ref Area DATE: Oct 2, 1988

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	Ei	Aj
1	1	Pied	1.8	20"			
1	2	Amal	3.8	14			
1	3	Pied	5.6	60			
1	4	Amal	2.8	8		14.0	12.25
2	1	Amal	7.6	100			
2	2	Fir Abco	5.3	2			
2	3	Abco	0.9	6			
2	4	Pifl	4.3	10		18.1	20.48
3	1	Ps me	9.4	14			
3	2	Pied	5.4	55			
3	3	Pied	1.5	20			
3	4	Abco	0.9	22		17.2	18.49
4	1	Amal	9.5 ~~10.2~~	20			
4	2	Pifl	4.4	5			
4	3	Amal	8.9	75			
4	4	Pied	8.7	14		31.5	62.02

VEGETATION SAMPLING
DENSITY

LOCATION: Ctn/W.I Rd Area DATE: 10-2-08

SLOPE: _____ EXPOSURE: _____ SAMPLER: _____
RECORDER: _____

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Ch	2.3	10		
1	2	Amal	4.0	3		
1	3	Pi me	5.3	2		
1	4	Ch	5.8	20		17.9 20.02
2	1	Amal	1.4	3		
2	2	Pi ed	6.2	22		
2	3	Ch	0.9	7		
2	4	Dfco	2.9	5		11.4 8.12
3	1	Abco	10.1		10"	
3	2	Amal	5.8	40		
3	3	Amal	6.7	6		
3	4	~~Amal~~ Guse	~~4.7~~ ~~12.4~~	~~8~~ ~~6~~		27.3 46.58
4	1	Pi ed	6.5	15		
4	2	Amal	7.9	100		
4	3	Amal	7.2	3		
4	4	~~Abco~~ Pifl	9.2	~~50~~ 12		30.8 59.29

VEGETATION SAMPLING
DENSITY

LOCATION: CW/WI Ref Area DATE: 10-2-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP
RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Le sp #3	4.6	5		
1	2	Ch	2.5	15		
1	3	Pied	1.3	8		
1	4	Pied	0.6	3		9.0 5.06
2	1	Ch	3.2	12		
2	2	Ch	5.0	18		
2	3	Amal	4.0	20		
2	4	Ch	4.2	12		16.4 16.81
3	1	Amal	6.2	60		
3	2	Ribes sp.	4.0	4		
3	3	Amal	11.0	12		
3	4	Artr	2.7	6		23.9 35.70
4	1	Pied	11.5	5		
4	2	Amal	11.1	75		
4	3	Gusa ~~Pied~~	3.4 ~~14.2~~	10 ~~5~~	~~5"~~	
4	4	Le sp. #3	6.9	2		32.9 67.65

VEGETATION SAMPLING
DENSITY

4

LOCATION: Cw/wil Rd Area DATE: 10-2-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VT

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Amal	7.1	70		
1	2	Pied	3.2	8		
1	3	Le sp.	7.3	6		
1	4	Pied	5.9	40		23.5 34.52
2	1	Pied	7.2		3	
2	2	Pifl	3.9	6		
2	3	Pied	12.4	20		
2	4	Amal	6.7	35		30.2 57.00
3	1	Pied	3.8	16		
3	2	Pied	22		3	
3	3	Pied	6.9	6		
3	4	Pied	6.9	15		19.8 24.50
4	1	Pied	4.9	30		
4	2	Amal	4.1	3		
4	3	Pied	6.8	22		
4	4	Ph sp.	6.0	14		21.8 29.70

VEGETATION SAMPLING
DENSITY

LOCATION: Gfwil Ck Area DATE: 10-2-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Psme	0.8	6		
1	2	Ch	1-5	8		
1	3	Erco	8-1	12		
1	4	Pied	4.6	16		15.0 14.06
2	1	Erco	6.3	4		
2	2	Pied	2.9	12		
2	3	Amal	6.9	5		
2	4	Pied	4.3	10		20.4 26.01
3	1	Psme	8.0	45		
3	2	Amal	6.1	48		
3	3	Alco	9.2	13		
3	4	Amal	7.2	80		30.5 58.14
4	1	Amal	7.4	95		
4	2	Pied	4.4	8		
4	3	Pied	6.7	10		
4	4	Pied	9.7	10		28.2 49.70

VEGETATION SAMPLING
DENSITY

LOCATION: Cottonwood/Wilbur Mine DATE: 10-3-18
Reference Area

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP
RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Ch sp.	4.8	12		
1	2	Amal	8.9	48		
1	3	Gusa	10.4	7		
1	4	Gusa	3.2	4		27.3 46.58
2	1	Le sp.	11.8	4		
2	2	Gusa	3.5	8		
2	3	Ch sp	6.1	16		
2	4	Gusa	9.1	4		29.5 54.39
3	1	Ch sp	7.5	12		
3	2	Amal	1.6	27		
3	3	Amal	10.0	8		
3	4	Artr	11.1	5		30.2 57.00
4	1	Pied Ch sp	4.7	10		
4	2	Amal	2.1	15		
4	3	Ch sp	4.3	17		
4	4	Atco	3.0	6		14.1 12.48

VEGETATION SAMPLING
DENSITY

LOCATION: Cottonwood/Wilberg Mine Ref. Area. DATE: 10-3-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Amal	10.3	65		
1	2	Atco	11.7	12		
1	3	Pied ~~Amal~~	11.6	24		
1	4	Amal	8.2	10		31.8 63.20
2	1	Pied	3.7	8		
2	2	Amal	6.4	27		
2	3	Amal	4.9	14		
2	4	Amal	5.9	16		20.9 27.30
3	1	Pied	7.1	30		
3	2	Amal	3.9	18		
3	3	Lesp	7.2	4		
3	4	Pied	5.3	15		23.5 34.52
4	1	Pied	7.8	12		
4	2	Amal	6.7	24		
4	3	Atco	9.1	8		
4	4	Amal	3.9	5		27.5 47.26

VEGETATION SAMPLING
DENSITY

C

LOCATION: Cottonwood/Wilbur Mine Ref. Area DATE: 10-3-88

SLOPE: _____ EXPOSURE: _____ SAMPLER: M

RECORDER: M

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Ch sp	6.1	20		
1	2	Pied	3.7	12		
1	3	Amal	6.0	8		
1	4	Pied	4.7	12		20.5 26.26
2	1	Erco	9.0	10		
2	2	Amal	6.4	5		
2	3	Pg me	8.3	8		
2	4	Amal	7.4	30		31.1 60.45
3	1	Ch sp	3.8	5		
3	2	Amal	5.3	10		
3	3	Amal	8.7	24		
3	4	Pied	7.7	5		25.5 40.14
4	1	Atco	3.2	6		
4	2	Pied	5.9	15		
4	3	Amd	7.4	40		
4	4	Ch sp	11.2	12		27.7 47.96

VEGETATION - SHRUB DENSITY

LOCATION: Channel U.I.b. / Ref. Area DATE: 10-3-86

SLOPE: _____ EXPOSURE: _____ SAMPLER: VP

RECORDER: VP

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Amal	6.8	36		
1	2	Ch sp	4.1	8		
1	3	Amal	10.8	10		
1	4	Amal	3.0	4		24.7 38.13
2	1	Pied	8.3	36		
2	2	Amal	4.2	60		
2	3	Pied	5.0	3		
2	4	Gusa	6.7	6		24.2 36.60
3	1	Ch sp	4.2	12		
3	2	Gusa	6.3	8		
3	3	Le sp.	3.9	4		
3	4	Amal	2.4	24		16.8 17.64
4	1	Abco	3.9	48		
4	2	Le sp	4.7	5		
4	3	Amal	5.9	12		
4	4	Amal	6.3	60		20.8 27.04

VEGETATION SAMPLING
DENSITY

LOCATION: Ctwd / W.16. Ref. Area DATE: 10-3-89

SLOPE: _____ EXPOSURE: _____ SAMPLER: WP

RECORDER: WP.

PLOT #	QUADRANT #	SPECIES	DISTANCE	HEIGHT	DBH	
1	1	Amal	11.1	50		
1	2	Pied	7.7	10		
1	3	Amal	8.7	4		
1	4	Pied	5.1	18		32.6 66.42
2	1	Ch.sp	7.8	10		
2	2	Pied	9.3	15		
2	3	Amal	4.7	48		
2	4	Amal	2.8	6		24.6 37.82
3	1	Pied	5.4	36		
3	2	Psme	9.4	18		
3	3	Amal	3.7	60		
3	4	Amal	1.3	8		19.8 24.50
4	1	Pied	2.8	6		
4	2	Pied	6.9	20		
4	3	Amal	8.8	12		
4	4	Amal	7.8	6		26.3 43.23

1989
VEGETATION MONITORING
REPORT

UTAH POWER AND LIGHT COMPANY

MINING DIVISION
PERMITTING AND COMPLIANCE
HUNTINGTON, UTAH 84528

PREPARED BY:

VAL PAYNE

SCOPE

The following is a report of vegetation monitoring and revegetation work which occurred at the coal mine properties operated by the Utah Power and Light Company - Mining Division. The report discusses activities completed during 1989 at the Deer Creek, Cottonwood/Wilberg and Des-Bee-Dove mine properties.

1989 VEGETATION MONITORING REPORT

INTRODUCTION

Monitoring during 1989 included qualitative surveys at areas of interim revegetation and quantitative sampling at final revegetation sites.

METHODS

Qualitative surveys involved site visits at each interim revegetation area. Observations were made to assess the general conditions of each area. Items of concern were noted i.e. erosion, insect or animal damage, etc.

Quantitative sampling methods, at the final reclamation sites and associated reference areas, are discussed in the report for each area.

INTERIM REVEGETATION MONITORING

Cottonwood/Wilberg - 4th East Road

Vegetation establishment is excellent. Grasses dominate the established vegetation. No erosion or other problems have been observed.

Cottonwood Fan Portal Area - Subsoil Storage

Vegetation establishment is excellent. Site is in very good condition.

Cottonwood Fan Portal Area - Topsoil Storage

Excellent vegetation establishment. Strawbales have been

replaced at toe of topsoil pile.

Des-Bee-Dove - Beehive Substation

General appearance of site is good. Some erosion occurring. This will be monitored.

Des-Bee-Dove - Bathhouse Slope

Area generally appears in good condition. Some evidence of deer and rabbit grazing. No erosion problems observed.

Des-Bee-Dove - Material Yard Slope

Good vegetation establishment. Evidence of deer and rabbit grazing. Erosion along half-round culvert has been repaired.

Des-Bee-Dove - Haul Road Bench

Vegetation establishment is improved from 1988. Fewer "weed" species present. Establishment of desirable species appears to be increasing. Extremely difficult site to achieve revegetation (mancos shale). Evidence of deer activity. Erosion occurring at several locations will be monitored.

Des-Bee-Dove - Sediment Pond Area

Vegetation establishment is fair. Evidence of deer and rabbit activity observed.

Deer Creek - Deer Canyon

Site is in good condition. Vegetation establishment is good. Evidence of deer use but no serious impact has occurred.

Deer Creek - Pipeline

General appearance is good. Vegetation establishment is

good. Much evidence of deer use, particularly at northern portion of area.

All Mine Locations - 1988 Revegetation

First year growth varies greatly at the various locations but generally appears good. No concerns were evident.

REVEGETATION - 1989

Deer Creek

Interim revegetation work was completed during 1989 at the Deer Creek Waste Rock Storage Facility. The purpose of the revegetation work is to stabilize the road and berm embankment slopes. The areas were hydroseeded with the seed mixture proposed for final reclamation at the site. (See map CM-10778-DR).

Hydroseeding on a portion of the Deer Creek Mine fan access road was completed in September 1989. (See map DS202E)

Cottonwood/Wilberg

Revegetation of Cells 5 and 6 at the Cottonwood/Wilberg - Des-Bee-Dove Waste Rock Site was completed in November 1989. (See map CM-10361-WB)

VEGETATION TEST PLOTS

Cottonwood/Wilberg

Test plots were established on a fill slope at the mine site to test the final revegetation seed mix. The plots were established in November 1989. The test plots are located northwest of the silo (see map KS1217D). Slope and exposure are

relatively constant throughout the area. Division approval was obtained prior to installation of the test plots. The test plots are designed to test the final revegetation seed mix and plantings under various moisture conditions and mulch applications.

Because of the limited size of the slopes involved, the test plot sizes must be limited. The plot layout and design is illustrated on the following page. The design provides for eight (8) seeding, mulch and irrigation combinations.

The test plot area is divided into eight (8) individual plots, each one 20 feet by 20 feet. Each plot is separated from adjacent plots by a buffer area five (5) feet in width. Each plot is permanently staked and the entire test area will be fenced in the Spring of 1990.

Prior to seeding, the test plot area was treated with Round-up herbicide per manufacturers recommendations and hand cultivated to remove existing vegetation. This resulted in a roughened seedbed.

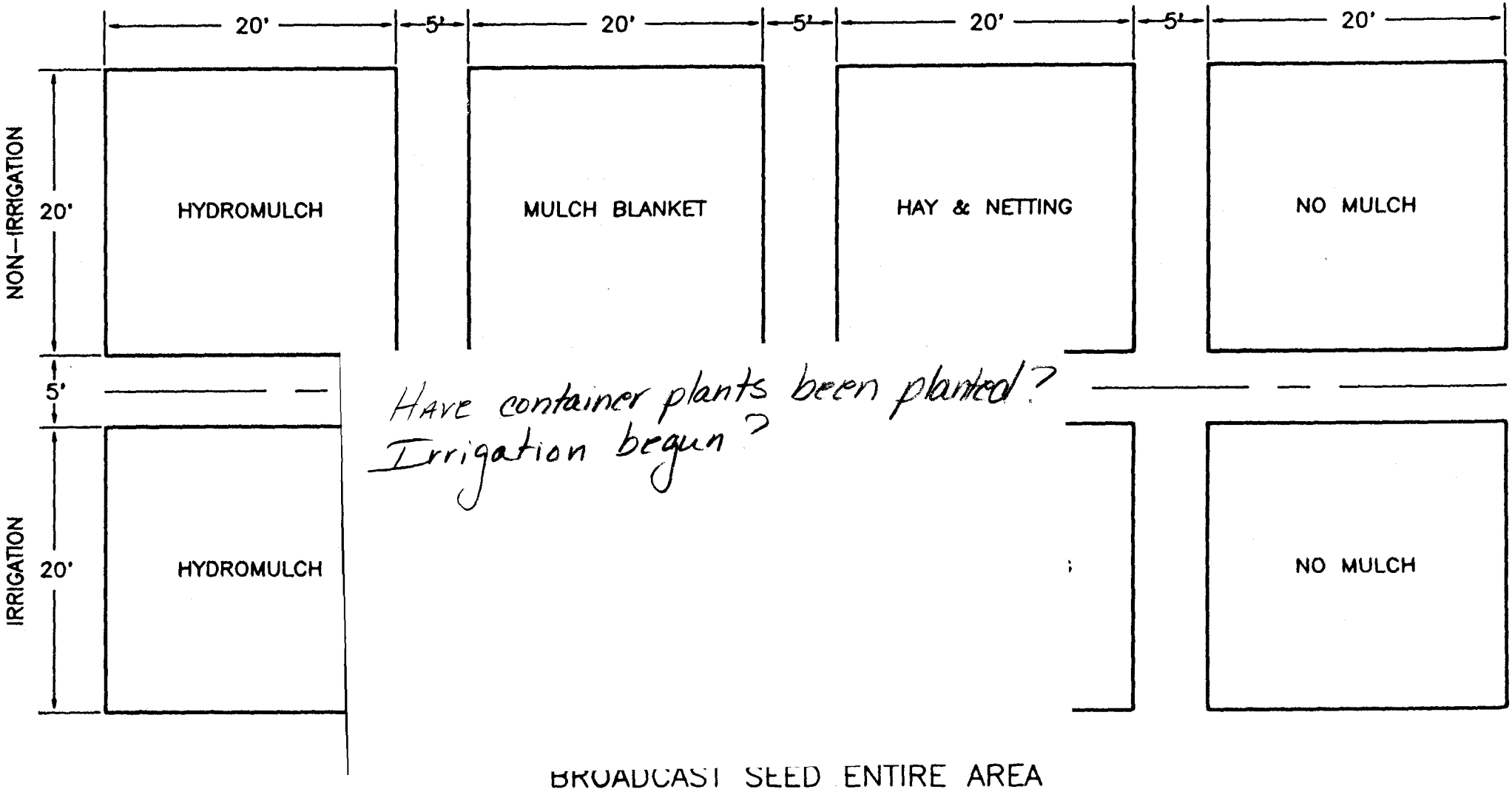
The final revegetation seed mixture was hand broadcast on all test plots as described in the Cottonwood PAP Final Revegetation Plan. The following fertilizer mixture was then broadcast, per DOGM recommendations:

Ammonium Nitrate	40 lbs/acre
Triple Super Phosphate	35 lbs/acre

The plots were then hand-raked to cover the seed and fertilizer.

Following seed and fertilizer application, the various mulch treatments were applied as indicated on page 5. During

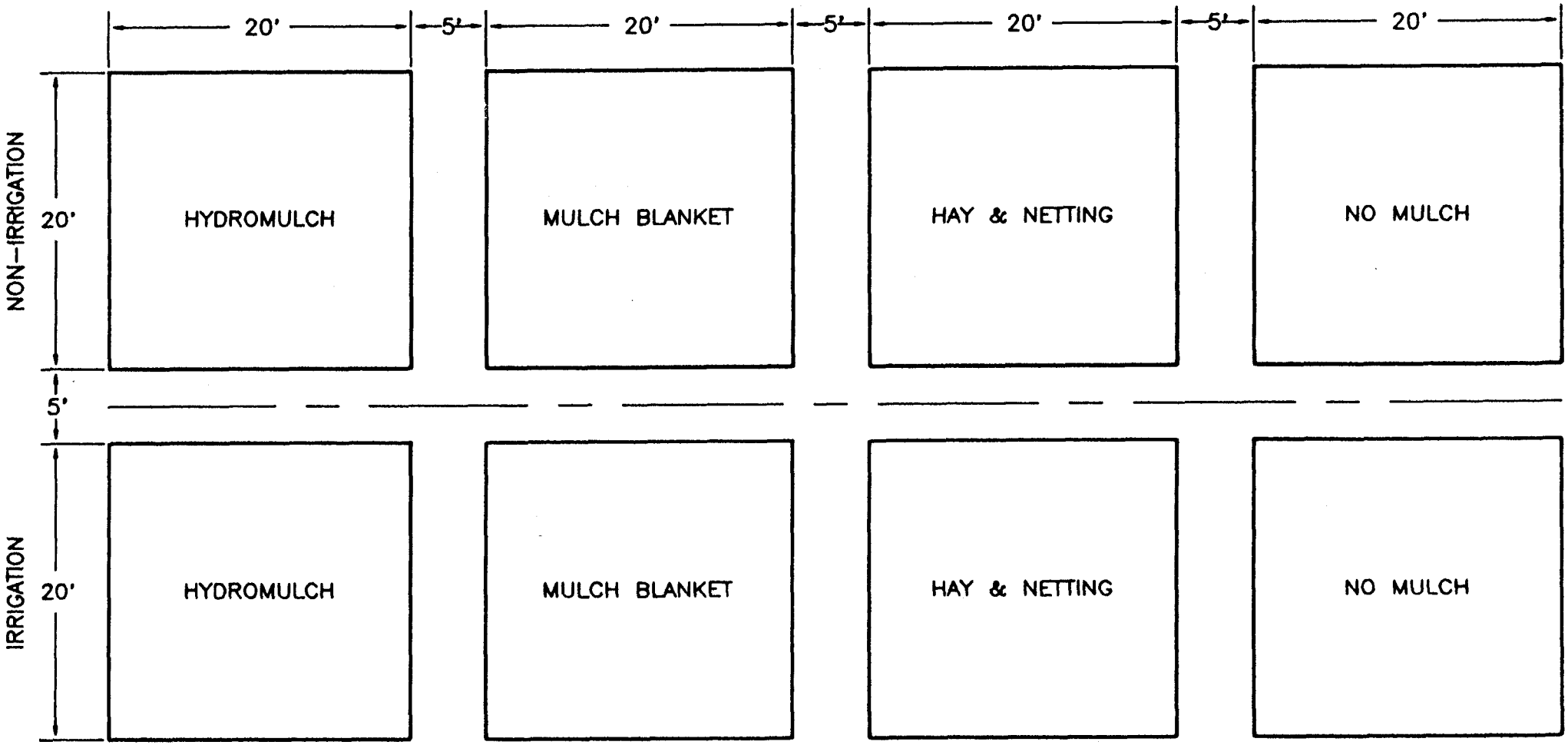
VEGETATION TEST PLOTS



Have container plants been planted?
Irrigation begun?

BROADCAST SEED ENTIRE AREA
ENTIRE AREA TO HAVE ROUGHENED SEED BED;
SAME SLOPE STEEPNESS ABOVE, BELOW,
AND ON PLOTS; SAME EXPOSURE.

VEGETATION TEST PLOTS



BROADCAST SEED ENTIRE AREA
ENTIRE AREA TO HAVE ROUGHENED SEED BED;
SAME SLOPE STEEPNESS ABOVE, BELOW,
AND ON PLOTS; SAME EXPOSURE.

hydromulch application, adjacent plots were covered to prevent contamination due to overspray or wind drift.

During the spring of 1990, containerized plants will be planted as described on pages 4-20 and 4-20.1 of the PAP.

Irrigation will be applied during the first two (2) years (growing seasons) following seeding and discontinued thereafter unless Cottonwood/Wilberg determines otherwise. The Division will be consulted concerning continuation of irrigation beyond the second growing season. Irrigation will begin with the onset of spring and will terminate at the first fall frost.

Irrigation will be applied once per week unless determined otherwise based on soil moisture and plant vigor appearance. Soil moisture conditions will be determined weekly by soil probing to a six (6) inch depth.

Irrigation will be supplied from a water truck using a hand-held sprayer attached to a hose. A flow meter will be placed in the line to measure the quantity of water applied. Water will be applied to the point of surface saturation or penetration to six (6) inches on the control plot. All irrigated plots will be watered equally. Irrigation will commence in the early evening and be completed by sundown.

Maintenance, monitoring and sampling methods and schedules will be as specified for Final Reclamation sampling (PAP pages 4-20.1 to 4-20.3). A minimum of 15, 1/4 meter quadrats will be evaluated per plot. Success standards will be as specified for the reference area (see PAP pages 2-101 to 2-116).

Des-Bee-Dove

Test plots were established at the Des-Bee-Dove Haul Road (see map CM-10602-DS) to test various soil stabilizing, soil enhancing and mulch treatments. The plots were established in cooperation with Division personnel in October of 1989. The test plot layout is illustrated on page 9. The treatments include:

Land Tech Irish Peat Soil Enhancer (1 Ton, Plot 4), Plot 1

Sulfur (250 lbs. each, Plots 1 & 4)

Soil Master Tackifier (25 gal. each, Plot 1 & 4)

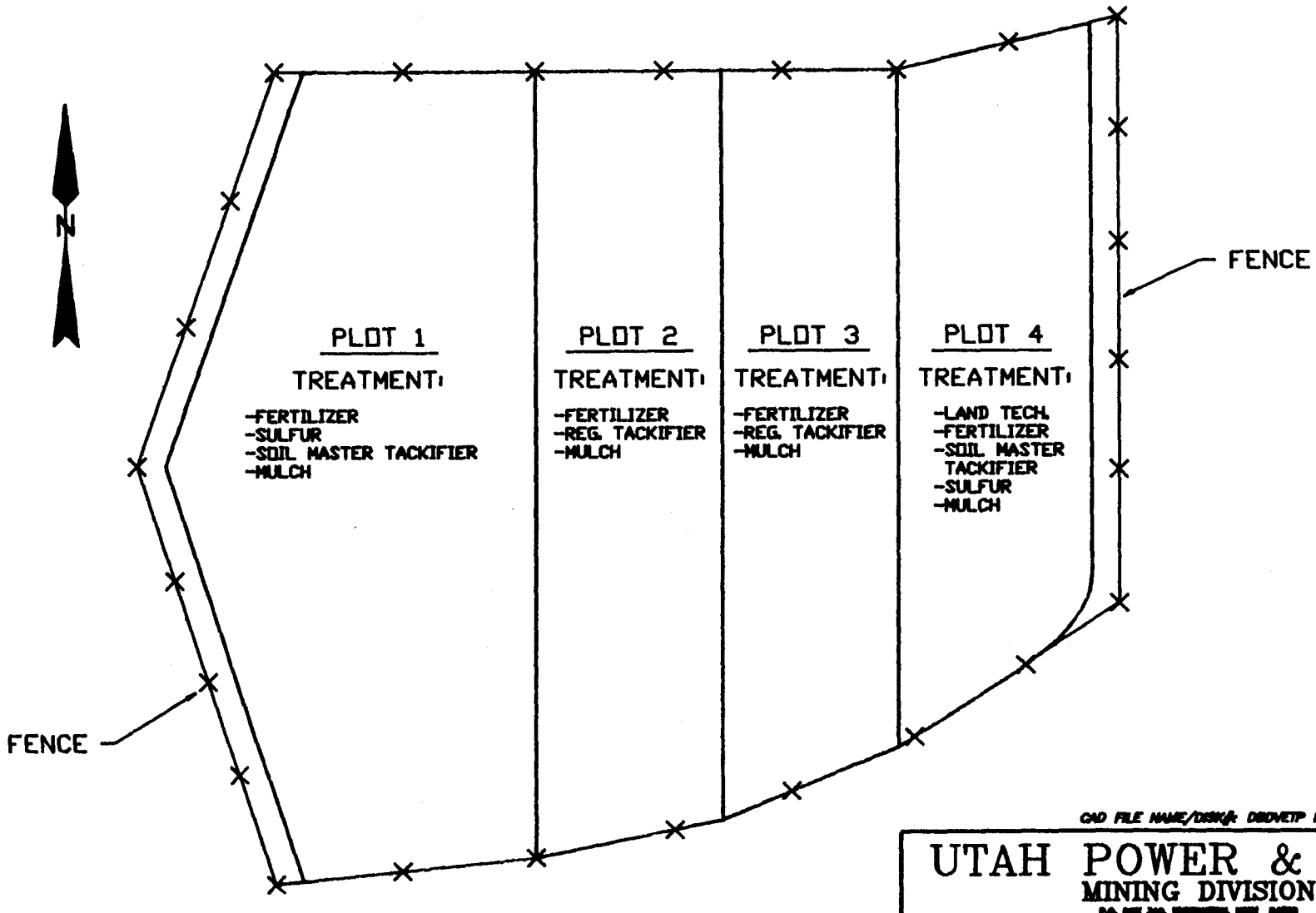
Ammonium Nitrate (100 lbs. total site)

Triple Super Phosphate (150 lbs. total site)

Wood Fiber Mulch (440 lbs. total site)

The following seed mixture was applied over the entire site at the rates indicated.

SPECIES		PLS LBS/ACRE
Agropyron dasystachyum	thickspike wheatgrass	6
A. smithii	western wheatgrass	8
Oryzopsis hymenoides	Indian ricegrass	6
Elymus cinereus	basin wildrye	8
Sporobolus airoides	alkali sakatoon	.5
Melilotus officinalis	yellow sweetclover	4
Linum lewisii	Lewis flax	2
Sphaeralcea grossularifolia	globemallow	1
Atriplex canescens	fourwing saltbush	4
A. corrugata	mat saltbush	4
A. confertifolia	shadscale	2
Ceratoides lanata	winterfat	4
Kochia prostrata	prostrate kochia	1
		50.5 LBS/AC



CAD FILE NAME/DISK#: DBOVETP KL3

UTAH POWER & LIGHT
MINING DIVISION

DES-BEE-DOVE MINE VEGETATION/EROSION TEST PLOT

DRAWN BY: K. LARSEN		CS1218A
SCALE: 1"=30'		DRAWING #:
DATE: 4-4-90	SHEET 1 OF 1	REV.

FINAL REVEGETATION MONITORING REPORTS

A Comparison of the Vegetation on a Reclaimed Slope and Reference Area in the Cottonwood Fan Portal Region.

Revegetation Monitoring of the Cottonwood/Wilberg, Des-Bee-Dove Waste Rock Site: 1989

Prepared by Mt. Nebo Scientific Research and Consulting.

A COMPARISON OF THE VEGETATION ON A RECLAIMED SLOPE AND REFERENCE AREA IN THE COTTONWOOD FAN PORTAL REGION

Prepared by

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for

UTAH POWER & LIGHT COMPANY
Mining Division
Post Office Box 310
Huntington, Utah 84528

Report: Patrick D. Collins, Ph.D.

Fieldwork: Patrick D. Collins
P. Dean Collins

Date: January 1990

TABLE OF CONTENTS

SCOPE

The following is a report of some plant communities in an area called the COTTONWOOD FAN PORTAL AREA. The purpose of this report is to compare an area that has been reclaimed, to another area that was undisturbed. The undisturbed community had been chosen previously as a reference area, or an area to be used as a the standard for reclamation success. Studies were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM).

Within the INTRODUCTION of the report, a General Site Description section is provided to give a brief descriptive overview of the area. A METHODS section is included in this report to provide the reviewers with all methodologies and standards used to obtain the data. The RESULTS section outlines the sampling results of the revegetated plant community and reference area. Maps showing the study areas are also included in this report.

INTRODUCTION

1.96 ac

General Site Description

The Cottonwood Fan Portal Area is located in Cottonwood Canyon, approximately 12 miles northwest of Orangeville, Utah. The reclaimed area studied was initially disturbed by previous mining and other activities. Its native vegetation was dominated by pinyon pine (Pinus edulis) and Utah juniper trees (Juniperus osterosperma), with salina wildrye (Elymus salinus) as the dominant understory species. Elevation of the study site ranged between 7,100 ft and 7,400 ft above sea level. Slopes of the study area were approximately 35 degrees.

Reference Area

As mentioned above, a reference area to be used as a standard for success at the time of final reclamation had previously been selected. The reference area is presently dominated by the same plant species as listed above. This area was chosen earlier to comply with guidelines provided by DOGM and was predicted to have similar slope, soils, exposure, species composition, precipitation, elevation and other environmental variables.

Date Reclaimed
? 1995

METHODS

Quantitative and qualitative data were taken for the above vegetation types. Sampling was accomplished between August 16 and

August 21, 1989. A second year of sampling will also be accomplished in August, 1990. This will make it possible to compare the sampling results of two years data.

Cover and Composition

Bi-directional random/regular placement of sampling plots were designed to provide unbiased accuracy of the data compiled. This was accomplished by establishing transect lines randomly placed on the areas to be sampled. These transect lines were placed over the entire study area to adequately represent the area as a whole. Regular points on the transect lines were then marked. From these marks, the sample points were determined by random distance numbers at right angles to the transect lines.

Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Additional information recorded on data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows Welch et al. (1987).

Woody Species Density

Density of woody plant species were recorded using the point quarter distance method (Cottom and Curtis 1956). In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was

equal to the square root of the mean area per individual.

Productivity and Range Condition

Productivity and Range Condition estimates for the Cottonwood Fan Portal Area will be performed by the U.S. Soil Conservation Service, Price Utah. Copies of these estimates will be supplied by Utah Power & Light, Mining Division.

Sample Adequacy and Group Comparison Tests

Sampling adequacy for cover and woody species density was achieved using formulas from Snedocor and Cochran (1980), insuring that 80% of the samples were within 10% of the true mean for the shrub communities of the area. On areas where sample adequacy was not met, the maximum sample size required by DOGM was achieved. Student's t-tests were also employed to compare the proposed disturbance and reference areas of all sites for cover and woody plant species density. All sample means, standard deviations, and sample sizes were included in this report to enable the reviewers to apply further statistical tests if desired.

Vegetation Mapping & Photographs

Vegetation mapping was done by walking the area and using contour maps. Sampling locations are also shown on these maps. Photographs of each sample area were taken and included in this report.

RESULTS

THE RECLAIMED SLOPES

The vegetative cover of the reclaimed slopes was estimated as 37.18% (Table 1). Trees and shrubs made up 20.04%, grasses 78.27%, and forbs 1.69% of the living cover (Table 1). The dominate shrub (by cover) of this area was four-winged saltbush (Atriplex canescens), of which comprised nearly 7%. The dominate grass species, Gt. Basin wildrye (Elymus cinereus), was estimated as 20.68% (Table 2). Most frequent species observed in the quadrats were Gt. Basin wildrye, crested wheatgrass (Agropyron cristatum), and big sagebrush (Artemisia tridentata). Woody plant species density was estimated at 704 individuals per acre (Table 3) by the point quarter sampling method.

THE REFERENCE AREA

The living cover for the reference area that was used as a standard for reclamation success was estimated as 42.93% (Table 4). Grasses also dominated the reference area. They comprised 60.35% of the cover, whereas, woody were 34.91% and forbs were 4.75% (Table 4). The two dominant plant species (by cover and frequency) were Salina wildrye (Elymus salinus) and pinyon pine (Pinus edulis), estimated at 19.88% and 11.45%, respectively (Table 5). Woody plant species density was estimated at 763 individuals per acre (Table 6).

STATISTICAL COMPARISONS

Student's t-tests were employed to statistically compare the cover and density of the reclaimed slopes with the reference area. These tests suggested no significant difference between the two areas for cover ($t = -1.089$) and density ($t = 1.037$). Refer to Table 7 for a statistical summary of comparisons between the reclaimed slopes and the reference area.

PHOTOGRAPHS OF THE PLANT COMMUNITIES

Photographs of the approximate sample locations of each plant community described in this report are shown following the data summation tables.

TABLE 1: Total cover and composition summary for the Reclaimed Slopes of the Cottonwood Fan Portal Area. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover*	37.18	21.71	40
Litter	9.08	4.64	40
Bareground	7.68	6.19	40
Rock	46.08	23.04	40
COMPOSITION			
Trees/Shrubs	20.04	29.15	40
Forbs	1.69	6.33	40
Grasses	78.27	30.50	40

* Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

Cover N(min) = 56

Non Cover N(min) = 31

TABLE 2: Species cover and frequency summary for the Reclaimed Slopes of the Cottonwood Fan Portal Area. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Artemisia tridentata	2.80	6.25	40	22.50
Atriplex canescens	6.68	18.45	40	20.00
FORBS				
Aster foliosus	0.58	2.48	40	7.50
GRASSES				
Agropyron cristatum	4.30	8.12	40	32.50
Elymus cinereus	20.68	21.07	40	77.50
Elymus junceus	1.95	5.39	40	17.50
Elymus salinus	0.13	0.78	40	2.50
Poa pratensis	0.08	0.47	40	2.50

TABLE 3: Woody species densities of the Reclaimed Slopes of the Cottonwood Fan Portal Area.

	NUMBER/ACRE*
Artemisia tridentata	431.10
Atriplex canescens	131.97
Atriplex confertifolia	87.98
Chrysothamnus nauseosus	30.79
Chrysothamnus viscidiflorus	21.99
TOTAL	703.83

* Sample size was 40 (n=40) and insured that 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 4: Total cover and composition summary for the Reference Area for the Reclaimed Slopes of the Cottonwood Fan Portal Area. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover*	42.93	25.37	40
Litter	16.08	14.89	40
Bareground	8.18	8.72	40
Rock	32.83	27.80	40
COMPOSITION			
Trees/Shrubs	34.91	32.23	40
Forbs	4.75	13.04	40
Grasses	60.35	32.18	40

* Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

Cover $N(min) = 57$

Non Cover $N(min) = 42$

TABLE 5: Species cover and frequency summary for the Reference Area for the Reclaimed Slopes of the Cottonwood Fan Portal Area. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Amelanchier utahensis	0.40	1.73	40	7.50
Chrysothamnus nauseosus	0.40	1.32	40	10.00
Ephedra viridis	1.43	6.32	40	12.50
Juniperus osteosperma	1.83	8.55	40	7.50
Mahonia repens	0.60	2.51	40	7.50
Pinus edulis	11.45	18.25	40	47.50
Pseudotsuga menziesii	2.68	12.09	40	7.50
FORBS				
Aster glaucodes	0.15	0.65	40	5.00
Galium aparine	0.03	0.16	40	2.50
Machaeranthera canescens	0.13	0.40	40	10.00
Sphaeralcea coccinea	0.15	0.79	40	5.00
Stanleya pinnata	0.80	2.87	40	10.00
GRASSES				
Elymus salinus	19.88	16.25	40	82.50
Stipa hymenoides	3.03	10.65	40	12.50

TABLE 6: Woody species densities of the Reference Area for the Reclaimed Slopes of the Cottonwood Fan Portal Area.

	NUMBER/ACRE*
Amelanchier utahensis	33.28
Atriplex confertifolia	42.78
Cercocarpos montanus	52.29
Chrysothamnus nauseosus	118.85
Chrysothamnus viscidiflorus	14.26
Ephedra viridis	137.86
Eriogonum corymbosum	14.26
Juniperus osteosperma	87.57
Mahonia repens	42.78
Pinus edulis	213.92
Pseudotsuga menziesii	4.75
TOTAL	762.60

* Sample size was 40 (n=40) and insured that 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 7: Statistical summary sheet for the Revegetated Slopes and Reference Area of the Cottonwood Fan Portal Area.

RECLAIMED SLOPES			
Total Living Cover	x = 37.18	s = 21.71	n = 40
Density	x = 91.65*	s = 22.92	n = 40
Aspect	West		
Slope	35 deg.		
REFERENCE AREA			
Total Living Cover	x = 42.93	s = 25.37	n = 40
Density	x = 85.23*	s = 31.74	n = 40
Aspect	West		
Slope	35 deg.		

Density
Reclaim
N(min) = 10

Reference
N(min) = 22.

STATISTICAL ANALYSES

COVER:
Student's t-value = -1.089
Degrees of freedom = 78
Significance level = N.S.

DENSITY
Student's t-value = 1.037
Degrees of freedom = 78
Significance level = N.S.

x = sample mean, s = sample standard deviation,
n = sample size, N.S. = nonsignificant,
* average distance in inches at each sample location.

PHOTO 1: Reclaimed Slope of the Cottonwood Fan Portal Area (orig. in color).

PHOTO 2: Reference Area for the Reclaimed Slopes of the Cottonwood Fan Portal Area (orig. in color).

REVEGETATION MONITORING OF THE COTTONWOOD/WILBERG DES-BEE-DOVE WASTE ROCK SITE: 1989

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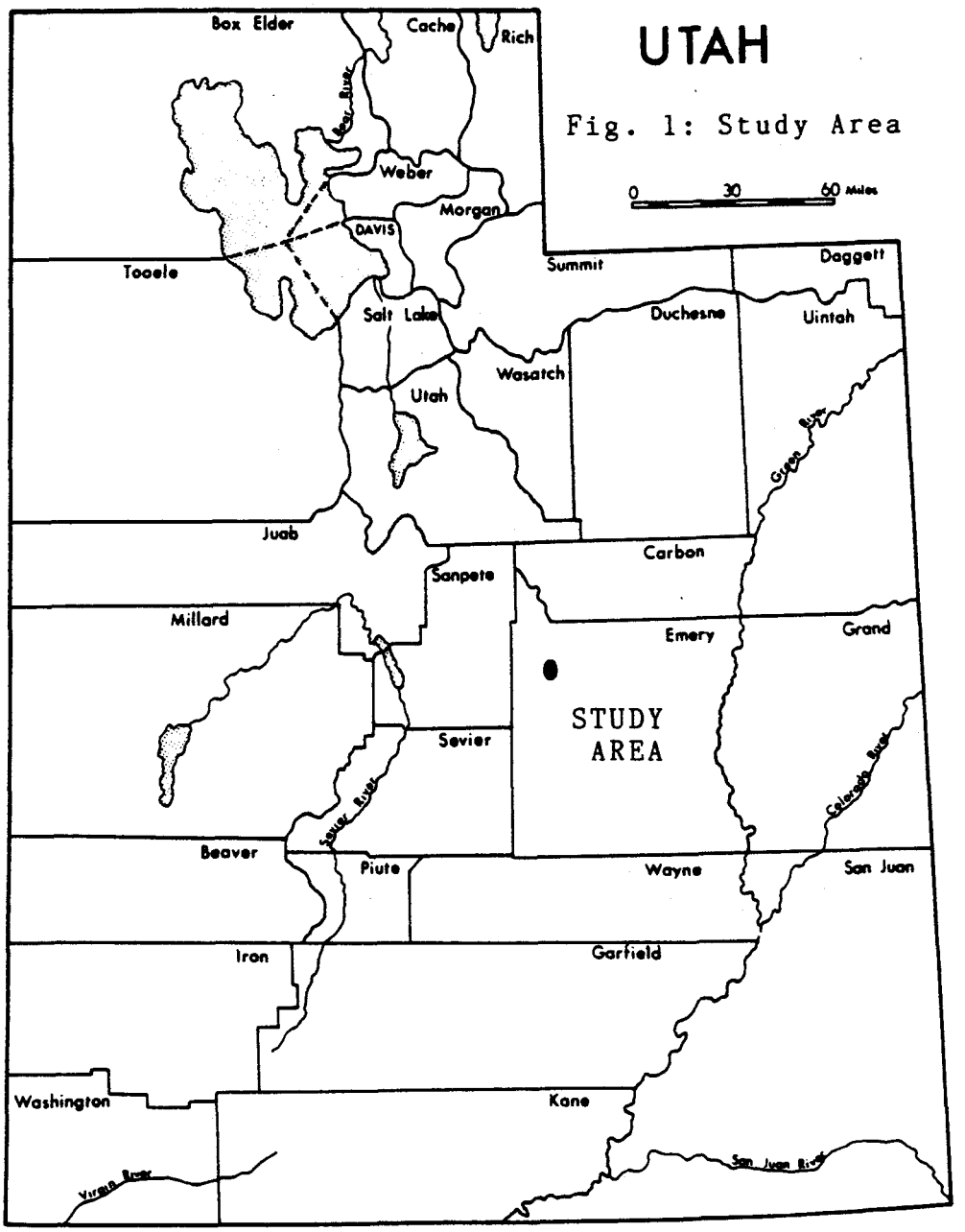


Fig. 1: Study Area

SCOPE

The following is a report to monitor revegetated cells and berms of the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. A reference area was also monitored to be used as a measure of comparison. Monitoring methodologies were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM).

Within the INTRODUCTION of the report, a General Site Description section is provided to give a brief descriptive overview of the area. A METHODS section is included in this report to provide the reviewers with all methodologies and standards used to obtain the data. The RESULTS section outlines the sampling results of the revegetated and reference areas. A DISCUSSION section is also included to consider trends of the revegetated plots. PHOTOGRAPHS and a MAP showing the sample locations are also included in this report.

REVEGETATION MONITORING OF THE COTTONWOOD/WILBERG DES-BEE-DOVE WASTE ROCK SITE: 1989

INTRODUCTION

General Site Description

The revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site is located approximately two miles east of the Cottonwood/Wilberg Mine in Emery County, Utah. The elevation of the area ranges from 6,700 ft to 6,800 ft above sea level. The area is the site of on-going waste rock disposal and consequent reclamation and revegetation.

There were generally three types of areas to monitor: cells, berms and a reference area. The cells constitute the greatest surface area. They are the reclaimed areas that cover the waste rock material which is disposed on site. The cells are relatively flat, but have a gentle slope of approximately 3 degrees with an eastern exposure.

The berms on the other hand, are the outside margins of the area and surround the entire revegetated waste rock site. These areas for the most part, are long, narrow reclaimed slopes. Their lengths are divided only by the year in which they were seeded (from 400 ft - 1000 ft), while their widths average about 20 ft. Slopes range from 1 to 30 degrees, but average nearly 20 degrees.

A reference area was permanently marked in the field. It provides an approximation of the reclaimed area prior to disturbance. This area was chosen earlier to comply with guidelines provided by DOGM and was predicted to have similar slope, soils, exposure, species composition, precipitation, elevation and other environmental variables. The area is located in an undisturbed pinyon-juniper community. This area can be used for present comparisons and as a standard of successful revegetation in subsequent years.

Cells and berms can be identified in this report numerically and by the year in which they were reclaimed and seeded. For example, Cell 2 (1984) indicates that this area is one of the level plot areas, and was seeded in the second year. The seeding year was 1984. This not only enables one to make comparisons between each plot, but allows one to monitor trends through time. A summary of the plots sampled follows:

Reference Area

Cell 1 (1983)

Cell 2 (1984)

Cell 3 (1985)

Cell 4 (1986)

Berm 1 (1983)

Berm 2 (1984)

Berm 3 (1985)

Berm 4 (1986)

acl 5 # 6 (1989)

METHODS

Quantitative and qualitative data were taken on each of the reclaimed cells and berms plus a reference area for comparisons. Sampling was accomplished between August 19 and August 24, 1989.

Cover and Composition

Bi-directional random/regular placement of sampling plots were designed to provide unbiased accuracy of the data compiled. This was accomplished by establishing transect lines randomly placed on the areas to be sampled. Several transects were placed on each cell or berm plot in order to get an adequate representation of the entire plot surface. Regular points on the transect lines were then marked. From these points, the sample locations were determined by random distance numbers at right angles to the transect lines.

Cover estimates were made (to the nearest percentage point) using ocular methods with meter square quadrats. Species composition by lifeform and relative frequencies were also assessed from the quadrats. Additional information recorded on data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows Welch et al. (1987).

Woody Species Density

Density of woody plant species in the reference area was recorded using the point quarter distance method (Cottom and Curtis 1956). In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual.

Due to plot sizes and compositional nature of the reclaimed areas, densities of woody plant species were measured by placing belt transects on the cells and berms. Sixteen belt transects were placed on each cell or berm plot to be sampled. The size of the belt transects on the cell plots were 6 ft wide by 50 ft long (300 sq ft). The area of the berm was usually distinctly smaller than the cell plots, and were much more narrow. Consequently, the belt size for sampling densities were reduced to 3 ft by 50 ft (150 sq ft).

Productivity and Range Condition

Productivity and range condition estimates for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site were not performed during this stage of the monitoring schedule. When they are accomplished, copies of these estimates will be supplied by Utah Power & Light, Mining Division.

Sample Adequacy

Sampling adequacy for cover was achieved using formulas from Snedocor and Cochran (1980), insuring that 80% of the samples were within 10% of the true mean for the shrub communities of the area. On areas where sample adequacy could not be met by reasonable sampling numbers, the maximum sample size required by DOGM was achieved. Sample means, standard deviations, and sample sizes were included in this report to enable the reviewers to apply further statistical tests if desired.

Plot Maps & Photographs

Plots had been previously mapped by Utah Power & Light Company. Transect lines and sampling locations were added to these maps. Photographs of each sample area were taken and are included in this report.

RESULTS

Because each plot often had a unique size or shape, sampling procedures or quadrat placement may have been slightly modified to accommodate them. This section of the report will clarify some of these differences plus compare sampling results between them. The summary tables in this section provides the reviewer with a method of comparing sampling results with each plot or with the reference area.

Seeding mixtures of all the cells and berms are shown on Table 34.

Reference Area

A reference area was permanently marked to be used as a standard of success for revegetation of the waste rock site. This area was located to the west and adjacent to the reclaimed area (see map) and is approximately 1.3 acres in size. The reference area is a pinyon-juniper community that approximates the waste rock site prior to disturbance.

The mean total living cover of the reference area was estimated at 32.25%, with nearly 78.46% of the cover being composed of trees and shrubs (Table 1). The dominant species of this area (Table 2) in descending order were: pinyon pine (Pinus edulis), Utah juniper (Juniperus osteosperma) and mountain mahogany (Cercocarpus montanus). No grass species were encountered in the sampling quadrats. Woody plant density was estimated at 660 individuals per acre (Table 3).

Cell 1

This reclaimed waste rock plot was a 200 ft by 200 ft square. Cell 1 was seeded in 1983.

Four transect lines were placed between 40 ft and 55 ft apart to cover the entire plot. Points were also marked at regular intervals on each of these transects followed by random placement of sampling

locations at right angles to the transect lines (see map).

Total living cover was estimated at 26.33% and was composed of 74.12% grasses, 15.54% woody plants and 13.36% forbs (Table 4). Dominant species by cover in descending order were: western wheatgrass (Elymus smithii), crested wheatgrass (Agropyron cristatum), four-winged saltbush (Atriplex canescens), and halogeton (Halogeton glomeratus). Refer to Table 5 for a list of species by cover and frequency. Woody species density was estimated at 1,769 individuals per acre with 90% of them four-winged saltbush (Table 6).

Cell 2

This area was approximately the same size and shape as Cell 1 above, but was seeded in 1984.

Previous investigations suggested a possible problem with salts in the soils of certain portions of Cell 2. The exact portion of the plot that was suspected to have this problem was marked by Utah, Power & Light. This area was sampled separately from the unaffected area so that the two areas within the plot could be used to speculate whether or not salts have affected the vegetation on Cell 2. Accordingly, three subsets of data are presented in this report for Cell 2: 1) Combined Data (both salt and non-salt areas combined), 2) Non-salt Problem Area, and 3) Salt Problem area.

The Non-salt Problem Area of Cell 2 had the highest cover (Table

10), followed by the Combined Data (Table 7), and then the Salt Problem Area (Table 13). The relationship was similar with respect to woody plant species densities. Student's t-test suggested the differences in cover between the Salt Problem and Non-salt Problem areas to be significant ($t = 2.933$, p .01). The species composition of the Combined Area and Non-salt Problem Area were similar, but the Salt Problem Area tended to have more grasses and less shrubs by cover than the other two areas (Table 7, Table 10 and Table 13).

Results from sampling the non-salt and salt areas separately suggest that the salts had an affect on the vegetational patterns. For comparisons, refer to Tables 7 - 15.

Cell 3

This reclaimed plot was located to the north of the above two plots, has a different shape, and was nearly double the surface area. The revegetation seed mixture for Cell 3 was seeded more recently (1985).

Two offset transect lines were placed in this plot and spaced to adequately cover much of the plot. The sampling locations were placed randomly along these lines (refer to Plot Map 1).

Total living cover was estimated at 35.88%, with 61.11% of that being grasses (Table 16). Dominant species by cover in descending order were: Russian thistle (Salsola iberica), four-winged saltbush,

western wheatgrass and crested wheatgrass. Refer to Table 17 for cover and frequency by species. Table 18 shows the woody species of Cell 3 to be 1,544 individuals per acre.

Cell 4

Cell 4 had the largest surface area of all the plots. The seeding of this plot was also some of the most recent, being accomplished in 1986. Offset transects also dissected this plot to constitute a sampling design that represented somewhat ample coverage of the plot.

Total living cover of this plot was 38.88%, with only 55.60% of that being grasses, a somewhat smaller representation when compared to the previously described cells (Table 19). The dominant species of Cell 4 were: crested wheatgrass, fivehook bassia (Bassia hyssopifolia), and Russian thistle (see Table 20).

The only woody plant species encountered in the belt transects when density measurements were performed was four-winged saltbush. The density of this species was only 572 individuals per acre (Table 21).

Berm 1

This berm had an exposure that was approximately south and a slope of nearly 20%. The berm was located on the southwest corner of the entire reclaimed waste rock area. Berm 1 was about 400 ft long and 20-25 ft wide. One transect line was placed the length of the plot.

Points were chosen at regular intervals along the transect lines, followed by random numbers for placement of the quadrats.

Mean total living cover was estimated as 27.00%, with nearly 89% of those being composed of forbs (Table 22). The dominant species of this berm was Russian thistle, a common annual weed. At a much smaller cover value, the next most prevalent species was crested wheatgrass (Table 23). Woody plant species density was only 290 plants per acre (Table 24).

Berm 2

Berm 2 was a longer berm, nearly 800 ft in length and approximately 25 ft wide. It was located on the west end and wraps around to the north end of the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. Transect locations were divided equally along this berm, followed by random quadrat placement. Exposure varied between west, northwest and north, with slopes ranging between 1 and 20 degrees. This berm was planted in 1984.

Total living cover was estimated at 34.13%, of which 60% were grasses and 36% were shrubs (Table 25). Dominant plants were more desirable species i.e. crested wheatgrass, four-wing saltbush and western wheatgrass (Table 26). Woody species density was also more respectable than the above berm - estimated as 3,284 individuals per acre (Table 27).

Berm 3

This berm was also a long berm and an extension of Berm 2. Berm 3 extended nearly 700 ft around the north side of the reclaimed waste rock area. Its exposures were primarily northeast with slopes ranging from 1 to 20 degrees. This berm was seeded in 1985.

As before, one long transect line was placed on this berm that extended the length of it. Regularly spaced points were established along the transect and random numbers were chosen for quadrat placement at right angles to the transect line. This design also allowed for representation of the entire length of the berm.

Total cover was 34.20% and was more equally represented by shrubs, forbs and grasses (Table 28). Dominant species of this berm were: Russian thistle, four-wing saltbush, and crested wheatgrass (Table 29). Woody species density was estimated at 3,104 individuals per acre (Table 30).

Berm 4

Berm 4 was located on the east end of the waste rock reclamation area. It was approximately 1,000 ft long and nearly 50 ft wide in some areas. Its slopes ranged between 1 an 20 degrees with exposures to the south, east and north. Data of all slopes and exposures were combined, but can be divided for more site-specific review in the future. This berm was seeded in 1986, the most recent seeding date.

Mean total living cover was calculated at 33.00%, and was nearly 60% weedy forb species (Table 31). The berm was dominated by Russian thistle and crested wheatgrass (Table 32). Berm 4 had a woody plant species density of 781 individuals per acre (Table 33).

PHOTOGRAPHS OF THE SAMPLE PLOTS

Photographs of each cell, berm and reference area showing the approximate sample locations are shown following the data summation tables.

DISCUSSION

Some of the data listed on the summary tables were extracted and illustrated graphically in Figures 2 - 7. Perhaps the most clear and concise method to compare the sample results for cover and density is to examine the graphs in this section of the report. This enables one to more easily observe potential trends in the revegetation program. Data from the reference area has also been added to each graph for comparisons.

Cover

When one compares the results for living cover (Figure 2) of the

cells beginning with the most recent seeding (Cell 4: 1986) through to the earliest seeding date (Cell 1: 1983), a negative trend can be observed. This is not necessarily negative from the standpoint of revegetation success, however. Figure 4 indicates that the decrease in time of living cover may be the result of a decrease in forbs. Further investigation of species composition shows the forbs that have decreased are the weedy, undesirable species such as Russian thistle and halogeton. Calculations reveal that in Cell 1 (the first plot to be seeded) only 17.13% of the living cover are weedy species, whereas, in Cell 4 (the last plot to be seeded), 48.41% of the living cover are weeds. More desirable species i.e. perennial grasses have actually increased with time (Figure 4).

Data of the berms (Figure 3) show similar, but less obvious trends; probably due to the extreme variability within and between berms (i.e. exposure, slope, moisture, seed holding capacity, etc.)

Composition

As briefly discussed above in the cover section, species composition (the percentage of cover by lifeform) can provide clues the changes in vegetative structure over time. For the cells, perennial grasses seem to be increasing and annual forbs decreasing over time (Figure 4). Shrub cover seems to remain fairly stable. The berm data again seems to be highly variable and not easily predictable by this data (Figure 5).

Density

The density of woody plant species is shown graphically for each cell in Figure 6 and each berm in Figure 7. As suggested by composition data for cells above, the woody plants seemed to have risen and then stabilized with time. A sharp drop in the number of woody species can be observed, however, in Berm 1.

TABLE 1: Reference Area - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	32.25	31.64	40
Litter	19.85	12.84	40
Bareground	19.75	19.90	40
Rock	28.15	26.55	40
COMPOSITION			
Trees/Shrubs	78.46	37.66	40
Forbs	21.54	37.66	40
Grasses	0.00	0.00	40

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 2: Reference Area - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS		Relative Cover		
Cercocarpus montanus	2.48	8.38	40	10.00
Ephedra viridis	0.95	3.40	40	15.00
Juniperus osteosperma	9.10	21.86	40	20.00
Pinus edulis	18.95	29.09	40	45.00
	31.48	98%		
FORBS				
Cryptantha humilis	0.38	1.13	40	15.00
Eriogonum bicolor	0.23	0.82	40	12.50
Euphorbia fendleri	0.05	0.22	40	5.00
Penstemon mucronatus	0.13	0.40	40	10.00
	.79	2%		
	32.25			

TABLE 3: Reference Area - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE**
Cercocarpus montanus	45.36
Ephedra viridis	131.96
Juniperus osteosperma	152.58
Opuntia polyacantha	74.23
Pinus edulis	239.18
Yucca harrimaniae	16.50
TOTAL	659.80

** Sample size was 40 (n=40) and insured that 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 4: Cell 1 (1983)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	26.33	9.37	40
Litter	10.13	6.47	40
Bareground	25.38	12.37	40
Rock	38.18	14.08	40
COMPOSITION			
Trees/Shrubs	15.54	20.63	40
Forbs	13.36	25.39	40
Grasses	74.12	31.39	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 5: Cell 1 (1983)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	3.55	6.09	40	12.50
Cercocarpus montanus	0.05	0.31	40	2.50
Chrysothamnus nauseosus	0.13	0.78	40	2.50
Ephedra viridus	0.13	0.78	40	2.50
Gutierrezia sarothrae	0.58	1.55	40	12.50
FORBS				
Bassia hyssopifolia	0.23	0.99	40	5.00
Descurainia pinnata	0.10	0.44	40	5.00
Halogeton glomeratus	3.18	13.75	40	25.00
Kochia scoparia	0.10	0.49	40	5.00
Salsola iberica	0.90	2.80	40	20.00
GRASSES				
Agropyron cristatum	7.98	6.49	40	90.00
Dactylis glomeratus	0.68	2.55	40	10.00
Elymus smithii	10.58	8.66	40	87.50
Hordeum jubatum	0.25	1.09	40	5.00
Stipa hymenoides	0.18	0.83	40	5.00

* Seeding dates are in parentheses.

TABLE 6: Cell 1 (1983)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Artemisia tridentata	8.71
Atriplex canescens	1678.51
Atriplex confertifolia	8.71
Cercocarpus montanus	27.59
Gutierrezia sarothrae	45.01
TOTAL	1768.53

* Seeding dates are in parentheses.

TABLE 7: Cell 2: [Combined Data (1984)*] - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	29.08	9.63	40
Litter	7.98	5.55	40
Bareground	34.68	13.41	40
Rock	28.28	9.81	40
COMPOSITION			
Trees/Shrubs	12.24	18.35	40
Forbs	14.12	19.80	40
Grasses	72.46	23.94	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 8: Cell 2: [Combined Data (1984)*] - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	3.83	6.56	40	42.50
Atriplex confertifolia	0.20	0.60	40	12.50
FORBS				
Bassia hyssopifolia	0.65	2.25	40	10.00
Descurainia pinnata	0.08	0.35	40	5.00
Kochia scoparia	0.50	1.79	40	10.00
Melilotus officinalis	0.03	0.16	40	2.50
Salsola iberica	2.70	4.75	40	52.50
GRASSES				
Agropyron cristatum	7.78	5.93	40	82.50
Bromus sp.	0.13	0.78	40	2.50
Dactylis glomeratus	1.00	2.22	40	20.00
Elymus smithii	6.45	8.26	40	60.00
Hordeum jubatum	3.08	4.12	40	45.00
Poa pratensis	0.13	0.78	40	2.50
Stipa hymenoides	2.55	3.67	40	40.00

* Seeding dates are in parentheses.

TABLE 9: Cell 2: [Combined Data (1984)*] - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	1492.66
Atriplex confertifolia	72.60
TOTAL	1565.26

* Seeding dates are in parentheses.

TABLE 10: Cell 2: [Non-salt Problem Area (1984)*] - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	30.68	9.04	24
Litter	7.82	5.65	24
Bareground	33.53	13.74	24
Rock	27.97	10.04	24
COMPOSITION			
Trees/Shrubs	14.03	19.32	24
Forbs	13.51	19.73	24
Grasses	72.05	24.78	24

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 11: Cell 2: [Non-salt Problem Area (1984)*] - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	4.41	6.94	24	66.67
Atriplex confertifolia	0.21	0.63	24	16.67
FORBS				
Bassia hyssopifolia	0.47	1.82	24	8.33
Descurainia pinnata	0.09	0.37	24	8.33
Kochia scoparia	0.59	1.93	24	16.67
Melilotus officinalis	0.03	0.17	24	4.17
Salsola iberica	2.85	5.07	24	62.50
GRASSES				
Agropyron cristatum	8.12	5.96	24	91.67
Bromus sp.	--	--	24	--
Dactylis glomeratus	1.18	2.37	24	33.33
Elymus smithii	6.85	8.71	24	62.50
Hordeum jubatum	3.18	4.16	24	45.83
Poa pratensis	0.15	0.84	24	4.17
Stipa hymenoides	2.56	3.64	24	37.50

* Seeding dates are in parentheses.

TABLE 12: Cell 2: [Non-salt Problem Area (1984)*] - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	1597.20
Atriplex confertifolia	81.68
TOTAL	1678.88

* Seeding dates are in parentheses.

TABLE 13: Cell 2: [Salt Problem Area (1984)*] - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	22.69	7.43	16
Litter	6.81	3.83	16
Bareground	41.06	8.69	16
Rock	29.44	8.51	16
COMPOSITION			
Trees/Shrubs	3.91	12.11	16
Forbs	11.69	17.56	16
Grasses	82.32	19.74	16

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 14: Cell 2: [Salt Problem Area (1984)*] - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	0.81	2.48	16	12.50
Atriplex confertifolia	0.06	0.24	16	6.25
FORBS				
Bassia hyssopifolia	0.88	2.55	16	6.25
Descurainia pinnata	--	--	16	--
Kochia scoparia	--	--	16	--
Melilotus officinalis	--	--	16	--
Salsola iberica	1.31	1.83	16	37.50
GRASSES				
Agropyron cristatum	8.00	6.60	16	75.00
Bromus tectorum	0.31	1.21	16	6.25
Dactylis glomeratus	--	--	16	--
Elymus smithii	4.06	4.71	16	56.25
Hordeum jubatum	3.63	4.57	16	43.75
Poa pratensis	--	--	16	--
Stipa hymenoides	3.63	4.57	16	43.75

* Seeding dates are in parentheses

TABLE 15: Cell 2: [Salt Problem Area (1984)*] - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	653.40
Atriplex confertifolia	---
TOTAL	653.40

* Seeding dates are in parentheses.

TABLE 16: Cell 3 (1985)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	35.88	10.04	40
Litter	16.13	7.20	40
Bareground	21.50	7.92	40
Rock	26.50	8.92	40
COMPOSITION			
Trees/Shrubs	17.24	20.61	40
Forbs	21.65	20.45	40
Grasses	61.11	21.20	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 17: Cell 3 (1985)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	6.38	8.81	40	52.50
Ephedra viridis	0.13	0.78	40	2.50
FORBS				
Bassia hyssopifolia	0.33	1.17	40	7.50
Circium spp.	0.08	0.47	40	2.50
Descurainia pinnata	0.50	1.40	40	12.50
Erodium cicutarium	0.35	1.89	40	5.00
Kochia scoparia	0.20	0.84	40	7.50
Salsola iberica	6.53	7.44	40	72.50
Sphaeralcea coccinea	0.10	0.44	40	5.00
GRASSES				
Agropyron cristatum	5.80	7.58	40	52.50
Dactylis glomeratus	1.50	3.20	40	22.50
Elymus smithii	7.45	7.94	40	65.00
Hordeum jubatum	4.40	5.59	40	50.00
Stipa hymenoides	2.15	2.98	40	35.00

* Seeding dates are in parentheses.

TABLE 18: Cell 3 (1985)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	1515.89
Gutierrezia sarothrae	27.59
TOTAL	1543.48

* Seeding dates are in parentheses.

TABLE 19: Cell 4 (1986)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	38.88	13.62	40
Litter	16.63	9.25	40
Bareground	20.38	12.82	40
Rock	24.13	13.60	40
COMPOSITION			
Trees/Shrubs	2.71	7.34	40
Forbs	42.00	34.18	40
Grasses	55.60	33.16	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 20: Cell 4 (1986)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Artemisia tridentata	0.18	0.83	40	5.00
Atriplex canescens	0.75	2.11	40	12.50
Cercocarpus montanus	0.03	0.16	40	2.50
FORBS				
Bassia hyssopifolia	8.43	13.75	40	42.50
Descurainia pinnata	0.55	1.52	40	12.50
Halogeton glomeratus	0.08	0.47	40	2.50
Kochia scoparia	1.45	3.52	40	25.00
Melilotus officinalis	0.13	0.78	40	2.50
Salsola iberica	7.90	12.22	40	47.50
Sphaeralcea coccinea	0.15	0.79	40	20.00
Taraxicum officinale	0.13	0.78	40	2.50
GRASSES				
Agropyron cristatum	11.60	8.22	40	80.00
Dactylis glomeratus	0.13	0.78	40	2.50
Elymus smithii	6.78	11.08	40	50.00
Hordeum jubatum	0.13	0.78	40	2.50
Stipa hymenoides	0.50	1.50	40	10.00

* Seeding dates are in parentheses.

TABLE 21: Cell 4 (1986)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	572.09
TOTAL	572.09

* Seeding dates are in parentheses.

TABLE 22: Berm 1 (1983)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	27.00	12.79	40
Litter	12.13	5.58	40
Bareground	18.88	8.62	40
Rock	42.00	14.27	40
COMPOSITION			
Trees/Shrubs	1.95	9.91	40
Forbs	88.64	18.20	40
Grasses	16.91	48.19	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 23: Berm 1 (1983)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Chrysothamnus nauseosus	0.58	3.43	40	5.00
Ephedra viridis	0.08	0.47	40	2.50
FORBS				
Bassia hyssopifolia	0.53	2.45	40	75.00
Halogeton glomeratus	2.25	3.89	40	45.00
Lepedium montanum	1.13	1.82	40	35.00
Salsola iberica	17.83	12.00	40	95.00
Sisymbrium altissimum	2.05	4.14	40	27.50
Taraxicum officinale	0.05	0.31	40	2.50
GRASSES				
Agropyron cristatum	2.28	4.02	40	32.50
Dactylis glomeratus	0.13	0.79	40	2.50
Elymus trachycaulum	0.13	0.78	40	2.50
Hordeum jubatum	0.38	2.34	40	2.50

* Seeding dates are in parentheses.

TABLE 24: Berm 1 (1983)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Chrysothamnus nauseosus	162.62
Ephedra viridus	37.75
Gutierrezia sarothrae	90.02
TOTAL	290.40

* Seeding dates are in parentheses.

TABLE 25: Berm 2 (1984)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	34.13	12.54	40
Litter	5.13	0.78	40
Bareground	9.88	0.78	40
Rock	50.88	12.54	40
COMPOSITION			
Trees/Shrubs	36.21	30.25	40
Forbs	3.59	8.98	40
Grasses	60.20	28.12	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 26: Berm 2 (1984)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	10.05	11.66	40	60.00
Atriplex confertifolia	2.88	6.79	40	30.00
Gutierrezia sarothrae	1.88	10.23	40	5.00
FORBS				
Halogeton glomeratus	0.10	0.62	40	2.50
Salsola iberica	0.93	2.66	40	17.50
GRASSES				
Agropyron cristatum	10.75	8.02	40	75.00
Bromus tectorum	0.38	1.73	40	5.00
Elymus smithii	6.80	10.63	40	47.50
Hordeum jubatum	0.38	2.34	40	2.50

* Seeding dates are in parentheses.

TABLE 27: Berm 2 (1984)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	2703.62
Atriplex confertifolia	580.80
TOTAL	3284.42

* Seeding dates are in parentheses.

TABLE 28: Berm 3 (1985)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	34.20	16.81	40
Litter	10.68	8.25	40
Bareground	18.25	11.16	40
Rock	36.88	16.08	40
COMPOSITION			
Trees/Shrubs	26.34	31.45	40
Forbs	41.84	38.19	40
Grasses	31.82	29.32	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 29: Berm 3 (1985)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	10.75	16.79	40	47.50
Cercocarpus montanus	0.25	1.56	40	2.50
FORBS				
Halogeton glomeratus	1.13	2.56	40	20.00
Kochia scoparia	1.25	6.30	40	7.50
Salsola iberica	12.70	15.63	40	72.50
Sisymbrium altissimum	0.05	0.31	40	2.50
GRASSES				
Agropyron cristatum	6.20	5.71	40	67.50
Elymus smithii	1.00	2.29	40	17.50
Elymus trachycaulum	0.25	1.09	40	5.00
Hordeum jubatum	0.13	0.78	40	2.50
Poa pratensis	0.38	1.73	40	5.00
Stipa hymenoides	0.13	0.78	40	2.50

* Seeding dates are in parentheses.

TABLE 30: Berm 3 (1985)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	3104.38
TOTAL	3104.38

* Seeding dates are in parentheses.

TABLE 31: Berm 4 (1986)* - Total cover and composition summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover and composition with standard deviations and sample sizes.

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZES
Total Living Cover**	33.00	15.24	40
Litter	9.03	5.43	40
Bareground	26.45	15.24	40
Rock	31.53	11.18	40
COMPOSITION			
Trees/Shrubs	5.02	9.50	40
Forbs	58.88	30.24	40
Grasses	36.10	27.39	40

* Seeding dates are in parentheses.

** Sample size insures 80% accuracy within 10% of the true mean or maximum samples suggested by the State of Utah, Division of Oil, Gas and Mining.

TABLE 32: Berm 4 (1986)* - Species cover and frequency summary for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site. The table shows the mean percent cover, standard deviation, sample size and relative frequency by species.

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Atriplex canescens	1.38	2.50	40	25.00
FORBS				
Bassia hyssopifolia	0.50	3.12	40	2.50
Descurainia pinnata	0.08	0.47	40	2.50
Halogeton glomeratus	0.75	2.11	40	12.50
Melilotus officinalis	0.13	0.78	40	2.50
Plantago patagonica	0.13	0.78	40	2.50
Salsola iberica	18.95	14.81	40	87.50
Sphaeralcea coccinea	0.15	0.79	40	5.00
GRASSES				
Agropyron cristatum	10.78	10.91	40	87.50
Elymus smithii	0.13	0.78	40	2.50
Hilaria jamesii	0.03	0.16	40	2.50
Stipa comata	0.03	0.16	40	2.50

* Seeding dates are in parentheses.

TABLE 33: Berm 4 (1986)* - Woody species densities for the revegetated area at the Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

	NUMBER/ACRE
Atriplex canescens	781.18
TOTAL	781.18

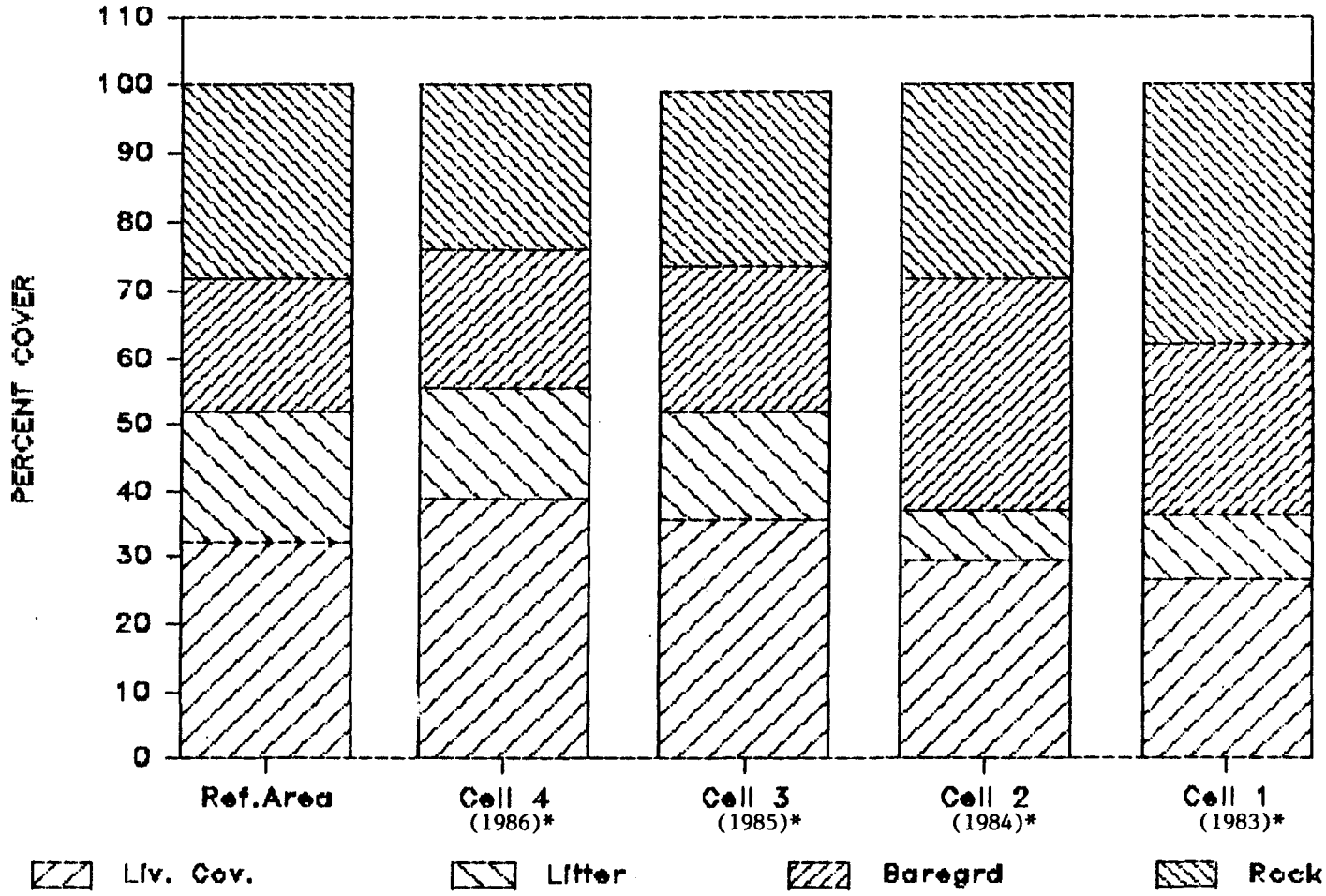
* Seeding dates are in parentheses.

TABLE 34: Revegetation seed mixture used for the cells and berms of Cottonwood/Wilberg Des-Bee-Dove Waste Rock Site.

SCIENTIFIC NAME	COMMON NAME	PLOTS*
SHRUBS		
Artemisia tridentata	Big Sagebrush	B
Atriplex confertifolia	Shadescale	A
Atriplex canescens	Four winged saltbush	A, B
Cercocarpos montanus	Mountain mahogony	B
Ephedra viridis	Mormon tea	A, B
FORBS		
Melilotus officinalis	Yellow sweetclover	B
Sphaeralcea coccinea	Scarlet globemallow	B
GRASSES		
Agropyron cristatum	Crested wheatgrass	A, B
Elymus hispidus	Intermediate wheatgrass	A
Elymus smithii	Western wheatgrass	B
Hilaria sp.	Galleta	B
Stipa comata	Needle-and-thread grass	B
Stipa hymenoides	Indian ricegrass	A, B

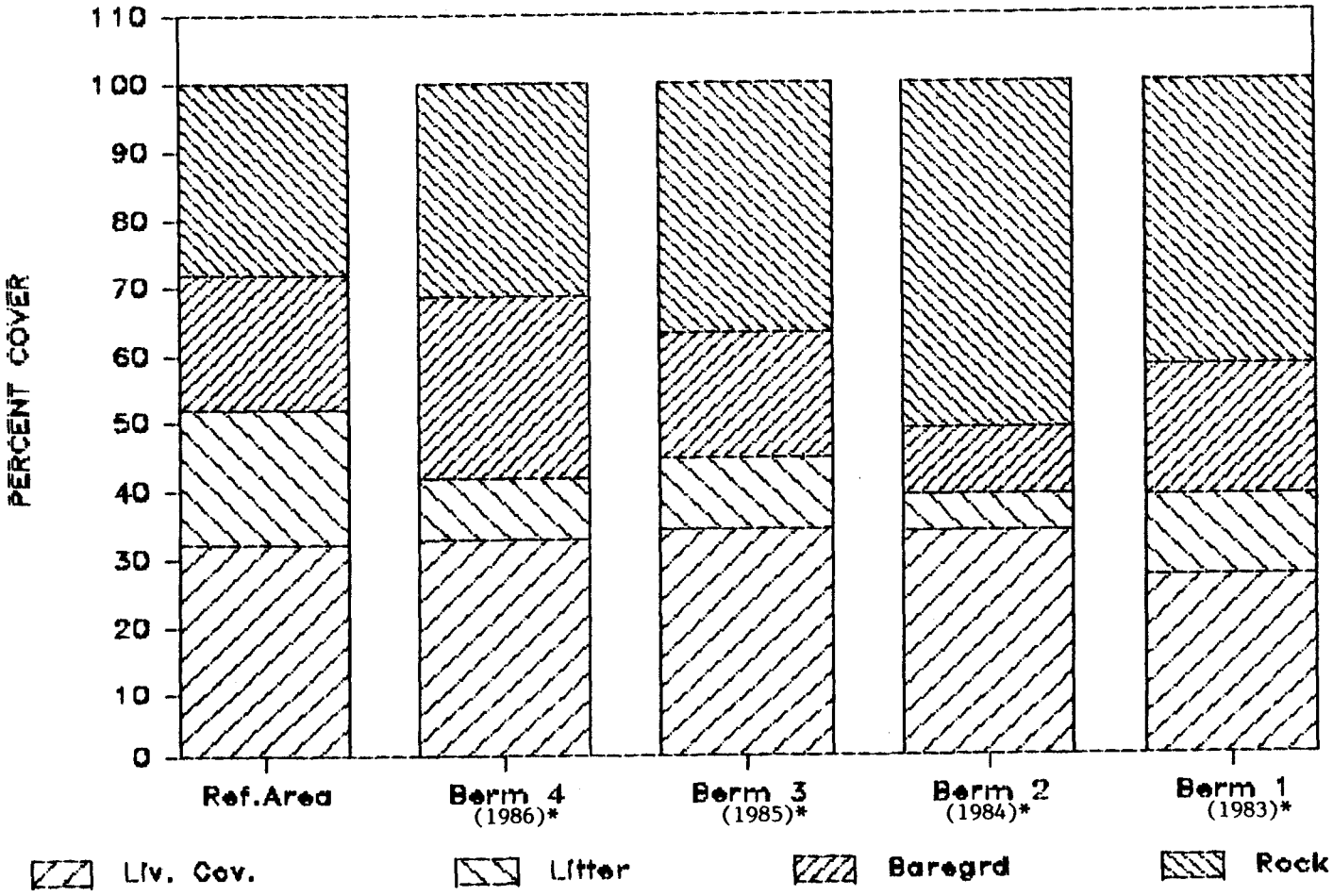
* A = Species used in mixture for Cell 1 and Berm 1 (1983).
B = Species used in all other cells and berms (1984-1986).

Fig. 2: Cell Cover Estimates -- 1989



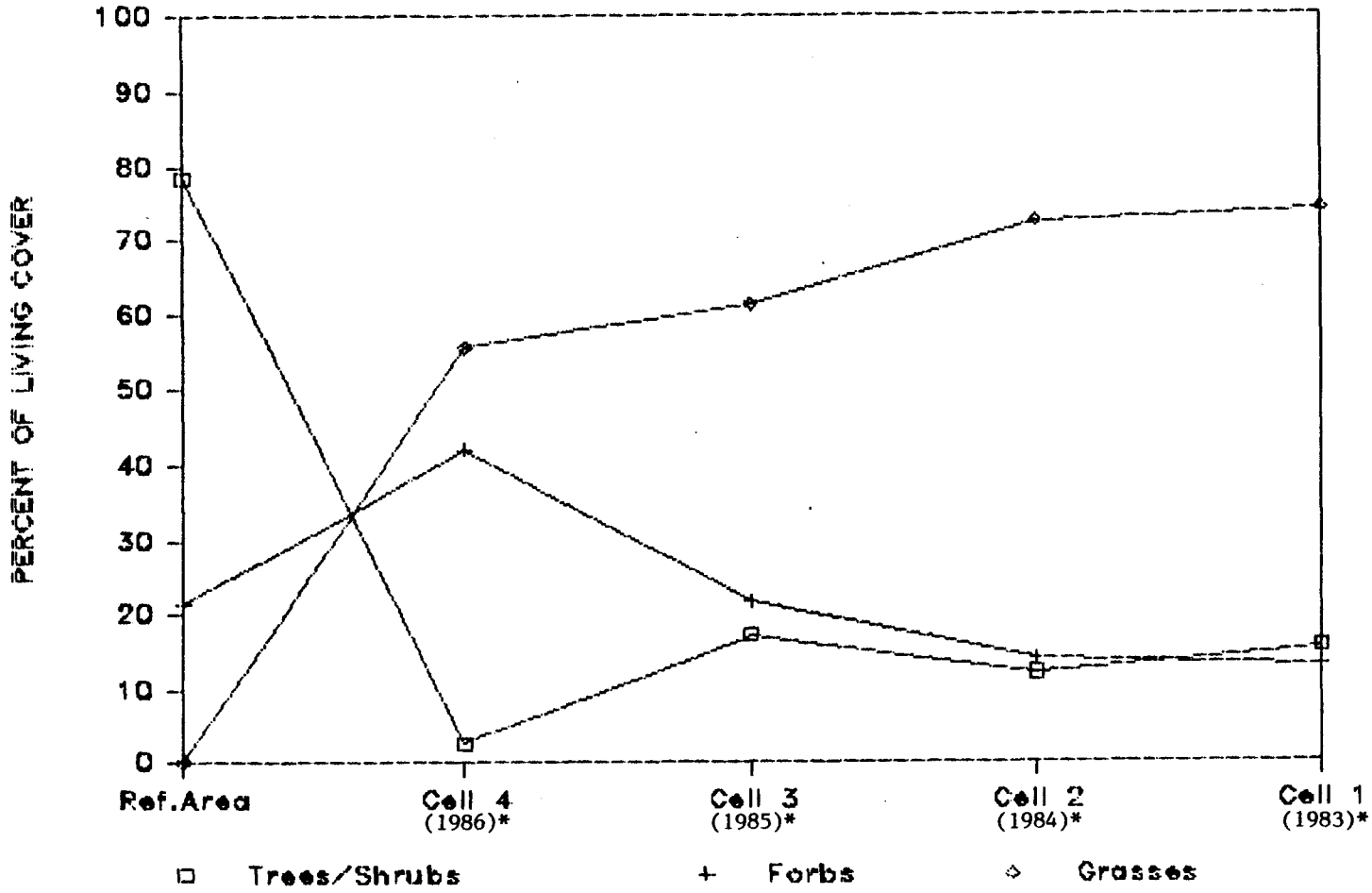
* Seeding dates

Fig. 3: Berm Cover Estimates -- 1989



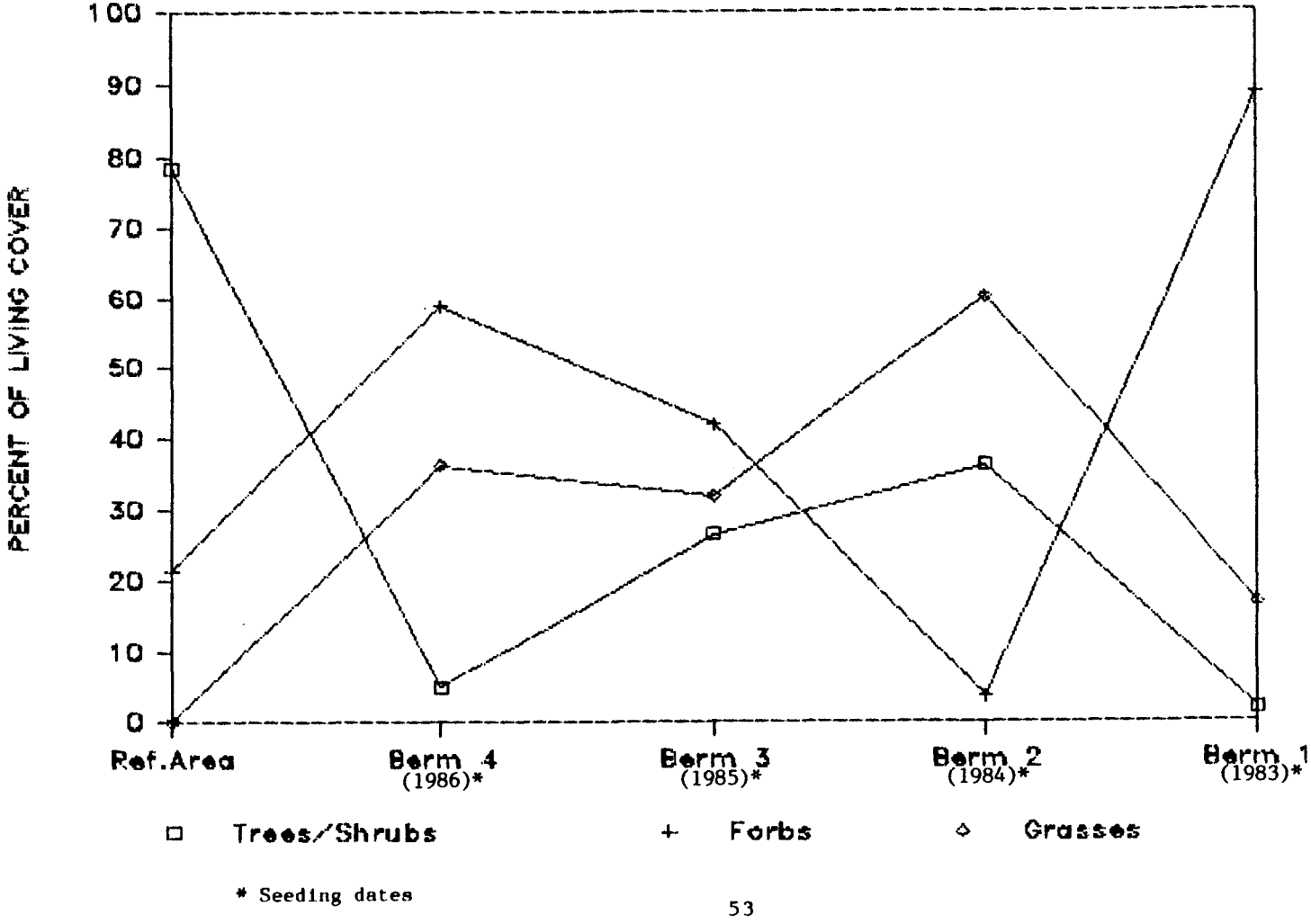
* Seeding dates

Fig. 4: Cell Composition -- 1989



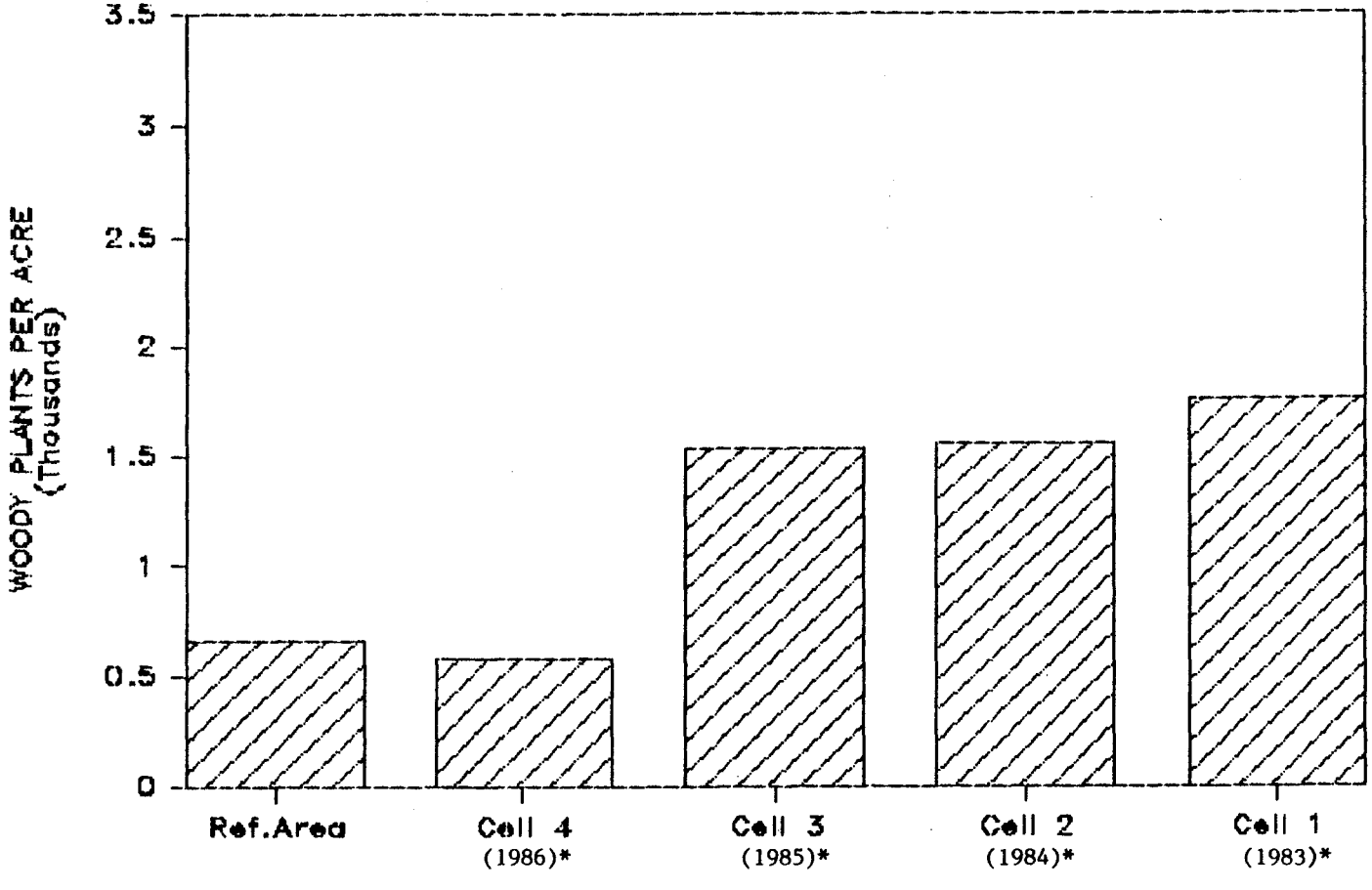
* Seeding dates

Fig 5: Berm Composition -- 1989



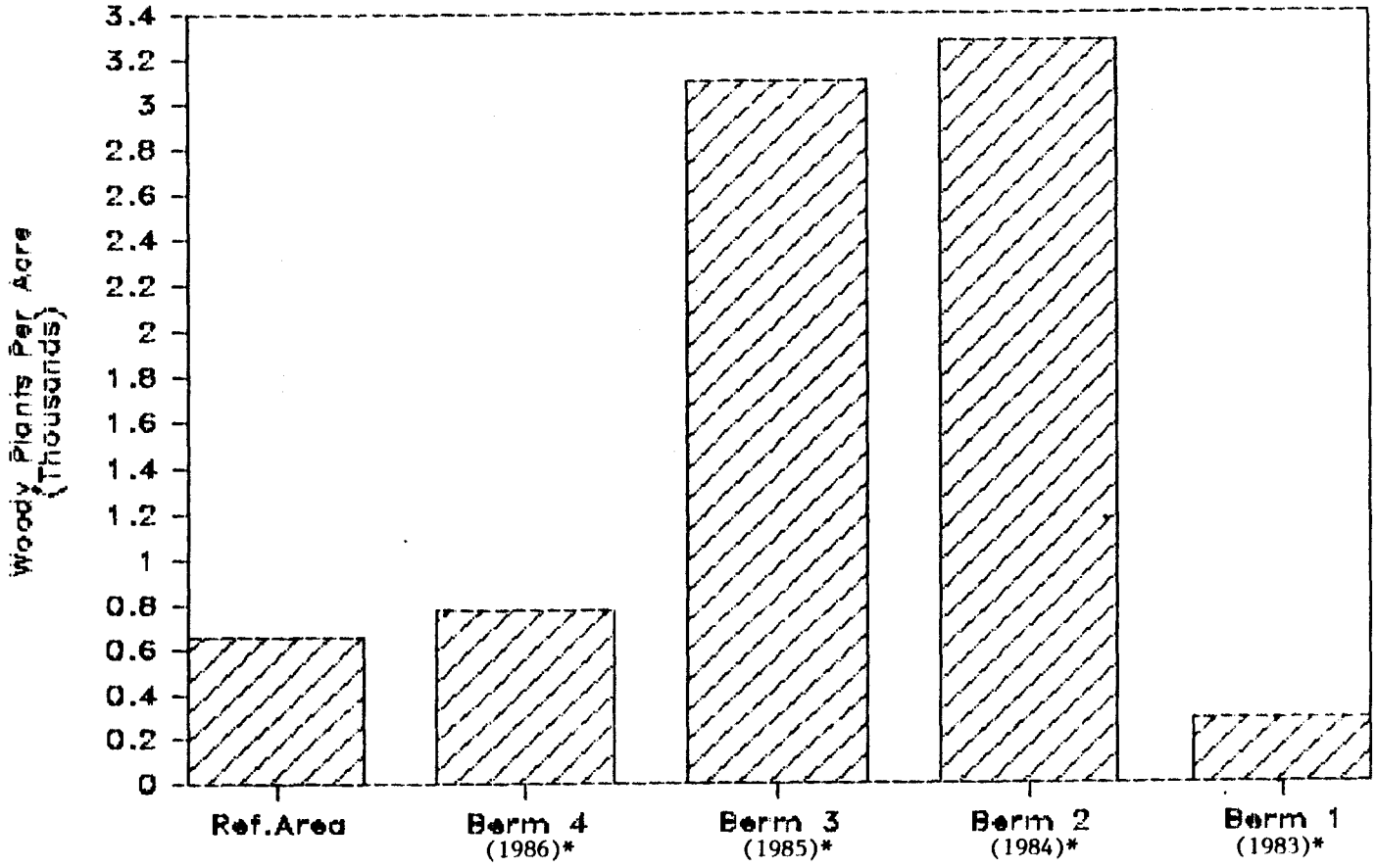
* Seeding dates

Fig. 6: Cell Density -- 1989



* Seeding dates

Fig 7: Berm Density -- 1989



* Seeding dates

Fig. 8: Active waste rock site before reclamation (color).

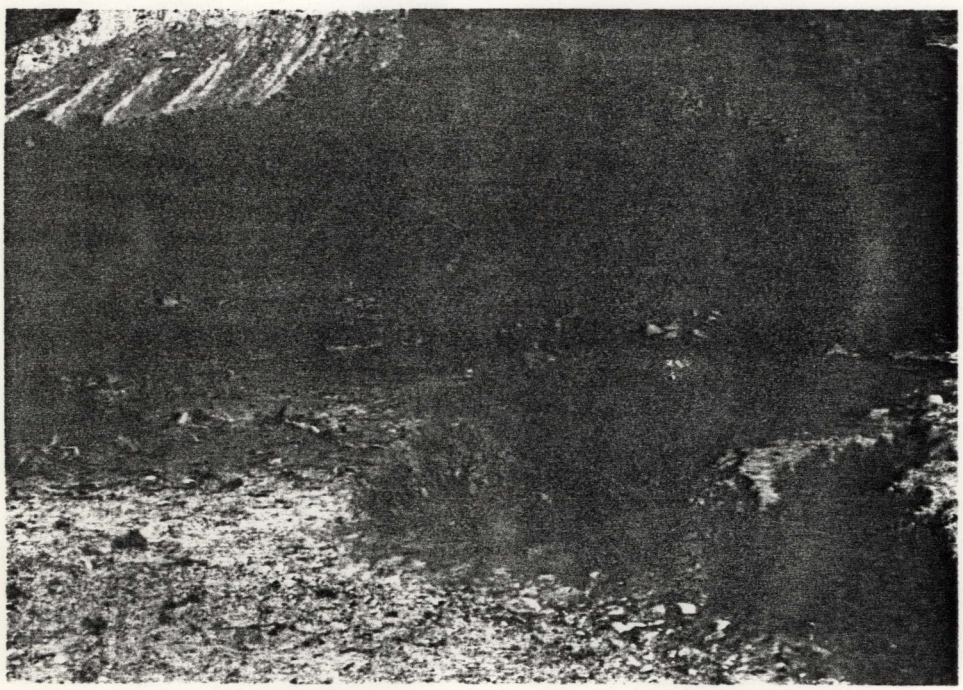


Fig. 9: Reference Area for all cells & berms (color).

Fig. 10: CELL 1 (orig. copies of all photos in color).

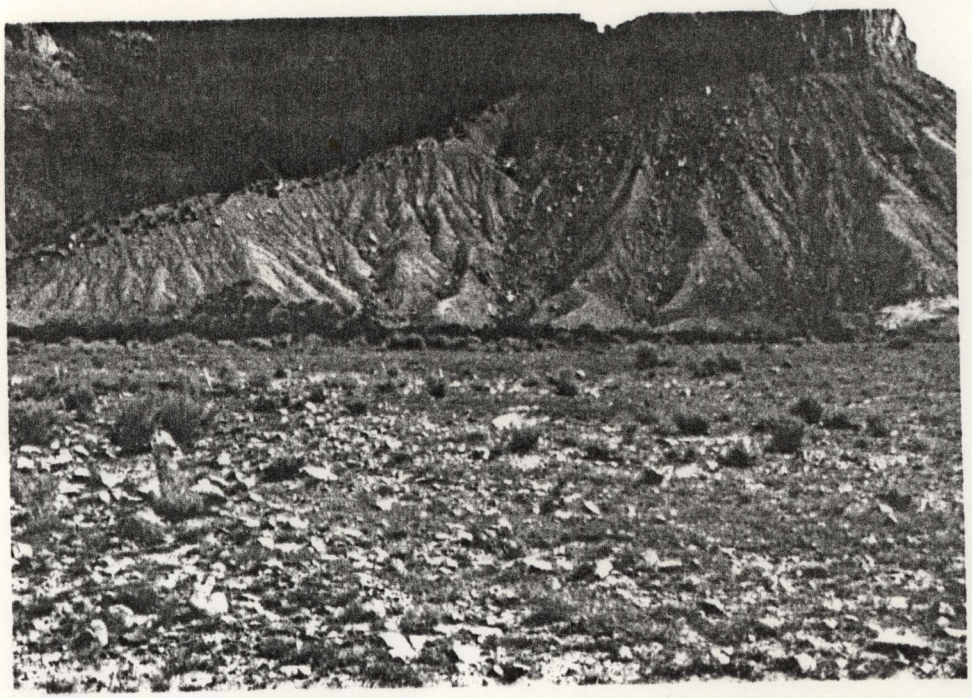


Fig. 11: Salt area shown between wooden stakes of CELL 2.

Fig. 12: CELL 3

Fig. 13: CELL 4

Fig. 14: BERM 1

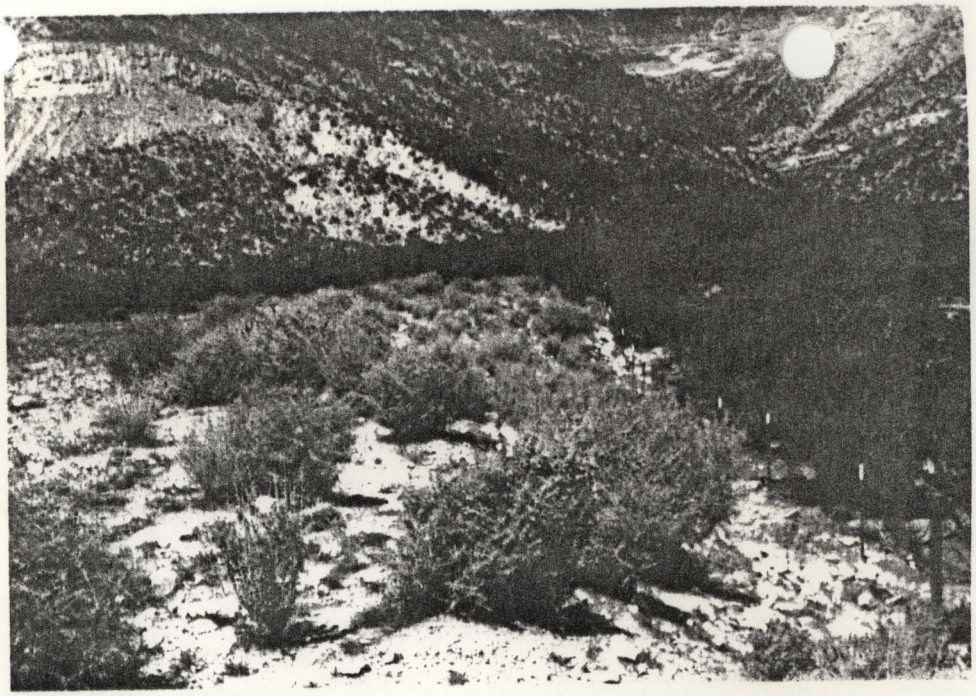


Fig. 15: BERM 2

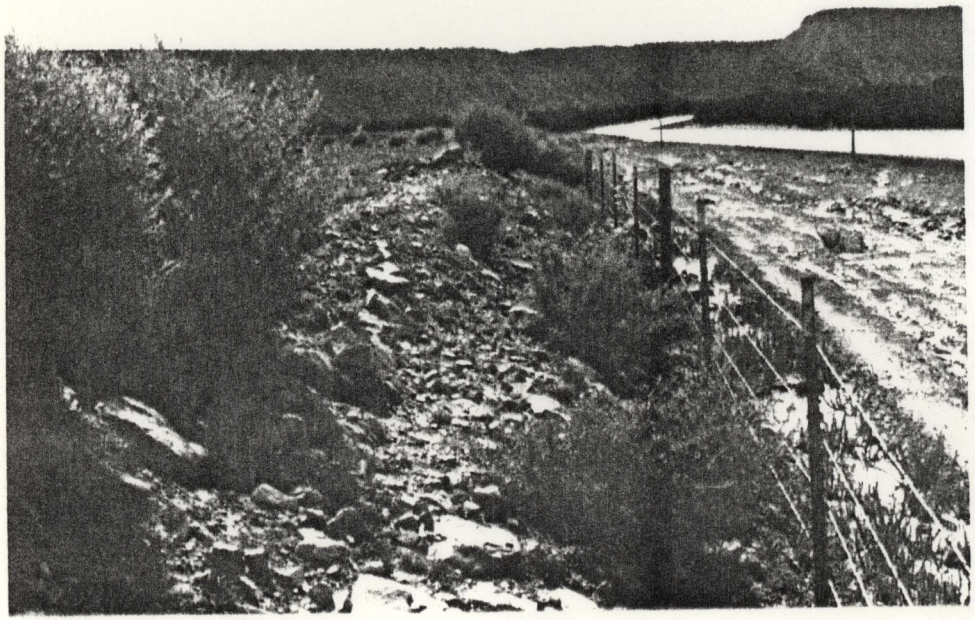


Fig. 16: BERM 3

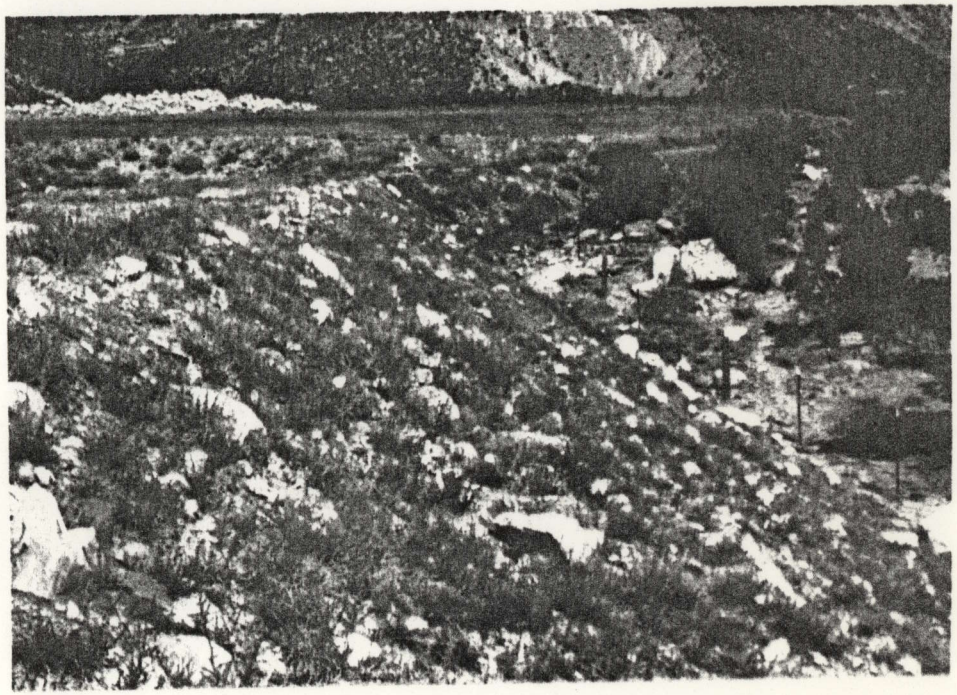


Fig. 17: BERM 4