SECTION 12

CLIMATE

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CLIMATE

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12 CLIMATE

12.1 Climatological Factors

Navajo Mine is located in an arid and semi-arid climatic region within the Colorado Plateau physiographic province of the Western United States, geographically west of the 100th meridian west longitude. The Permit Area ranges in elevation from 5,000 to 5,600 feet above sea level. The average annual precipitation is 5.90 inches with an annual average net evaporation rate of 55 inches (Class A Pan method) (Williams 1986). The average relative humidity ranges from 33 percent in July to 65 percent in January with an annual average of 45 percent (Navajo Mine).

Navajo Mine has collected climatological data from two onsite meteorological monitoring stations designated Met Station I and Met Station II (see Exhibit 12-1 for locations) since 1991. In addition, long term climatological data are available from other stations in the area, including the New Mexico State University (NMSU) Agriculture Science Center which provides the most continuous long term data base near the Navajo Mine.

12.1.1 Precipitation

Long term precipitation data is obtained from the NMSU Agriculture Science Center, located nine miles east of the Navajo Mine (Smeal et. al., 2003). The average annual precipitation for the general area for the last 34 years (1969-2003) has been 8.10 inches with a minimum of 3.57 inches in 1976 and a maximum of 14.65 inches in 1986. Automated Navajo Mine precipitation data collected since 1991 and the NMSU data sets are summarized in Table 12-1.

Most precipitation in the region occurs from July through September from localized, high intensity, short duration thunderstorms.

12.1.2 Temperature

The NMSU site shows temperature extremes were -34 ^{o}F in 1961 and 105 ^{o}F in 1971. Navajo Mine's temperature data for the 2003 calendar year averaged approximately 56.3 ^{o}F for Met Station II. The temperature extremes in Table 12-2 were based on one-hour averages and were 32.9 ^{o}F and 79 ^{o}F. The NMSU temperature data are summarized in Table 12-2 and the 2003 Navajo Mine data is summarized in Table 12-3.

12.1.3 Growing Season

From the NMSU 1957 through 1992 data, the average frost-free growing season is 146 days. The average date of the last frost (32 ^{o}F) is usually May 19th and the first frost is usually October 11th. This data is summarized in Table 12-2.

12.1.4 Wind Data

The wind speed and direction data are available from Navajo Mine Met Station I and Met Station II. Cumulative wind roses for both stations are shown in Figure 12-1 and Figure 12-2 for the calendar years 1991 through 2003.

The wind rose data shows hourly average wind speed in meters per second (m/s) and direction. The wind rose profiles at the Navajo Mine show the prevailing high and low velocity wind directions. Episodic wind events can reach velocities up to 51 m/s (115 mph). Generally, the highest winds occur in the spring and during summer thunderstorm events. These high velocity winds are responsible for and can be correlated to the collection of elevated fugitive dust emission data.

Approximately 75 percent of the wind speed data collected falls between 1.1 to 5.0 meters/second (2.5 to 11 mph) and comes from the prevailing wind directions SSE, SE, ESE, and E. Approximately, 25 percent of the wind speed data collected falls within 5.1 to 15.0 m/s (11 to 33 mph) and comes from the opposite NW and NNW directions.

The wind direction patterns shown are different for the two meteorological stations. At Met Station I the predominant directions are NW-WNW and E-ESE. At Met Station II the predominant directions are NNW-NW and SE-SSE. These differences represent effects of the local topography. The northern Met Station I is affected by the San Juan River Valley drainage winds which account for the shift in the prevailing wind direction to a more easterly orientation. The Met Station II wind direction patterns are considered the most representative of the wind direction patterns in the central (i.e., Hosteen and Barber) and southern (i.e., Lowe and Dixon) areas of the mine.

12.2 Climate Information Collection and Analysis

Navajo Mine meteorological monitoring program was redesigned in the spring of 1991. The two existing three meter tripods were replaced with two 10 meter towers at the same locations meteorological sensors and data acquisition systems were replaced. The meteorological equipment is operated in compliance with Prevention of Significant Deterioration (PSD) Meteorological Program Guidance for Regulatory Model Applications (U.S. EPA 1987). The location of the monitoring stations are shown in Exhibit 12-1.

Each station produces hourly averages of wind speed, wind direction, sigma theta (standard deviation of horizontal wind direction), temperature, relative humidity, and hourly precipitation totals. The wind, temperature, and humidity sensors are mounted on the towers at approximately 10 meters (about 33 feet) above ground level. The precipitation sensor is at ground level. The meteorological data collected at each station is used to document climatic condition and the identification of sources of natural (i.e., high winds) or mine related fugitive dust. Cumulative twelve-year wind rose graphic representations of the wind speed and wind direction are shown in Figure 12-1 and Figure 12-2. Data used for Figure 12-1 and Figure 12-2 are located in Appendix 12.A.

References

Navajo Mine. Onsite met tower data from Navajo Mine's meteorological stations.

Smeal, D., M. K. O'Neill, C. K. Owen, Z. F. Williams, M. M. West, and R. N. Arnold. 2003. Thirty-five Years (1969-2003) of Climatological Data: NMSU' Agricultural Science Center at Farmington, New Mexico." New Mexico State University Agricultural Experiment Station Research Report 756. Available online at:

http://aces.nmsu.edu/pubs/research/weather_climate/RR756.pdf.

US Environmental Protection Agency. 1987. Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). Office of Air Quality Planning and Standards, Research Triangle Park, NC. EPA-450/4-8/00/, May.

US Environmental Protection Agency. 1987. Onsite Meteorological Program Guidance for Regulatory Model Applications. EPA-450/4-87-013.

Williams, Jerry, 1986 New Mexico in Maps. University of New Mexico.

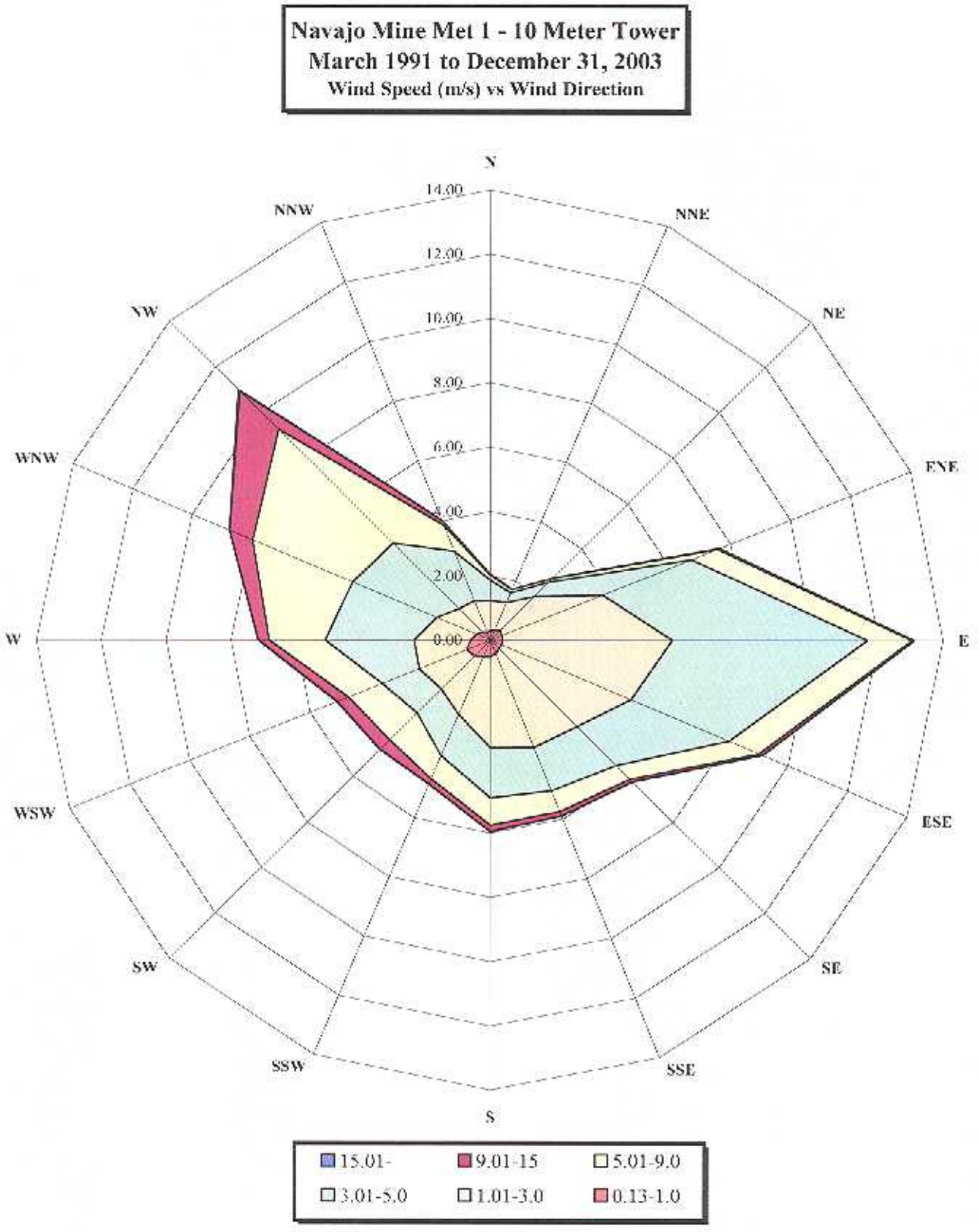
Navajo Mine Met 1 - 10 Meter Tower
March 1991 to December 31, 2003
Wind Speed (m/s) vs Wind Direction
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
15.01-
9.01-15
5.01-9.0
3.01-5.0
1.01-3.0
0.13-1.0

Figure 12-1

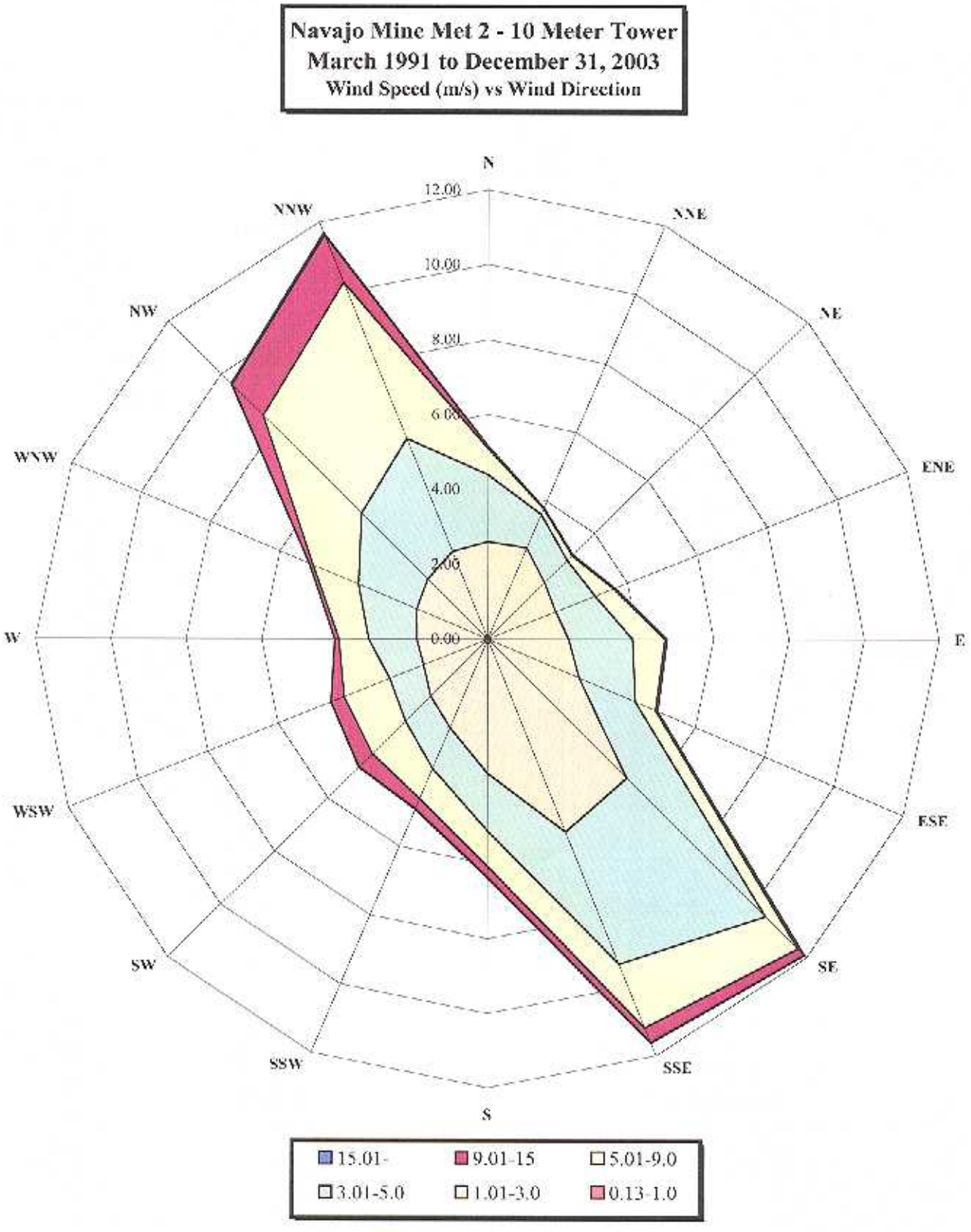
Navajo Mine Met 2 - 10 Meter Tower
March 1991 to December 31, 2003
Wind Speed (m/s) vs Wind Direction
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
12.00
10.00
8.00
6.00
4.00
2.00
0.00
15.01-
9.01-15
5.01-9.0
3.01-5.0
1.01-3.0
0.13-1.0

Figure 12-2

Table 12-1 Navajo Mine Regional Precipitation Data (inches)

MET I & II Average													Annual	Monthly	Monthly
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total	Maximum	Minimum
	.	.	.	.	0.86	0.19	0.17	1.06	0.82	0.33	1.08	0.86	5.41	1.08	0.17
	0.12	0.14	0.92	0.03	1.08	0.02	0.46	2.03	0.55	0.36	0.15	0.38	6.21	2.03	0.02
	1.51	0.60	0.41	0.16	0.37	.	0.04	1.84	0.87	0.85	0.45	0.07	6.89	1.84	0.04
	0.03	0.44	0.13	0.26	1.17	0.12	0.39	0.39	1.10	0.77	0.40	0.36	5.55	1.17	0.03
	0.32	0.25	0.57	0.91	0.41	0.35	0.17	0.86	0.78	0.02	0.13	0.47	5.21	0.91	0.02
	0.11	0.24	0.16	0.10	0.09	0.91	0.25	0.62	0.37	1.33	0.31	0.11	4.57	1.33	0.09
	0.38	0.08	0.00	2.43	0.79	0.47	1.20	1.44	1.11	0.25	0.41	0.54	9.07	2.43	0.00
	0.17	0.43	0.20	0.04	0.01	0.00	0.46	0.95	0.58	1.69	0.84	0.03	5.38	1.69	0.00
	0.15	0.00	0.26	1.11	1.19	0.26	1.07	2.77	0.20	0.01	0.07	0.09	7.15	2.77	0.00
	0.41	0.08	1.65	0.02	0.00	0.03	0.39	0.56	0.25	1.04	0.37	0.12	4.89	1.65	0.00
	0.32	0.35	1.16	0.28	0.48	0.01	0.63	1.13	0.24	0.18	0.26	0.31	5.33	1.16	0.01
	0.01	0.00	0.05	0.30	0.00	0.00	0.11	0.31	2.57	1.09	0.53	0.21	5.15	2.57	0.00
	0.16	0.97	0.36	0.09	0.07	0.01	0.34	0.79	0.46	1.00	0.28	0.04	4.56	1.00	0.01
MET I & II Ave.	0.32	0.24	0.50	0.51	0.54	0.21	0.44	1.16	0.78	0.66	0.41	0.29	5.90		

NAVAJO MET I

													Annual
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Monthy Average	0.38	0.34	0.55	0.49	0.53	0.20	0.39	1.20	0.85	0.80	0.53	0.36	6.67

Table 12-1 (Continued)

NAVAJO MET II

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
Monthy Average	0.23	0.25	0.43	0.43	0.47	0.19	0.48	1.06	0.67	0.57	0.29	0.20	5.13

Total monthly precipitation depth (inches) recorded at the NMSU Agricultural Science Center at Farmington from 1969 to 2003

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Mean	0.47	0.44	0.71	0.57	0.52	0.26	0.85	1.10	1.09	0.95	0.72	0.42	8.10
Rank	9	10	6	7	8	12	4	1	2	3	5	11	

Table 12-2 NMSU Temperature Extremes and Frost Free Periods

Year	Max. Temp. in ^{0}F	Date of Max. Temp.	Min. Temp. in ^{0}F	Date of Min. Temp.	Date of Last 32^0 Temp. Spring	Date of First 32^0 Temp. Fall	No. of Frost Free Days
1957	100	06/28	7	01/22	04/28	10/23	178
1958	102	07/12	0	12/23	04/27	10/17	173
1959	99	07/23	-6	01/04	05/06	09/25	142
1960	102	07/29	-10	01/18	05/26	10/05	132
1961	102	06/22	-34	12/12	05/22	09/04	105
1962	101	08/15	-17	01/03	05/16	10/11	148
1963	100	07/19	-20	01/12	05/13	10/14	154
1964	101	07/20	-10	12/13	05/09	10/07	115
1965	98	08/11	-7	12/13	05/29	09/21	115
1966	100	07/06	-4	12/29	05/13	09/14	154
1967	99	07/04	-7	01/08	06/17	10/07	99
1968	100	06/23	-6	12/23	05/18	09/17	122
1969	103	08/09	4	12/31	05/01	10/05	157
1970	101	06/27	-5	01/07	05/08	09/26	141
1971	105	07/13	-22	01/07	05/30	09/18	111
1972	101	07/15	0	02/03	05/26	09/30	127
1973	100	07/05	-4	01/15	06/19	09/26	98
1974	102	06/29	16	01/03	05/22	09/28	129
1975	99	08/08	-6	01/04	06/19	09/26	98
1976	103	07/10	-5	01/02	06/15	10/07	113
1977	99	07/26	-8	01/10	04/21	10/31	193
1978	103	07/13	-15	12/11	05/06	09/20	137
1979	102	07/08	-11	01/28	05/11	10/22	164
1980	103	06/26	9	11/22	05/22	09/29	129
1981	100	07/16	1	12/24	05/07	10/22	168
1982	97	07/22	-3	02/07	05/06	10/05	152
1983	99	08/06	9	01/03	05/20	09/21	124
1984	95	07/07	2	01/18	05/08	10/15	158
1985	100	07/07	-1	02/01	05/14	09/30	139
1986	96	07/15	8	01/08	04/27	10/12	168
1987	98	07/25	1	12/15	04/21	10/19	181
1988	99	06/23	-2	01/28	05/07	11/29	206
1989	103	07/07	-14	02/07	04/30	10/18	171
1990	103	07/01	-16	12/24	04/10	10/09	181
1991	97	07/08	-3	01/01	05/05	10/28	176
1992	95	08/04	-2	12/21	04/21	10/08	170

Table 12-3 Navajo Mine 2003 Temperature Summary (hourly average in degree Fahrenheit)

Met Station II

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
Max	58.3	62.1	70.7	75.2	93.9	93.6	101.7	95.9	90.9	86.2	62.6	57.6	79.0
Min	19.8	14.4	23.5	27.3	33.8	53.4	61.9	59.0	42.4	32.2	15.4	11.1	32.9
Mean	38.5	36.8	44.5	53.6	65.6	73.9	82.7	76.3	67.8	59.6	41.2	34.7	56.3

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- × 5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 / 5422.45 — HORIZ. & VERT. CONTROL
- L-30 — LEASE CORNER
- LEASE BOUNDARY

NM-01 — AIR QUALITY MONITORING STATION

METEOROLOGICAL STATION No.1 — METEOROLOGICAL STATION

2000 0 2000 4000

CONTOUR INTERVAL: 10'

"NOTE"
ADDITIONAL MINE STRUCTURES, INCLUDING ROADS RAILROAD, PONDS, IMPOUNDMENTS AND CULVERTS, ALTHOUGH PRESENT ON THIS EXHIBIT AS PART OF THE AERIAL BASE MAPPING, ARE NOT INTENDED TO BE CURRENT OR ACCURATE ON THIS EXHIBIT. PLEASE REFER TO THE APPROPRIATE P.A.P TEXT SECTION FOR A MINE STRUCTURE EXHIBIT REFERENCE.

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.Q.	P.S.	ENG.
				APPROVALS			
11-A	FEB-2011	PJF	Removed Air Monitoring Station NM04B, added NM04C on the east side of Burnham Twp. Remove road and submitted to OSM for Review.	Shawn Smith	N. Briggs		
09-C	7-12-09	PJF	ADDED IBR EASTSIDE OF LOWE PIT AND SUBMITTED TO OSM FOR REVIEW.	Shawn Smith	YB		
09-B	5-07-09	PJF	REVISED NM07 AIR MONITORING STATION LOCATION IN A4N AND SUBMITTED TO OSM FOR REVIEW.	D. VAUGHN	YB		
09-A	3-18-09	PJF	ADDED NM07 AIR MONITORING STATION IN A4N AND SUBMITTED TO OSM FOR REVIEW.	WS	YB		
07-A	10-31-07	PJF	RESUBMITTED FOR THE A4N DEVELOPMENT TO OSM FOR REVIEW AND APPROVAL.	WS	YB		
E	1-23-07	PJF	ADDED A4N WET 3 STA (SOUTH OF COTTONWOOD WASH AND WESTSIDE OF BURNHAM ACCESS ROAD, AND SUBMITTED TO OSM FOR REVIEW.	WS	MC		WB
D	4-19-01	PJF	REMOVED NM02A, CHANGE NM04A TO NM04B AND SUBMITTED TO OSM FOR PERMIT UPDATE.	MC	MC		WB
C	12-21-00	PJF	CHANGE NM-03 TO NM-03-1,REMOVED NM-02B AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	MC	MC		WB
B	9-11-98	PJF	CHANGE NM-04 TO NM-04A AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	JL	MC		WB
A	5-26-98	PJF	MID-TERM SUBMITTAL TO OSM FOR REVIEW AND APPROVAL	GW	PNS		WB

EXHIBIT 12-1

bhpbilliton

BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico, 87416
Phone: 505-598-4200
Fax: 505-598-3361

AIR QUALITY AND METEOROLOGICAL MONITORING STATIONS

PREPARED BY PJF	DRAWN BY PJF	SCALE 1" = 2000'
APPROVED BY	DATE April 14, 1998	

Path: G:\Gs\Permit F\Ch 4\Exhibit 4-001\NM_PAP EXH\OSM Subm FEB-2011\EXH_4-1.pro
PJFoster \Plot Time: Tue Feb 08 15:02:34 2011

Appendix 12.A

Met 1 and Met 2 Wind Direction vs. Wind Speed Back-up Data

Met 1 Wind Data

Navajo Mine Met 1 - 10 Meter Tower
March 1991 to December 31, 2003
Wind Direction vs Wind Speed

Wind Direction (degrees)	Wind Speed (m/s)						
	0.13-1.0	1.01-3.0	3.01-5.0	5.01-9.0	9.01-15	15.01-	Total
N	0.29	0.93	0.64	0.16	0.02	0.00	2.05
NNE	0.33	0.93	0.33	0.11	0.02	0.00	1.72
NE	0.43	1.49	0.63	0.15	0.03	0.00	2.74
ENE	0.38	3.36	2.96	0.87	0.06	0.00	7.64
E	0.38	5.24	6.04	1.37	0.07	0.00	13.10
ESE	0.37	4.36	3.29	1.00	0.11	0.01	9.13
SE	0.38	3.41	1.72	0.61	0.11	0.01	6.23
SSE	0.44	3.16	1.46	0.68	0.14	0.00	5.89
S	0.51	2.84	1.56	0.84	0.20	0.01	5.95
SSW	0.55	1.95	1.40	0.78	0.17	0.01	4.87
SW	0.69	1.45	1.06	1.19	0.42	0.01	4.81
WSW	0.79	1.57	1.23	1.13	0.37	0.01	5.10
W	0.61	1.73	2.76	1.72	0.33	0.01	7.16
WNW	0.46	1.34	2.82	3.34	0.77	0.01	8.74
NW	0.35	1.03	2.89	4.98	1.70	0.06	11.00
NNW	0.26	1.06	1.66	0.87	0.18	0.00	4.03
Total	7.22	35.85	32.44	19.81	4.69	0.15	100.15

Met 2 Wind Data

Navajo Mine Met 2 - 10 Meter Tower
March 1991 to December 31, 2003
Wind Direction vs Wind Speed

Wind Direction (degrees)	Wind Speed (m/s)						
	0.13-1.0	1.01-3.0	3.01-5.0	5.01-9.0	9.01-15	15.01-	Total
N	0.09	2.50	1.79	0.70	0.07	0.00	5.15
NNE	0.09	2.55	0.97	0.17	0.01	0.00	3.80
NE	0.08	2.04	0.86	0.19	0.02	0.00	3.19
ENE	0.07	1.87	1.13	0.52	0.04	0.00	3.64
E	0.07	2.08	1.69	0.86	0.06	0.00	4.76
ESE	0.08	2.56	1.63	0.58	0.06	0.00	4.91
SE	0.11	5.12	5.23	1.22	0.23	0.00	11.91
SSE	0.11	5.42	3.82	1.83	0.42	0.01	11.63
S	0.11	3.47	1.52	0.95	0.29	0.01	6.36
SSW	0.11	2.45	1.18	0.88	0.28	0.02	4.93
SW	0.12	2.02	0.94	1.24	0.50	0.01	4.84
WSW	0.09	1.75	0.97	1.31	0.38	0.00	4.50
W	0.10	1.79	1.28	0.79	0.12	0.00	4.07
WNW	0.09	1.97	1.67	1.31	0.12	0.00	5.16
NW	0.11	2.16	2.48	3.69	1.17	0.03	9.64
NNW	0.10	2.41	3.25	4.49	1.37	0.06	11.69
Total	1.51	42.18	30.42	20.75	5.13	0.16	100.16