

# 2008 Meteorological Monitoring Report

## Yerington Mine Site

### 1.0 FIELD ACTIVITIES

Field activities during 2008 consisted of calibration, auditing, monitoring, and maintenance as indicated in the following table. Field activities were conducted according to Standard Operating Procedures and guidance provided in the AQM Work Plan Revision 2, Quality Assurance Project Plan Revision 2, and the revised Site Health and Safety Plan.

#### 1.1 Meteorological Station Calibration

On June 19, 2008, semi-annual calibration was performed on the meteorological stations at AM-1, AM-3, and AM-6. The calibration report for the meteorological stations is provided as Appendix D-1 and the major findings are summarized below.

- AM-1: This station was taken out of active service, although the data logging and telemetry systems have been left in-place and are functioning. The station and tower were found in good condition and the Wind Monitor AQ was operating correctly when removed and the bearings (speed and direction) and signal outputs were within specifications
- AM-3: This station was taken out of active service, although the data logging and telemetry systems have been left in-place and are functioning. The station and tower were found in good condition and the Wind Monitor AQ was operating correctly when removed and the bearings and signal outputs were within specifications.
- AM-6: This station will continue to operate to support site-wide activity. The installed Wind Monitor AQ wind sensor was found in good condition and operating correctly. The wind speed and direction bearings were well within threshold specifications and no “dead band” issues were observed as noted during previous visits. The instruments for relative humidity, temperature, atmospheric pressure, precipitation, and 3-meter/10-meter temperature all passed calibration criteria.

#### 1.2 Auditing

EPA’s representative conducted an audit during March 5 to 28, 2008. All meteorological stations successfully passed all audit criteria. No equipment failures, leaks, or anomalies were observed during the audit procedure. The audit report is provided in Appendix D-2.

### 1.3 Meteorological Monitoring

Meteorological monitoring was conducted at locations AM-1 and AM-3 from January 1, 2008 through June 18, 2008, and at AM-6 from January 1, 2008 through December 31, 2008. The parameters indicated in the following table were measured at locations AM-1, AM-3, and AM-6.

<b>Meteorological Data Acquisition</b>						
<b>Parameter</b>	<b>Location</b>			<b>Units</b>	<b>Frequency</b>	
	<b>AM-1</b>	<b>AM-3</b>	<b>AM-6</b>		<b>15 min</b>	<b>60 min</b>
Wind direction (resultant mean vector & stand. dev.)	X	X	X	degrees	X	X
Wind speed (scalar avg. & resultant mean vector)	X	X	X	m/s	X	X
Barometric pressure			X	mBar	X	X
Ambient temperature			X	°C	X	X
Relative humidity			X	percent	X	X
Solar radiation			X	kJ/m <sup>2</sup>	X	X
Precipitation			X	inches	X	X
2m/10m delta temperature system			X	°C	X	X

The data loggers at each location were programmed to sample every 2 seconds and record integrated data every 15 minutes. At hourly intervals, the data logger calculates and records summary data (e.g., sum of precipitation readings) for the previous hour. Selected meteorological data is summarized on Table 2 for monitoring events during 2007.

### 1.4 Meteorological Station Maintenance

Routine maintenance conducted on the meteorological station at AM-6 during this reporting period consisted of ensuring the tipping bucket on the precipitation sensor was aligned to vertical and ensuring that the solar radiation sensor was aligned to vertical.

<b>Field Activity Log, 1Q 2008</b>	
<b>Date</b>	<b>Activity</b>
2/21/08	Re-programmed the data logger at AM-1 and AM-3 to correct for negative readings of wind direction that occur from about 355 to 360 degrees.
3/5/08	EPA audit of meteorological stations at AM-1, AM-3, and AM-6
6/19/08	Calibration of AM-1, AM-3, and AM-6

## **2.0 METEOROLOGICAL DATA VALIDATION**

Meteorological data is downloaded electronically from the meteorological stations on a daily basis (during business days) using Campbell Scientific LoggerNet 3.3 software to communicate to the Campbell Scientific CR1000 data loggers. The communication is wireless using Airlink Raven 100 cellular digital modes, Yagi antennas, and Verizon data plans with static IP<sup>1</sup> addresses for each monitoring location. The electronic files are subsequently uploaded automatically into the project database. The meteorological data for 2008 are provided electronically on compact disc in Microsoft Excel format in this Appendix D.

All meteorological data were validated according to the criteria provided in the Work Plan Revision 2. The validation routines were programmed in Microsoft Visual Basic and incorporated into the Microsoft Access database as modules that can be run on a selected date range. The validation results are provided in the following sections for data completeness, wind speed, wind direction, temperature, solar radiation, barometric pressure, and relative humidity.

In summary, the verification indicates that the majority of meteorological data generated during this period are usable with 114 records flagged as rejected due to maintenance, calibration, auditing and other issues.

### **2.1 Data Completeness**

The Work Plan Revision 2 specified a data completeness goal of quarterly valid data retrieval of 90 percent for meteorological data. Twelve months of meteorological data were collected during the reporting period at AM-6, and about six months at AM-1 and AM-3. The completeness for meteorological data during this reporting period was calculated to be 99.6 percent for AM-1, 99.9 percent for AM-3, and 99.9 percent for AM-6, each of which exceed the program goal of 90 percent.

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<sup>1</sup> IP refers to Internet Protocol

Summary of Records Affected for Maintenance, Calibration, and Auditing of Meteorological Stations									
Activity	AM-1			AM-3			AM-6		
	Start Time/Date	Stop Time/Date	Qty. Records	Start Time/Date	Stop Time/Date	Qty. Records	Start Time/Date	Stop Time/Date	Qty. Records
Maint./Cal.	1/1/08 Various	1/3/08 Various	64	---	---	---	---	---	---
Auditing	3/5/08 8:35	3/5/08 9:35	6	3/5/08 10:20	3/5/08 11:40	7	3/5/08 13:25	3/5/08 15:25	10
Calibration	---	---	---	---	---	---	6/19/08 10:00	6/19/08 17:00	27

## 2.2 Wind Speed

The Work Plan Revision 2 specified three validation criteria for wind speed:

- Less than zero or greater than 56 miles per hour (mph; 25 meters per second [m/s]);
- Does not vary by more than 0.2 mph (0.1 m/s) for 3 consecutive hours; and
- Does not vary by more than 1.1 mph (0.5 m/s) for 12 consecutive hours.

A total of 62 records were flagged for the second wind speed criteria from February 23 at 8:15 p.m. to February 24 at 1:30 a.m. at all three air monitoring locations.

## 2.3 Wind Direction

The Work Plan Revision 2 specified three validation criteria for wind direction:

- Less than zero or greater than 360°;
- Does not vary by more than 1 degree for more than 3 consecutive hours; and
- Does not vary by more than 10 degrees for 18 consecutive hours.

No records were flagged for any of the criteria during this reporting period.

## 2.4 Temperature

The combined relative humidity/temperature sensor is mounted on the 10-meter tower at air monitoring location AM-6. The Work Plan Revision 2 specified four validation criteria for temperature:

- Greater than the local record high;
- Less than the local record low;
- Greater than a 18°F (10 degrees Celsius or °C) change from the previous hour; and
- Does not vary by more than 1°F (0.5°C) for 12 consecutive hours.

The following temperature records provide high and low temperatures recorded by the meteorological stations by month.

<b>Site Temperatures Compared to Local Records</b>				
	<b>Site Data (°F)</b>		<b>Local Record<sup>1</sup> (°F)</b>	
<b>2008</b>	<b>High</b>	<b>Low</b>	<b>High</b>	<b>Low</b>
January	57.90	11.35	72	-26
February	70.52	16.30	76	-23
March	71.87	17.33	83	-2
April	81.93	20.22	92	5
May	96.01	26.84	100	15
June	95.65	35.33	102	26
July	101.35	47.79	107	30
August	100.49	46.12	106	26
September	93.25	33.61	100	19
October	87.58	18.18	93	5
November	70.84	17.02	80	-5
December	63.82	0.14	74	-20

Note: <sup>1</sup>Source: NWS/COOP Station 269229 located in Yerington, Nevada

These data include local record highs and lows from National Weather Service Cooperative Observer Program (“NWS/COOP”) Station 269229 in Yerington, Nevada. No records were flagged for any of the criteria during this reporting period.

## 2.5 Solar Radiation

The solar radiation sensor is mounted on a cross arm attached to the 10-meter tower at air monitoring location AM-6. The Work Plan Revision 2 specified the following two validation criteria for solar radiation:

- Greater Than Zero at Night: The times for sunset and sunrise were obtained for every day of the year for Yerington, Nevada from the Astronomical Applications Department of the U.S. Naval Observatory. For the purposes of evaluating this criterion, night was defined as the meteorological station measurement readings that occurred between the time for sunset and sunrise on a given day. A total of 4,092 records were flagged for this criterion. The majority of records (3,526) that were flagged were less than 1 kJ/m<sup>2</sup> which, given the sensitivity of the sensor, is generally considered to be zero. The remaining 566 records that were flagged (range of 1.0001 to 19.76 kJ/m<sup>2</sup>) occurred at the calculated sunrise or sunset. The solar radiation data was determined to be usable (no corrective action necessary).
- Greater Than the Maximum Possible for the Date and Latitude: The maximum possible solar radiation for each day of the year at Yerington, Nevada was calculated using *Evaporation, Evapotranspiration, and Climatic Data – Developments in Atmospheric Science 22* (Burman, et. al., 1994). The solar radiation measurements from each meteorological station were totaled for each day during this reporting period and compared to the maximum possible. A total of 2,215 records were flagged for this criterion during this reporting period.

Maximum Solar Radiation <sup>1</sup> (kJ/m <sup>2</sup> day)	
January	11,681
February	16,390
March	22,047
April	27,157
May	31,061
June	32,701
July	31,801
August	28,478
September	23,661
October	18,016
November	12,794
December	8,282

## 2.6 Barometric Pressure

The barometric pressure sensor is mounted inside the Campbell Scientific enclosure which is inside the weatherproof shed at air monitoring location AM-6. The Work Plan Revision 2 specified two validation criteria for barometric pressure:

- Greater than the local record high; and
- Less than the local record low.

Local record highs and lows were obtained from the Automated Weather Observing Station (“AWOS”) 93102 located in Fallon Naval Air Station, Nevada. For purposes of comparison, the mean sea level pressure was estimated using a modified National Oceanic and Atmospheric Administration (“NOAA”) method. No records were flagged for any of the criteria during this reporting period.

## 2.7 Relative Humidity

The combined relative humidity/temperature sensor is mounted on the 10-meter tower at air monitoring location AM-6. The Work Plan Revision 2 specified two validation criteria for relative humidity which are described below followed by a discussion of the validation results.

- Less than 30 Percent During Precipitation Events: For the purposes of evaluating this criterion, a precipitation event was defined as a precipitation reading greater than zero inches. Two records were flagged for this criterion on June 29.
- Varies by 30 Percent of the Local Average for 24 Consecutive Hours: Local average relative humidity by month was obtained from AWOS Station 93102 located in Fallon Naval Air Station, Nevada. 171 records were flagged for this criterion from January 13 through January 15.

<b>Local Average Relative Humidity<sup>1</sup></b>	
January	65%
February	58%
March	49%
April	40%
May	37%
June	32%
July	28%
August	30%
September	35%
October	45%
November	57%
December	55%

Note: <sup>1</sup>Source: AWOS Station 93102 located in Fallon Naval Air Station, Nevada

### **3.0 METEOROLOGICAL DATA SUMMARY**

Meteorological data generated during 2008 consisted of precipitation, temperature, relative humidity, barometric pressure, solar radiation, wind speed, and wind direction. These meteorological parameters are summarized in the AM-6 Meteorological Data Summary – Monthly Value 2008 Table (also Table 3-1 in the 2008 GMR) which is located and discussed below.

#### **3.1 Precipitation**

Total annual precipitation in 2008 measured by the meteorological station was 4.15 inches. Monthly precipitation is summarized in the table below. The maximum monthly precipitation in 2008 was 1.53 inches in January. No precipitation was recorded for April, August, and September.

#### **3.2 Temperature**

The average, minimum, and maximum temperatures for each month of 2008 are presented in the table below. The average monthly temperature measured by the meteorological station varied from approximately 31°F in January and December to 77°F in July.

#### **3.3 Relative Humidity**

The average, minimum, and maximum relative humidity for each month of 2008 are presented in the table below. The average monthly relative humidity measured by the meteorological station varied from approximately 25 percent in August to 75 percent in January.

#### **3.4 Barometric Pressure**

The average, minimum, and maximum barometric pressures for each month of 2008 are presented in the table below. The average monthly barometric pressure measured by the meteorological station was relatively constant at around 870 mBar.

#### **3.5 Solar Radiation**

Total monthly solar radiation measured by the meteorological station varied from approximately 263,000 kJ/m<sup>2</sup> in December to 845,000 kJ/m<sup>2</sup> in July.

### 3.6 Wind Speed

Wind speed measured by the meteorological station at AM-6 during 2008 ranged from zero to approximately 41.4 mph. The majority (approximately 83 percent) of measurements were 10 mph or less. Approximately 63 percent of the total measurements were less than 5 mph. High wind speeds (greater than 20 mph) during 2008 represented about 4 percent of the measurements. The average, minimum, and maximum wind speed measured by AM-6 for each month of 2008 are presented in the table below. The average monthly wind speed varied from 3.8 mph in November to 8.4 mph in April.

AM-6 Meteorological Data Summary - Monthly Values 2008									
			Precipitation Total	Temperature Avg./Min./Max.			Relative Humidity Avg./Min./Max.		
Location	2008	Count	(inches)	(F)			(%)		
AM-6	Jan	2,976	1.53	30.92	11.35	57.90	74.91	15.09	99.90
AM-6	Feb	2,782	1.27	37.35	16.30	70.52	65.36	19.10	98.70
AM-6	Mar	2,966	0.02	44.90	17.33	71.87	40.43	6.95	88.10
AM-6	Apr	2,880	0	50.10	20.22	81.93	31.35	7.15	81.10
AM-6	May	2,976	0.96	57.93	26.84	96.01	44.57	6.18	96.40
AM-6	Jun	2,853	0.02	69.16	35.33	95.65	27.72	6.06	78.45
AM-6	Jul	2,976	0.03	77.41	47.79	101.35	26.38	5.30	87.40
AM-6	Aug	2,976	0	76.30	46.12	100.49	25.41	3.93	74.56
AM-6	Sep	2,878	0	65.13	33.61	93.25	29.41	7.16	78.90
AM-6	Oct	2,976	0.09	51.60	18.18	87.58	37.48	9.44	96.10
AM-6	Nov	2,880	0.09	42.75	17.02	70.84	58.08	12.26	98.70
AM-6	Dec	2,976	0.14	31.10	0.14	63.82	59.73	13.11	96.70
			Solar Radiation Total	Barometric Pressure Avg./Min./Max.			Wind Speed Avg./Min./Max.		
Location	2008	Count	(kJ/m <sup>2</sup> )	(mBar)			(mph)		
AM-6	Jan	2,976	266,618.74	868.01	847	882	6.095	0.004	38.319
AM-6	Feb	2,782	378,207.70	869.54	847	879	4.811	0	36.261
AM-6	Mar	2,966	605,243.23	870.38	859	880	7.494	0.004	41.406
AM-6	Apr	2,880	723,795.77	867.81	856	879	8.397	0.025	38.408
AM-6	May	2,976	748,444.12	866.32	851	877	6.429	0.096	30.803
AM-6	Jun	2,853	831,757.09	867.87	858	873	6.795	0.315	36.552
AM-6	Jul	2,976	844,677.48	867.18	860	873	5.410	0.143	23.331
AM-6	Aug	2,976	777,178.10	866.34	858	872	6.108	0.020	32.257
AM-6	Sep	2,878	615,077.99	868.63	858	875	4.148	0.085	31.362
AM-6	Oct	2,976	442,265.48	871.80	858	883	4.746	0.002	28.141
AM-6	Nov	2,880	283,212.10	872.56	857	883	3.761	0	28.588
AM-6	Dec	2,976	262,236.14	868.35	848	883	5.480	0.092	37.670

Notes: (1) Data for meteorological monitoring stations AM-1 and AM-3 consisting only of wind speed and direction are located in Appendix D