

CLIMATE

CHAPTER 11

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INDEX

Introduction	1
Precipitation	1
Temperature	2
Evaporation	2
Wind	2

LIST OF FIGURES

Figure 1.	4
The Black Mesa Region of Northern Arizona	
Figure 2.	5
Meteorological Monitoring Sites	
Figure 3.	6
Average Annual Precipitation by Site	
Figure 4.	7
Average Monthly Precipitation	
Figure 5.	9
Annual Precipitation	
Figure 6.	15
Distribution of Wind Direction - Site 8	
Figure 7.	16
Distribution of Wind Direction - Site 7	

LIST OF TABLES

Table 1.	8
Maximum Rainfall Intensities by Monitoring Location	
Table 2.	10
Temperature Statistics	
Table 3.	11
Pan Evaporation	
Table 4.	12
Monthly Average and Maximum Wind Speed	
Table 5.	13
Joint Frequency Distribution of Wind Direction	
and Speed - Site 1	
Table 6.	14
Joint Frequency Distribution of Wind Direction	
and Speed - Site 8	

Introduction

The Black Mesa is located in a remote region of Northeastern Arizona characterized by flat topped mesas and plateaus, isolated buttes and desert valleys. The Black Mesa is one of the three highest plateaus and mesas of the Colorado Plateau Physiographic Province. The other two high plateaus and mesas are the Defiance Plateau which parallels the New Mexico border just west of Fort Defiance and the Skeleton Mesa west of Kayenta (Figure 1).

Weather data were not systematically collected on Northern Black Mesa prior to Peabody's initiation of a meteorological monitoring program in the spring of 1980. Since that time, meteorological data have been collected at the locations shown in Figure 2 and Drawing 85600. The monitoring network consists of eight primary monitoring locations equipped as follows: one 40-meter tower; three ten-meter towers; and four supplemental rain gauges. Approximately five years of data have been collected, and analyses of these data form the basis of the following discussions.

Precipitation

The Black Mesa has a dry climate, receiving approximately ten inches of precipitation during an average year (Figure 3). Much of the precipitation falls during the summer months, when afternoon showers form in the moist air which moves over the strongly heated mesa from its source region in the Gulf of Mexico. Showers and thunderstorms are usually accompanied by brief, intense rainfall and are often preceded by strong gusty winds. Very infrequently, late summer precipitation is increased by a dissipating tropical disturbance which moves northeastward over the mesa from Baja, California or from the coast of Southern California.

Most precipitation is received in the summer months (Figure 4). Forty-six percent of the annual precipitation is received in the months of July, August and September, and sixty-four percent is received in the period April through September. In the winter, spring and fall, only occasional storms bring significant moisture from the Pacific Coast. Many winter and spring storms are dry, bringing only high winds and cold temperatures.

Wind speeds average approximately three meters per second (approximately seven miles per hour). A maximum wind speed of 33 meters per second (74 miles per hour) has been recorded (see Table 4). The highest average monthly wind speeds occur in April and May and the

Wind

Evaporation has been monitored annually at four locations (1, 8, 9, 12) during the period May 15 through October 15. Table 3 contains a summary of the evaporation data. Mean annual evaporation for these months is 45 inches with the greatest monthly evaporation occurring during June and July.

Evaporation

Because of its moderate high elevation, the Black Mesa leasehold has mild summer and cold winter temperatures. The average temperature is approximately 48° F. Daily temperatures from the middle of June until the end of August range from a low in the mid to high 40's to a high in the high 80's or low 90's. Readings above 100° F are rare. Summer nights are occasionally quite cool with early morning temperatures falling into the low 40's. In winter, early morning temperatures normally fall to the high teens or low 20's; however, the air usually warms rapidly, reaching the high 30's, or more, by early afternoon. Table 2 contains temperature statistics for the Black Mesa leases. The data have been collected at four sites (1, 8, 9, 12) at the ten-meter level.

Temperature

It appears that the total amount of precipitation received at various locations on the leasehold may be related to topographic features and elevation. Figure 5 shows the distribution of annual average precipitation and topography. As the length of the data record increases, this potential relationship may be examined more closely.

Most often precipitation falls in a showerly form. Because of this, it is common to experience widely different amounts of precipitation at the various monitoring sites during the same period. Rainfall intensities as high as 0.90 and 1.98 inches in one hour and twenty-four hours, respectively, have been observed (Table 1).

Most snowfalls are small and melt within a few days.

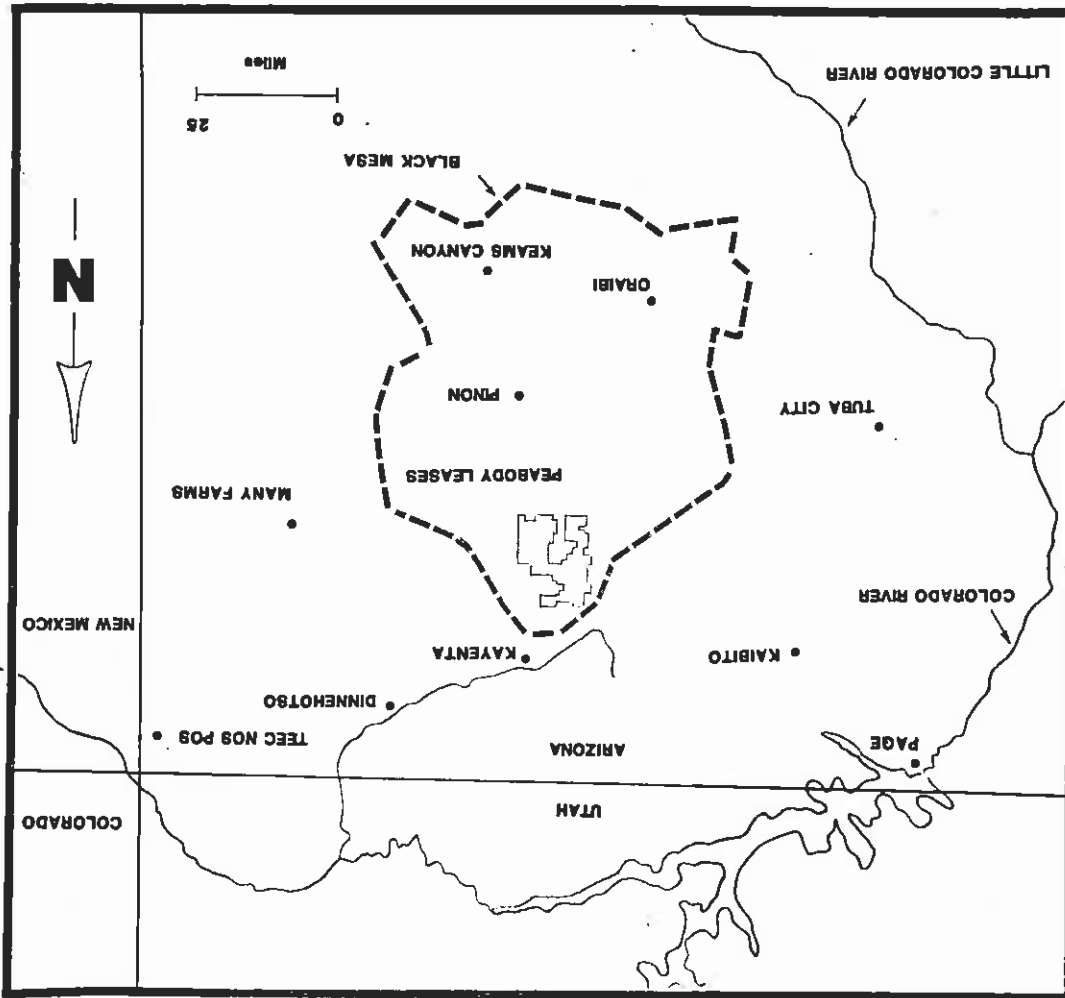
lowest occur in January and September.

The joint frequency distribution of wind speed and direction for Sites 1 and 8 may be found in Tables 5 and 6, respectively. There is a significantly different distribution of wind direction between these two sites because of their locations. The topography is such that Site 1 is located at the bottom of a "bowl" (elevation 6407 feet) on relatively flat terrain. Site 8 is located at the rim of the "bowl" at an elevation of 7040 feet. The result is a greater percentage of calm periods at Site 1 compared to Site 8 (32.25 percent versus 22.66 percent). During calm periods, wind direction becomes variable due to the absence of a pronounced pressure gradient.

The distribution of wind direction and speed at Sites 8 and 1 may be found in Figures 6 and 7, respectively. Both sites exhibit a predominance of southerly winds with southwesterly winds being most frequent.

THE BLACK MESA REGION OF NORTHERN ARIZONA

FIGURE 1



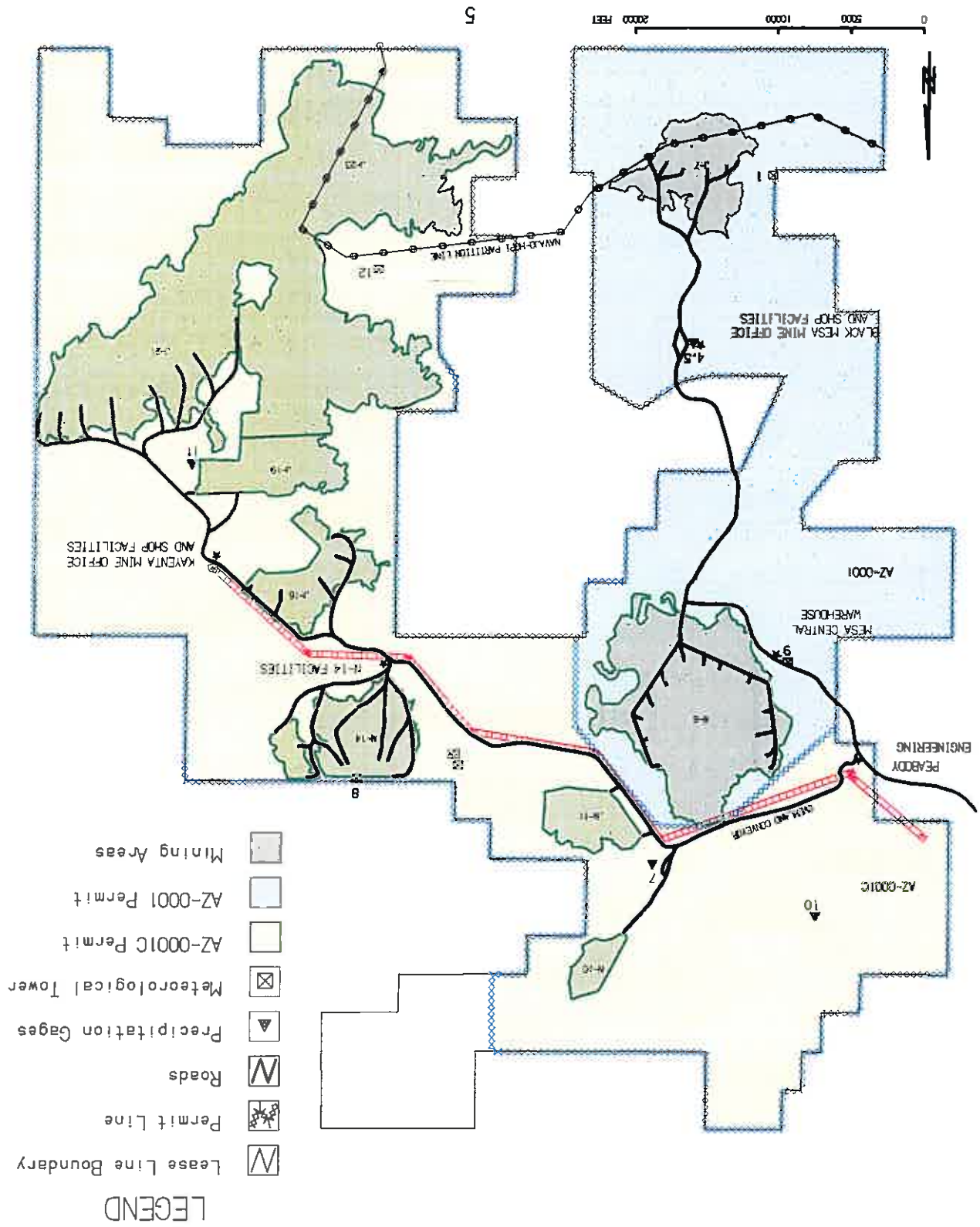


FIGURE 2

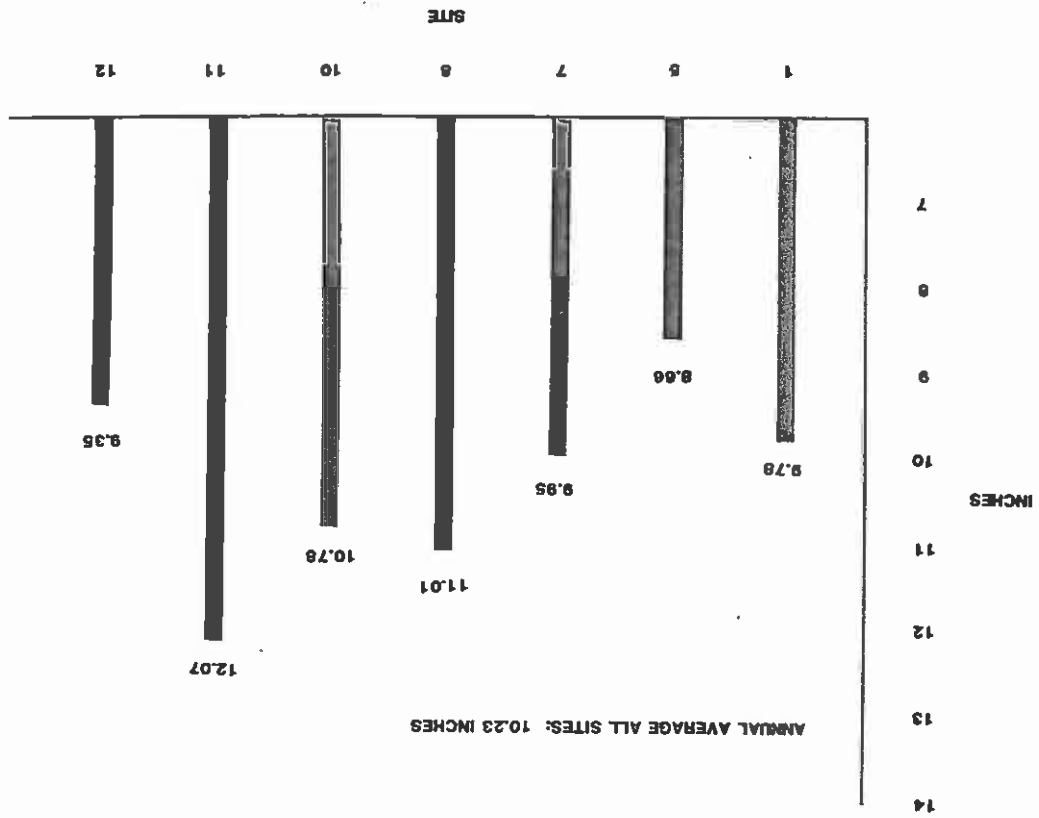


FIGURE 3
AVERAGE ANNUAL PRECIPITATION BY SITE
BLACK MESA LEASES
PEABODY COAL COMPANY
(March, 1980 - June, 1985)

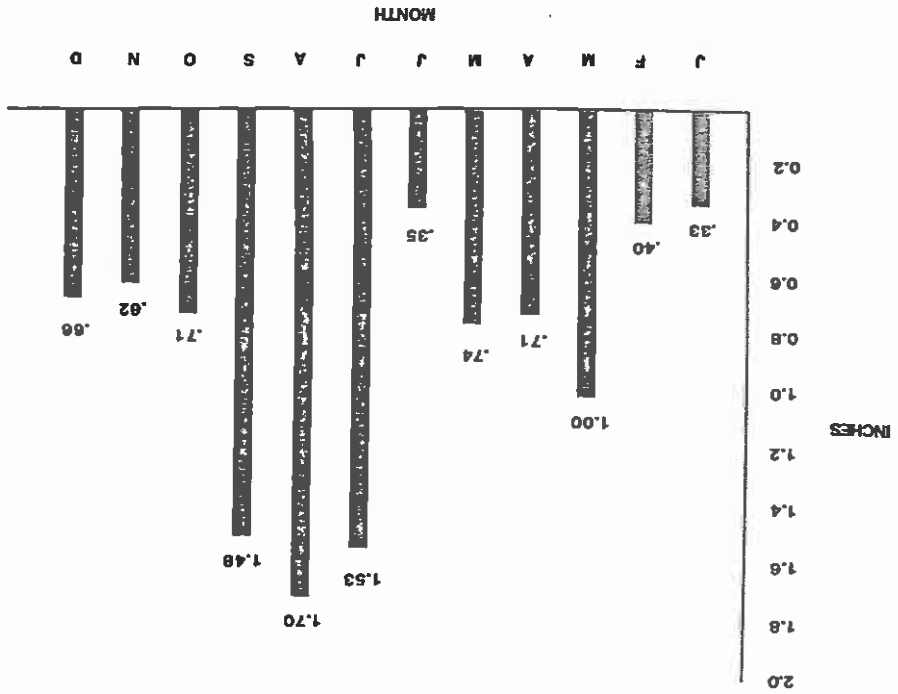


FIGURE 4
 AVERAGE MONTHLY PRECIPITATION
 BLACK MESA LEASES
 PEABODY COAL COMPANY
 (March, 1980 - June, 1985)

Maximum Rainfall Intensities
 By Monitoring Location
 Black Mesa Leases
 Peabody Coal Company
 March, 1980 - June, 1985

<u>SITE</u>	<u>Month/Year</u>	<u>DAILY</u> Amount (inches)	<u>Month/Year</u>	<u>HOURLY</u> Amount (inches)
1	Sept/1983	1.32	Aug/1982	0.74
5	Sept/1983	1.03	Aug/1980	0.49
7	Sept/1983	1.59	Aug/1983	0.85
8	Sept/1983	1.40	Aug/1984	0.58
10	Sept/1983	0.96	Jul/1984	0.60
11	May/1980	1.98	Jun/1984	0.90
12	Jul/1982	1.14	Aug/1981	0.69

TABLE 1

PEABODY COAL COMPANY

BLACK MESA LEASES

(Inches)

ANNUAL PRECIPITATION

FIGURE 5

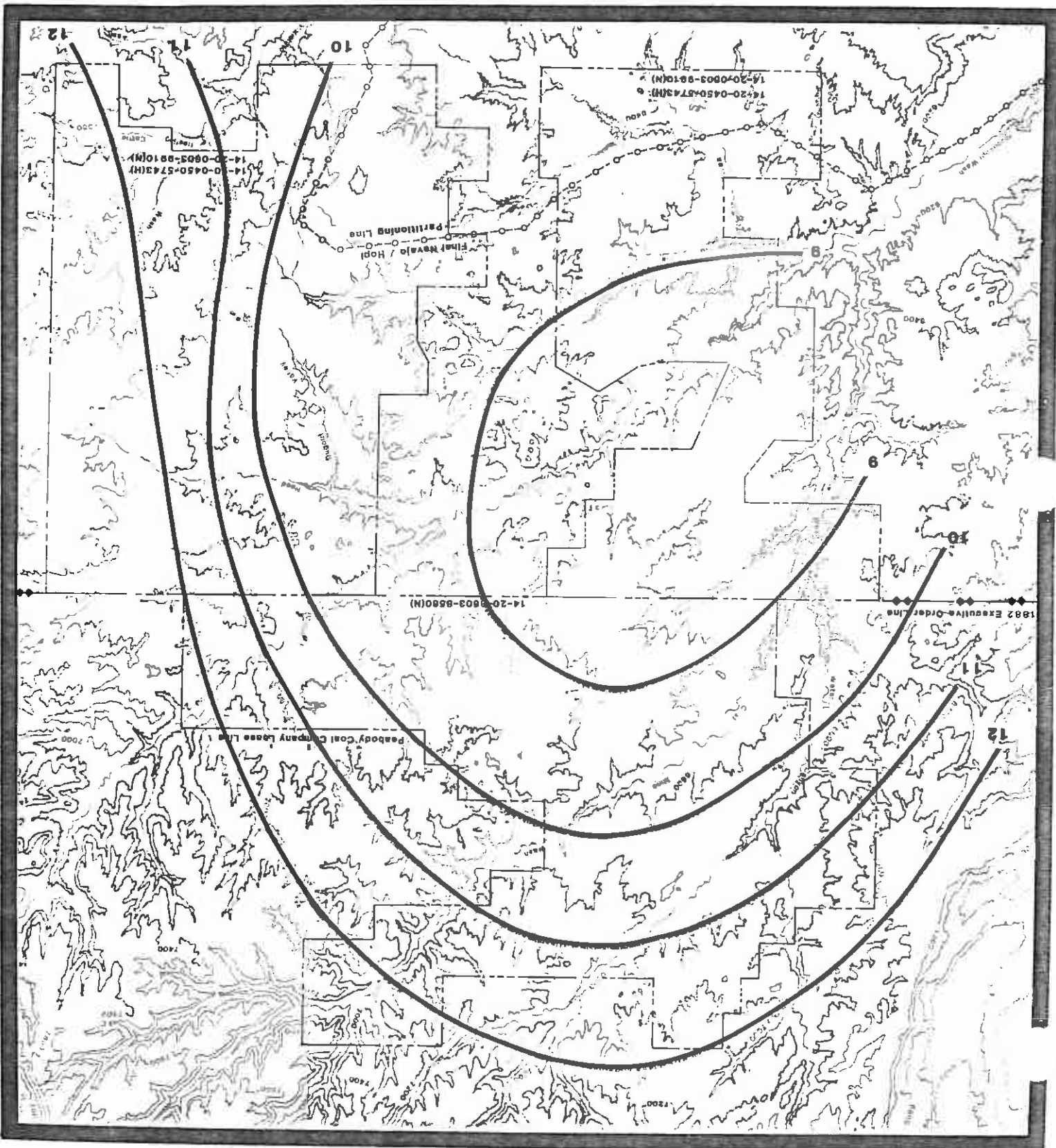


TABLE 2

Temperature Statistics

Black Mesa Leases

Peabody Coal Company

(July, 1980 - June, 1985)

Month	Mean (°F)	Average Maximum (°F)	Average Minimum (°F)
January	31	42	22
February	32	44	24
March	37	47	27
April	45	58	31
May	55	68	40
June	65	79	48
July	69	83	56
August	66	80	55
September	60	74	47
October	47	59	34
November	38	49	29
December	33	42	25

Evaporation is monitored from May 15 to October 15.

Month	Evaporation (inches)
May	6.0
June	11.5
July	10.7
August	8.0
September	6.1
October	2.7

(May, 1980 - June, 1985)

Peabody Coal Company

Black Mesa Leases

Pan Evaporation

TABLE 3

TABLE 4
 Monthly Average and Maximum
 Wind Speed
 Black Mesa Leases
 Peabody Coal Company

Month	Average Wind Speed (M/S)	Maximum Wind Speed (M/S)
January	2.4	17.0
February	2.6	22.0
March	3.7	24.6
April	3.8	23.6
May	3.8	20.7
June	3.4	21.5
July	2.6	18.2
August	2.6	33.2
September	2.4	18.6
October	2.9	21.6
November	3.0	22.8
December	2.6	18.7

TABLE 5
 Joint Frequency Distribution
 Wind Direction and Speed
 (Percent)

Site 1: May, 1980 - June, 1985

Black Mesa Leases

Pebody Coal Company

Wind Speed (M/S)

Direction	0-3	4-6	7-10	11-16	17-21	Total
N	1.44	0.64	0.20	0.02		2.30
NNE	1.89	0.83	0.14	0.01		2.87
NE	1.80	0.71	0.12	0.01		2.64
ENE	1.80	0.42	0.07	0.00		2.29
E	2.58	0.35	0.08	0.01		3.02
ESE	4.19	0.59	0.14	0.03		4.95
SE	3.69	1.00	0.32	0.06		5.07
SSE	2.25	1.40	0.63	0.10		4.38
S	1.98	1.72	1.06	0.23	0.01	5.00
SSW	1.87	2.36	1.50	0.34	0.01	6.08
SW	2.57	3.03	1.55	0.38	0.02	7.55
WSW	2.57	2.32	0.97	0.21	0.01	6.08
W	2.08	1.56	0.70	0.14		4.48
WNW	1.85	1.33	0.74	0.16	0.01	4.09
NW	1.74	1.15	0.62	0.13		3.64
NNW	1.81	1.05	0.40	0.05		3.31
Total	36.11	20.46	9.24	1.88	0.06	67.75

Calm 32.25

TABLE 6

Joint Frequency Distribution
 Wind Direction and Speed
 (Percent)

Site 8: May, 1980 - June, 1985

Black Mesa Leases

Peabody Coal Company

Wind Speed (M/S)

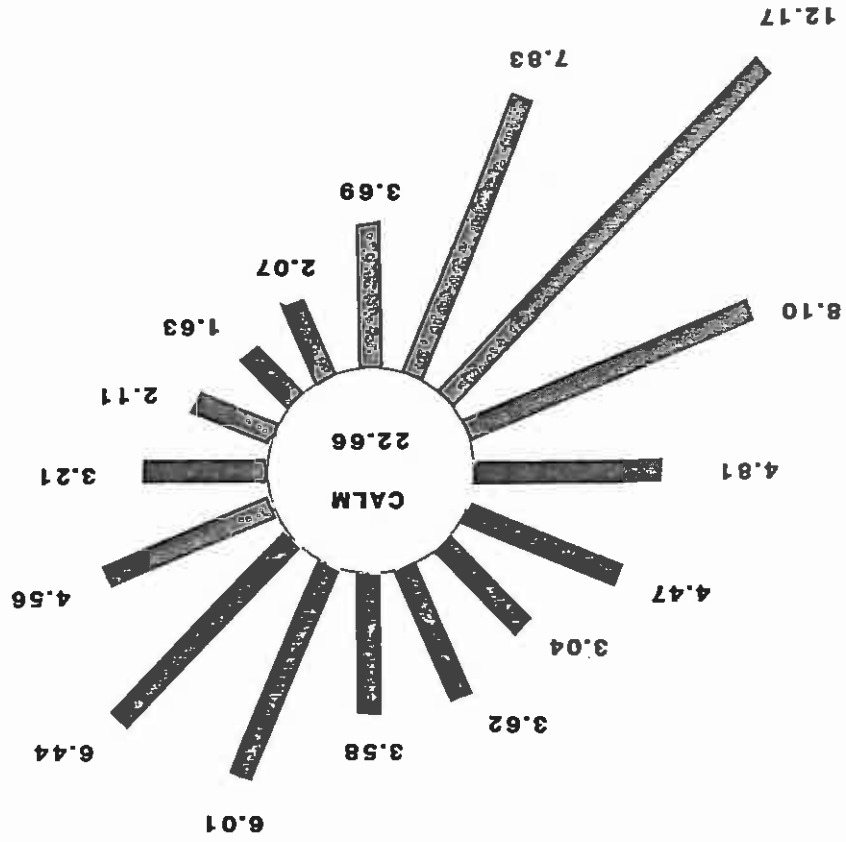
Direction	0-3	4-6	7-10	11-16	17-21	Total
N	2.23	1.11	0.22	.02		3.58
NNE	3.57	1.97	0.43	.04		6.01
NE	4.35	1.68	0.36	.05		6.44
ENE	3.62	0.81	0.12	.01		4.56
E	2.78	0.39	0.04			3.21
ESE	1.82	0.26	0.03			2.11
SE	1.42	0.19	0.02			1.63
SSE	1.70	0.30	0.07			2.07
S	2.41	0.92	0.33	.03		3.69
SSW	3.74	2.61	1.23	.24	.01	7.83
SW	4.98	4.48	2.19	.49	.03	12.17
WSW	3.60	2.84	1.36	.29	.01	8.10
W	2.65	1.60	0.51	.05		4.81
WNW	2.70	1.38	0.37	.02		4.47
NW	2.07	0.79	0.17	.01		3.04
NNW	2.31	1.03	0.26	.02		3.62
Total	45.95	22.36	7.71	1.27	0.05	77.34
Calm						22.66

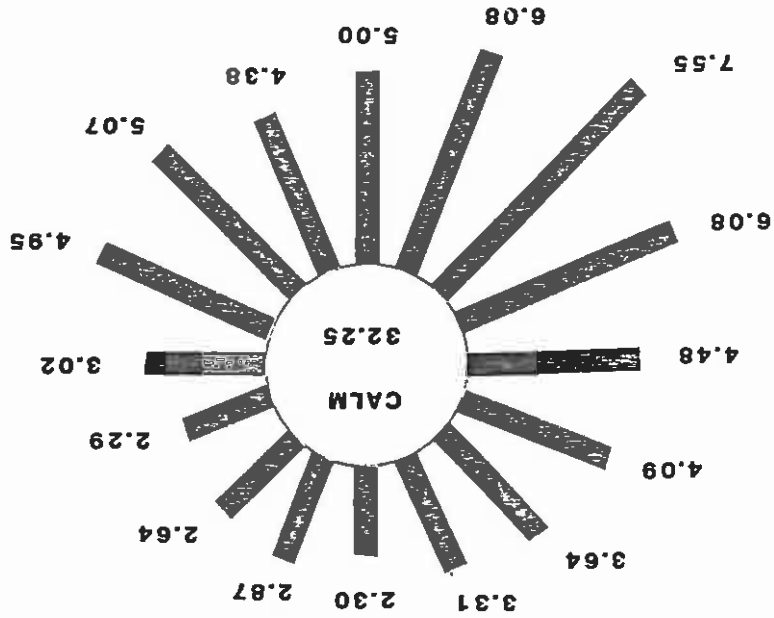
FIGURE 6

DISTRIBUTION OF WIND DIRECTION
(Percent)

Site 8: May, 1980 - June, 1985

BLACK MESA LEASES
PEABODY COAL COMPANY





**PEABODY COAL COMPANY
BLACK MESA LEASES
Site 1: May, 1980 - June, 1985**

**DISTRIBUTION OF WIND DIRECTION
(Percent)**

FIGURE 7