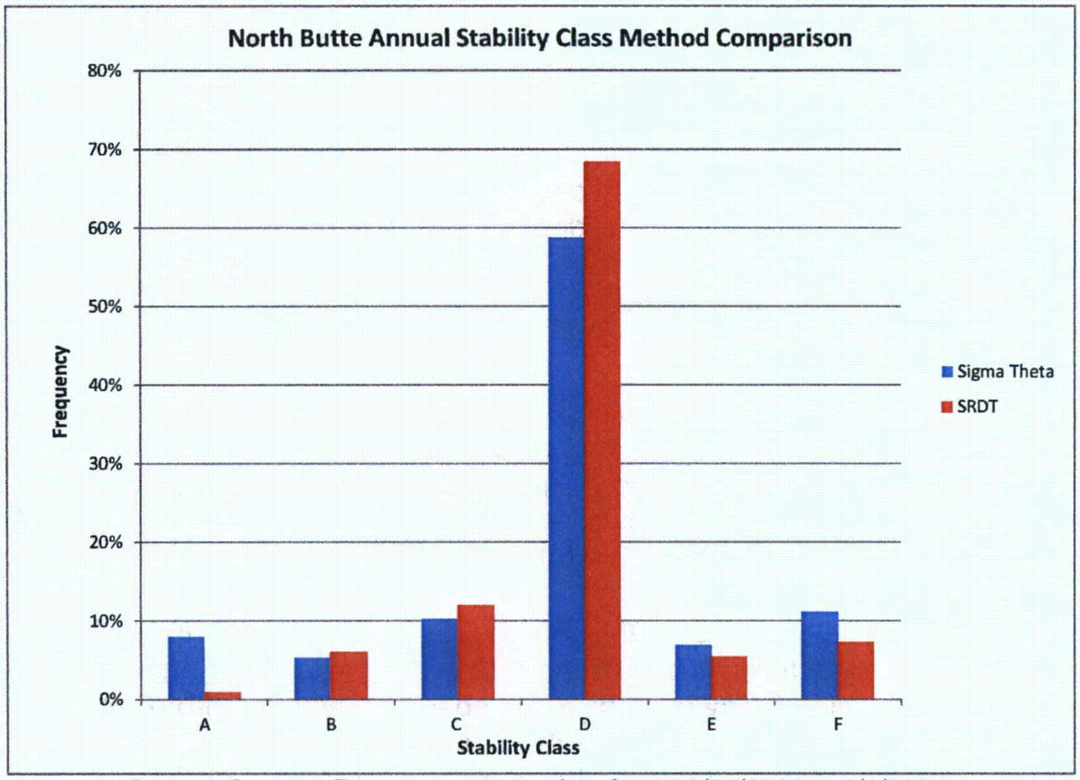
Atmospheric Stability Class

The σ_θ method was used to determine the Pasquill-Gifford stability class, where σ_θ refers to the standard deviation of the horizontal wind azimuth angle in degrees. This method is also referred to as the σ_A method (EPA 2000). It is a lateral turbulence-based method which uses the standard deviation of the wind direction in combination with the scalar mean horizontal wind speed. Wind speed and direction data are recorded hourly at a height of 10 meters. To minimize the effects of wind meander, the 1-hour σ_θ is defined using 15-minute σ_θ values which are in turn based on more frequent sampling of wind direction (e.g. every five seconds).

According to this method, initial stability classes are assigned based solely on standard deviation of wind direction, or σ_θ. The initial assignments are then adjusted for horizontal wind speed. The magnitude of this adjustment depends on whether the measurement is taken during daylight or nighttime hours, a diurnal dependency that varies with the time of year.

Regulatory Guide 3.63 (NRC, 1988) states: "For obtaining an indication of the atmospheric stability, a method such as one of the following (Refs. 1-4) may be used: *insolation cloud cover and wind speed (Pasquill-Gifford and similar methods)*, temperature lapse rate method, wind fluctuation method, split-sigma method, or Richardson Number." The σ_θ method is based on wind fluctuation and therefore qualifies as an appropriate method for the North Butte Remote Satellite.

In order to demonstrate its reliability, a comparison was made between the σ_θ method and the SRDT (Solar Radiation Delta Temperature) method at the North Butte site. **Figure 2.5-24** shows this comparison. It can be seen that the two methods yield similar distributions. The percent of time characterized by stable air classes (E and F) is slightly higher for the σ_θ method. Given that stable air is less subject to dispersion than neutral or unstable air, it is expected that for North Butte, the σ_θ method will result in more conservative modeling predictions than the SRDT method.

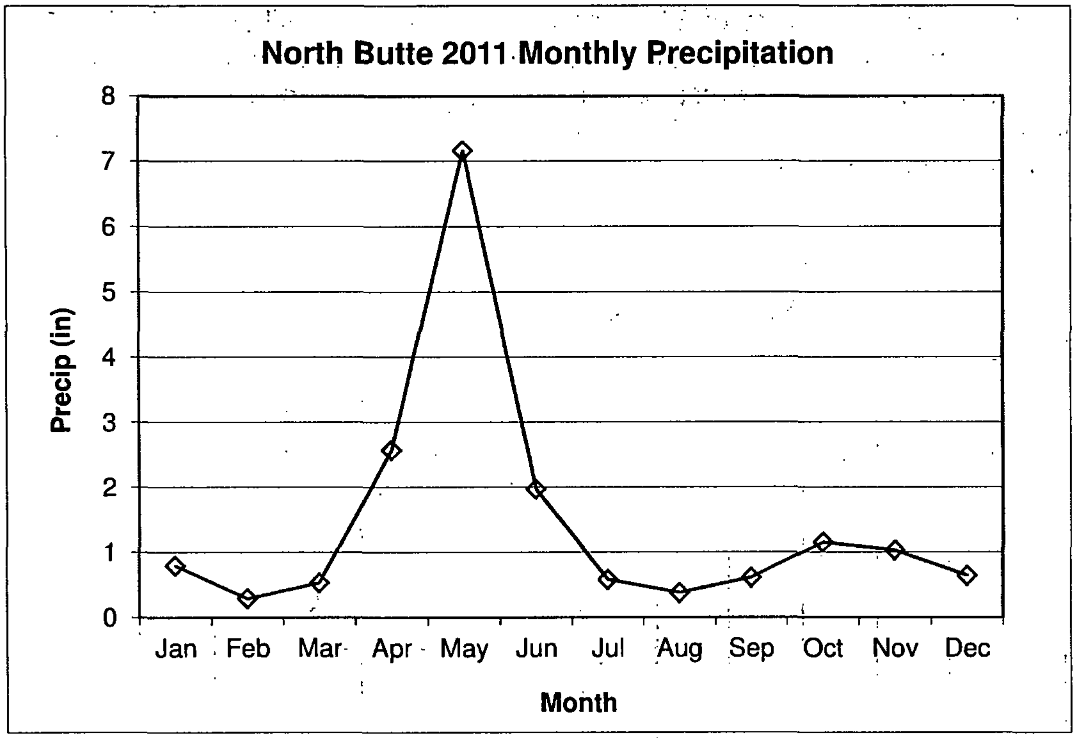


Source: Cameco Resources, 2012, data from 12/21/2010 to 1/5/2012.

Figure 2.5-24. North Butte Stability Class Method Comparison.

Precipitation

Figure 2.5-25 shows the monthly precipitation measured at the North Butte site. Total precipitation during the baseline monitoring year was approximately 17.7 inches (approximately 450 mm), with over 40% of that falling during the month of May. Late summer and winter saw the lowest amounts of precipitation. This is about 1.5 times greater than the long term annual average precipitation measured at the Antelope Mine site from 1986 to 2012 (11.1 inches per year).

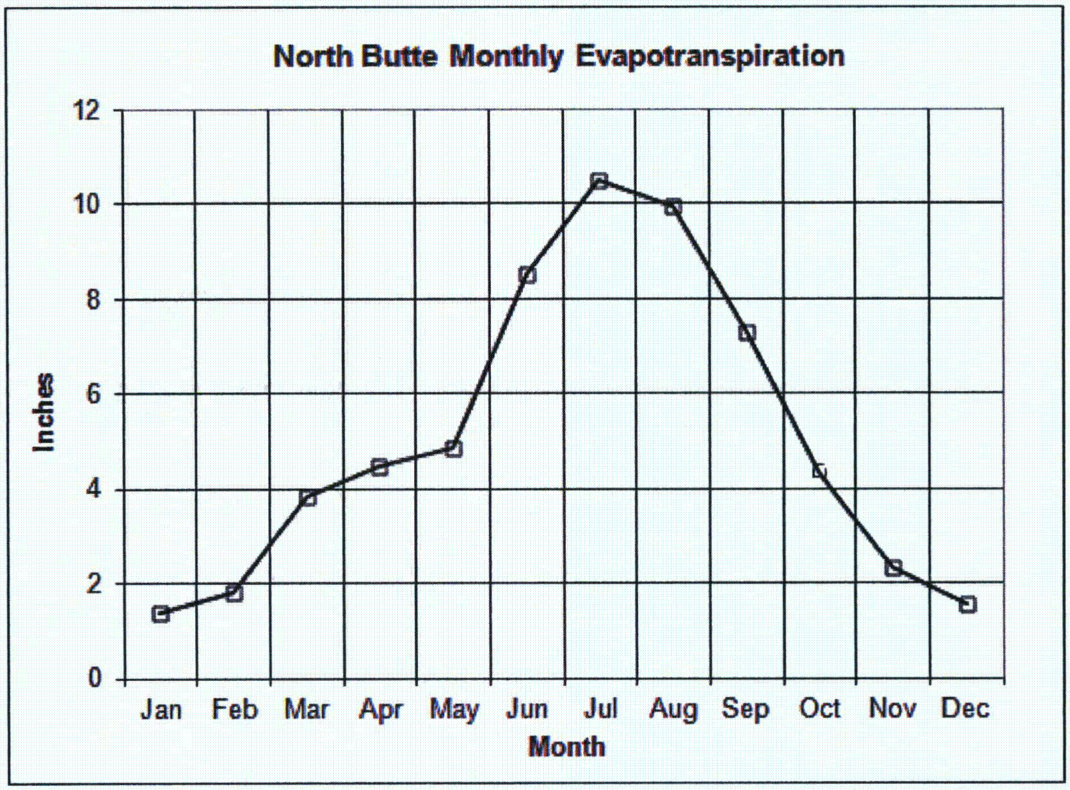


Source: Cameco Resources, 2012, data from 12/21/2010 to 1/5/2012.

Figure 2.5-25. North Butte Monthly Precipitation.

Evapotranspiration

No pan evaporation data were available at Cameco's North Butte site, so daily evapotranspiration rates were calculated using the Penman Equation. This equation uses recorded solar radiation, wind speed, temperature, and relative humidity to estimate evapotranspiration rates, which were then summed to give monthly rates. These monthly rates are shown in **Figure 2.5-26** for the baseline monitoring period. From these calculations, the annual evapotranspiration is approximately 61 inches. Excluding the months of December through March, the total becomes approximately 52 inches, which compares favorably to the long-term pan evaporation rate of 51 inches observed at the Gillette AP site 41 miles away (no pan evaporation was measured here for December through March). The North Butte evapotranspiration also shows a similar trend to the pan evaporation rates seen at Gillette AP, with higher rates observed during the warmer summer months.



Sources: Calculation based on Penman Equation, from data supplied by Cameco Resources, from 12/21/2010 to 1/5/2012.

Figure 2.5-26. North Butte Potential Monthly Evapotranspiration.

Justification of Baseline Year as Representative of Long Term

The North Butte Remote Satellite is located in northeast Wyoming. The baseline meteorological monitoring period extended approximately one year, from December 21, 2010 through January 5, 2012. To demonstrate that this baseline year is representative of the longer term wind conditions, the Antelope Mine site was analyzed. Among the weather stations in the region with available data, the Antelope site was the closest to the North Butte Remote Satellite site. Antelope is approximately 36 miles southeast of the project site, with an elevation roughly 400 feet lower than North Butte. Hourly data were available at the Antelope site from January 1987 to January 2012, representing just over 25 years.

Figure 2.5-27 shows wind roses for the Antelope Mine. The left wind rose displays 25 years of monitoring, while the one on the right reflects just the time during the North Butte baseline monitoring period. These wind roses show that the wind speeds and directions are very similar between these two monitoring periods.

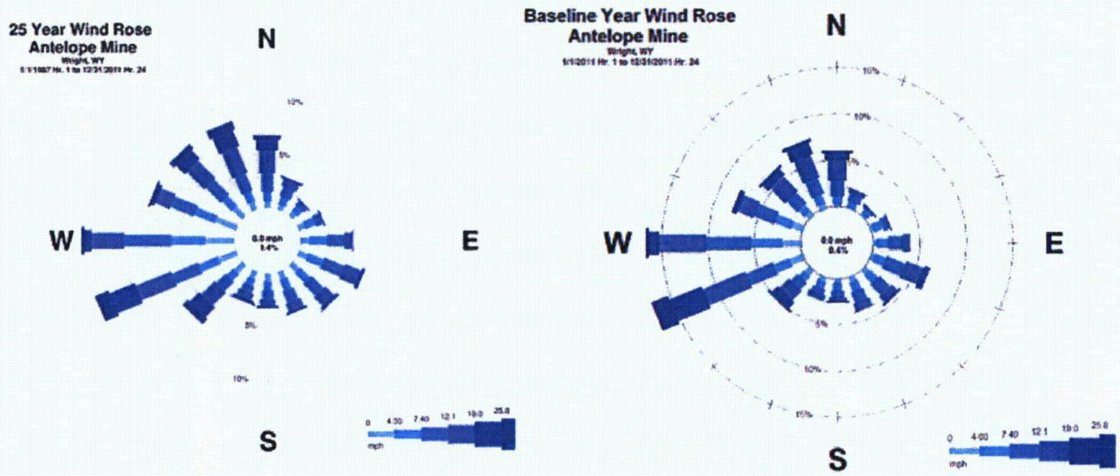
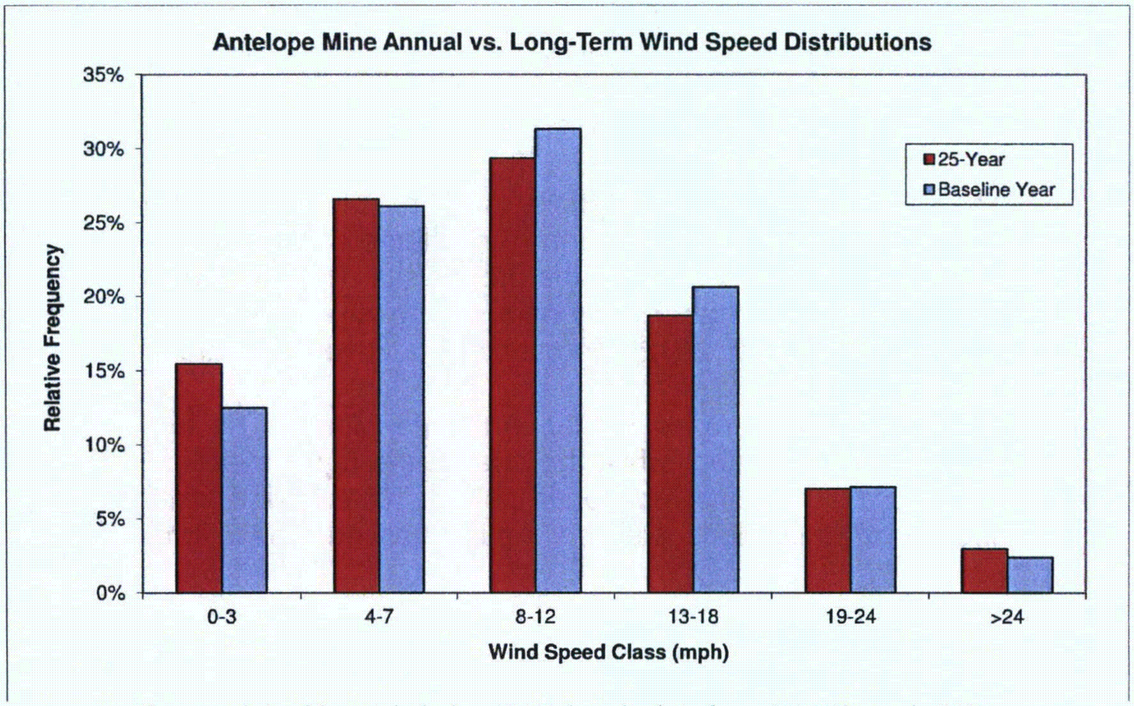


Figure 2.5-27. Antelope Mine 25-Year vs. Baseline Year Wind Roses.

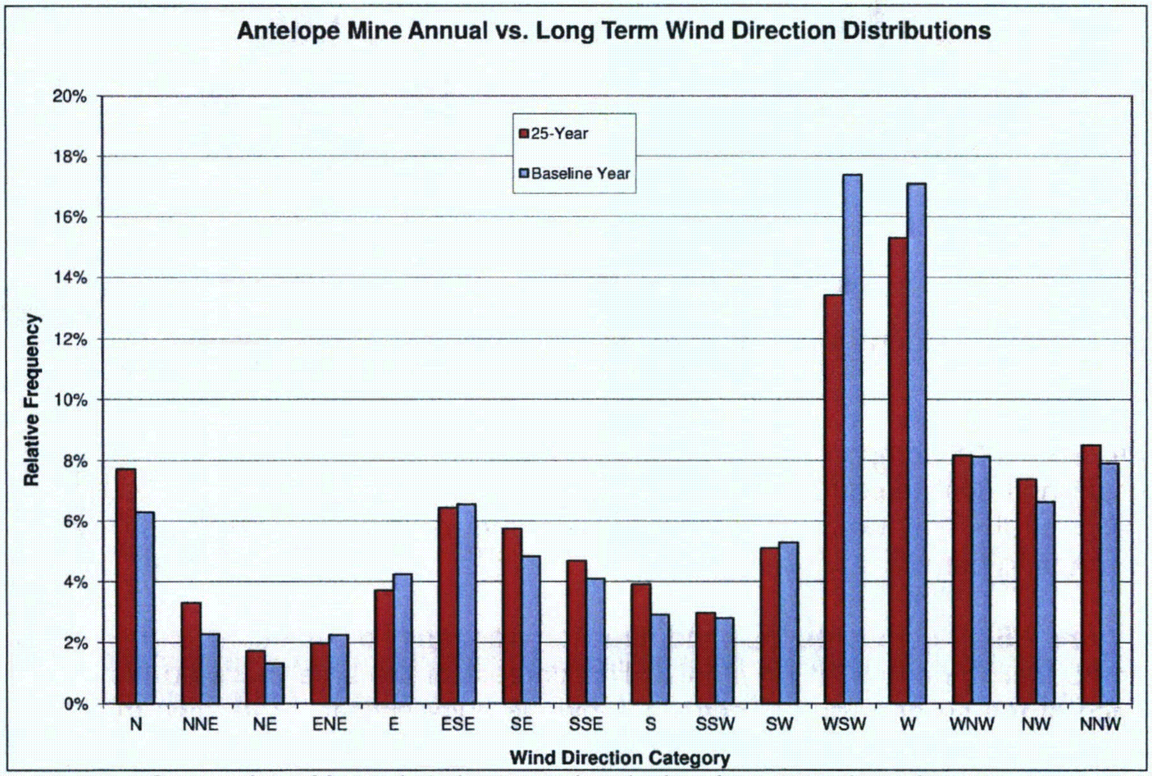
Figure 2.5-28 compares the wind speed frequency distributions between the 25-year and baseline periods at Antelope. The percent of the time the wind blows in each of the six wind speed categories shown is quite similar for the two monitoring periods.

Figure 2.5-29 compares the wind direction frequency distributions of the 25-year and baseline periods at Antelope. The percent of the time the wind blows from each of the sixteen wind directions shown is quite similar for the two monitoring periods.



Source: Inter-Mountain Labs, 2012, hourly data from 1987 through 2012.

Figure 2.5-28. Antelope Mine 25-Year vs. Baseline Year Wind Speeds.



Source: Inter-Mountain Labs, 2012, hourly data from 1987 through 2012.

Figure 2.5-29. Antelope Mine 25-Year vs. Baseline Year Wind Directions.

In order to quantify this similarity, it is useful to isolate wind speed and wind direction variables and to correlate short-term and long-term frequency distributions. This constitutes a statistical methodology for assessing the degree to which the distributions of wind speed class and wind direction frequencies from one year of monitoring at a particular location represent the long-term distributions at that same location.

For the joint frequency wind distribution used in the MILDOS-AREA model, wind speeds are divided into six classifications ranging from mild (0 – 3 mph) to strong (> 24 mph), as illustrated in **Table 2.5-5** and **Figure 2.5-28** above. Likewise, wind directions are divided into 16 categories corresponding to the compass directions illustrated in the wind roses presented above and in **Figure 2.5-29**.

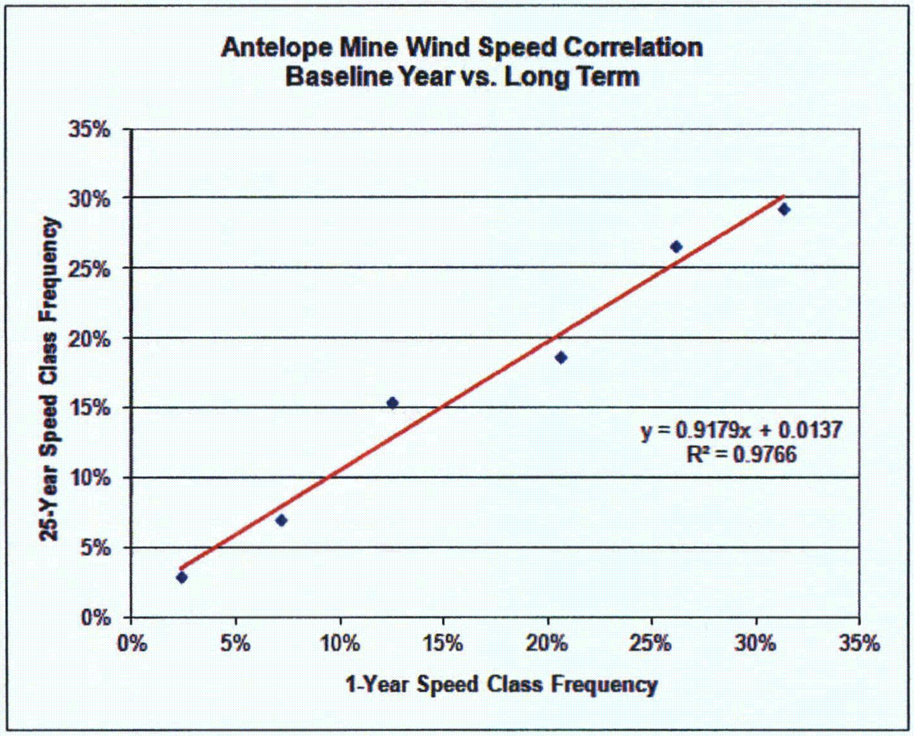
The percent of the time that winds occur in each of the six wind speed categories can be calculated to produce a wind speed frequency distribution. The percent of the time that winds blow from each of the sixteen directions can be calculated to produce a wind direction frequency distribution. For each parameter, the one-year and 25-year distributions can then be compared. Linear regression analysis provides a useful tool to assess the degree of correlation between short and long-term distributions.

Figure 2.5-30 presents this correlation for the wind speed distributions at Antelope Mine. Each point represents one of the six wind speed classes. The x coordinate corresponds to the percent of the one-year period during which the wind speed fell in a given class, while the y coordinate corresponds to the percent of the 25-year period during which the wind speed fell in that same class.

The regression line (red) in **Figure 2.5-30** represents the least-squares fit to the six data points. The corresponding R^2 value of 97.7% implies very strong linear correlation.

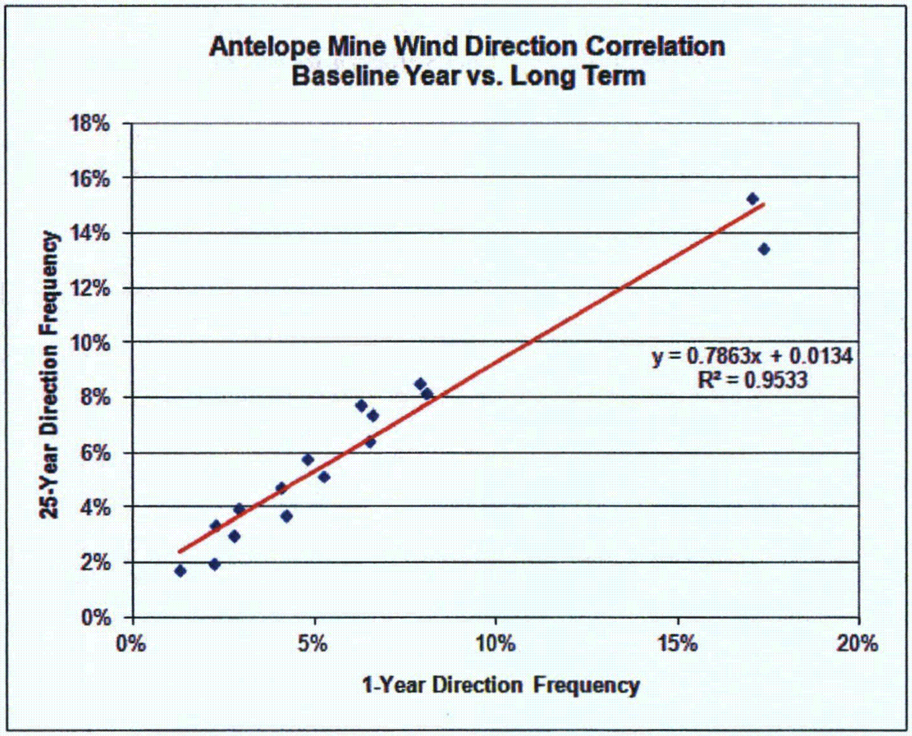
A similar analysis can be performed for wind direction frequencies. **Figure 2.5-31** presents this correlation, again for the Antelope Mine site. Each point represents one of the sixteen wind direction categories. The x coordinate corresponds to the percent of the one-year period during which the wind blew from a given direction, while the y coordinate corresponds to the percent of the 25-year period during which the wind blew from that same direction.

The regression line (red) in **Figure 2.5-31** represents the least-squares fit to the sixteen data points. The corresponding R^2 value of 95.3% implies very strong linear correlation.



Sources: Analysis by IML Air Science using hourly data from 1987 to 2011.

Figure 2.5-30. Antelope Mine 25-Year vs. Baseline Year Wind Speed Distributions.



Sources: Analysis by IML Air Science using hourly data from 1987 to 2011.

Figure 2.5-31. Antelope Mine 25-Yr vs. Baseline Yr Wind Direction Distributions.

Figures 2.5-30 and **2.5-31** offer conclusive evidence that the 2011 baseline monitoring year adequately represents the last 25 years at Antelope Mine. Statistically, the p-value provides a measure of the probability that no linear relationship exists between the short and long-term wind data distributions. A p-value of 0 reflects the highest confidence possible that a linear relationship exists. The regression analyses of wind speed distributions and wind direction distributions both show p-values of 0.000. This result justifies a high degree of confidence that the R^2 values are real and that the use of baseline-year wind data to predict long-term wind behavior is legitimate.

<u>On-Site Meteorological Instrument Specifications</u>

Table 2.5-15 lists the meteorological instruments employed at the North Butte meteorological monitoring station. The table shows instrument models, accuracy specifications, and instrument heights above the ground. Calibration records for the meteorological instruments are contained in **Appendix A** to this document.

Meteorological data collection, management and reporting methods at the project site conform to NRC atmospheric dispersion modeling requirements for uranium milling operations, and meet the acceptance criteria established in the NRC's NUREG-1569. The on-site monitoring program was developed according to NRC Regulatory Guide 3.63, "Onsite Meteorological Measurement Program For Uranium Recovery Facilities – Data Acquisition and Reporting." Hourly average values for wind speed, wind direction, sigma theta, temperature, relative humidity, precipitation and solar radiation are generated by field instruments and recorded by continuous data loggers. Data recovery exceeded 98% for the 12-month monitoring period. All hourly data have been downloaded to a relational database for quality assurance, statistical analysis and reporting purposes.

Parameter	Measurement Method	Manufacturer and Model Number	Sampling Frequency	Averaging Period	Measurement Range	Instrument Reading Accuracy	Monitoring Height
Horizontal Wind Speed	Frequency	RM Young 05305-AQ	1 second	Minute/Hourly	0 – 50 m/s	±0.2 m/s	10 meters
Wind Direction	Precision potentiometer	RM Young 05305-AQ	1 second	Minute/Hourly	0 - 360°	±3°	10 meters
Ambient Temperature	Thermistor	Met One 062	1 second	Minute/Hourly	-50° to +50° C	±0.05° C	10 meters
Ambient Temperature	Thermistor	Met One 062	1 second	Minute/Hourly	-50° to +50° C	±0.05° C	2 meters
Ambient Temperature	Thermistor	Vaisala HMP45C	1 second	Minute/Hourly	-45° to +60° C	±0.5° C	2 meters
Dew Point Temperature	Calculated	Calculated	Calculated	Minute/Hourly Calculated	N/A	N/A	2 meters
Differential Temperature	Calculated	Calculated	1 second	Minute/Hourly	N/A	N/A	2 -10 meters
Relative Humidity	Capacitive polymer H-chip	Vaisala HMP45C	1 second	Minute/Hourly	0.8% to 100%	±2% (0-90%RH) ±3% (90-100%RH)	2 meters
Solar Radiation	Silicon photovoltaic detector	Campbell LI200X	1 second	Minute/Hourly	0-2000 W/m^2	±5%	2 meters
Precipitation	Tipping Bucket	Texas Instruments TE525WS	Event Data	Minute/Hourly	Finite increments of tip of rainfall	±1%	75 cm

Source: Cameco Resources, 2012

Table 2.5-15. North Butte Monitoring Details

Upper Atmosphere Characterization

Mixing height is the height of the atmosphere above the ground that is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. Higher mixing heights are associated with greater dispersion, all other parameters being the same. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. The MILDOS-AREA model uses mixing height, along with other wind parameters, to predict pollutant dispersion. Unstable air leads to more dispersion, which leads to lower predicted impacts on ambient air quality. The default mixing height used by MILDOS-AREA is 100 meters, a very conservative value.

The nearest upper-air data available from the National Weather Service are from Lander, Wyoming, approximately 150 miles west of the site. Average mixing heights were derived from the AERMOD calculations used for dispersion modeling, based on hourly data obtained from the National Weather Service station in Lander (upper air). The AERMOD calculation is based on a combination of mechanically and convectively driven boundary layer processes. The results of these calculations are provided for morning and afternoon periods in **Table 2.5-16**. The 24-hour annual average mixing height is 916 meters.

Time Period (Filtered)	Average Mixing / Inversion Height
Morning (2 am – 7 am)	579 meters
Afternoon (2 pm – 7 pm)	1,123 meters

Sources: IML computation based on data from National Climate Data Center, 2011

Table 2.5-16. Lander Mixing Heights.

The mixing or inversion heights are entered as inputs to the MILDOS-AREA model for pollutant dispersion modeling. For the North Butte Project, the MILDOS modeling run used the default mixing height of 100 meters, which is more conservative than the measured mixing heights at Lander.

Bodies of Water and Special Terrain Features

There are no significant bodies of water near the proposed North Butte project which would have an impact on meteorology.

The nearest and most dominant terrain feature is North Butte, located approximately 2 miles to the northwest. North Butte acts to shield the project area from the northwest winds found in the region and introduces some diurnal convection winds. However, the predominant winds in the region are from the west, west-southwest, and southwest, and are not affected by the proximity of the site to North Butte.

Conclusion

The North Butte Remote Satellite in northeast Wyoming is located in a semi-arid or steppe climate. The area is characterized by abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. The region has large diurnal and annual variations in temperature.

Three meteorological stations were used to characterize regional weather patterns. The region is characterized seasonally by cold winters, warm, dry summers, and cool springs and autumns. Temperature extremes range from approximately -40° F in the winter to 100° F in the summer. The region generally receives little precipitation, with annual averages between 4 and 19 inches. Spring and early summer precipitation events are responsible for the majority of the yearly average.

The region is characterized by annual average wind speeds of 9 to 12.5 mph. Winds at the North Butte site are expected to average about 10 mph annually, with summer averages dropping below 9 mph and winter and spring averages exceeding 11 mph. The predominant wind direction is from the west-southwest, with stronger western components at the Antelope Mine and stronger southwestern components in the North Butte Remote Satellite area.

The Antelope Mine meteorological station was included in the site specific analysis to validate the temporal representativeness of on-site wind data by incorporating wind monitoring results from a longer period of record. The Antelope Mine site is located 36 miles southeast of the North Butte project site. The distributions of wind speeds and directions at Antelope Mine during the baseline monitoring period have been shown to closely represent Antelope's 25-year distributions of wind speeds and directions. This evidence strongly supports the assertion that winds at the North Butte project site during the baseline year of 2011 are representative of the long term.

References

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National Climatic Data Center (NCDC), 2012: *Surface Data, Monthly Extremes.* Available: https://nes.ncdc.noaa.gov/sub-login.html [2012].

NRC, *NUREG-1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Final Report*, June 2003.

NRC, *Regulatory Guide 3.63, Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting*, March 2008.

U.S. EPA, *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, February 2000.

Western Regional Climate Center (WRCC), *Pan Evaporation by State*, 2012. Available: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html.

Appendix A

North Butte Meteorological Station Calibration Records

WIND SPEED SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 12/22/2010
Start: 10:50 12/22/2010
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: RM Young
Model: 05305-5 Wind Monitor - AQ
SN: WM106261

Propeller SN:
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Variable motor. R.M.Young, 18820A/18830A (200 to 15,000 rpm) **SN:** CA03277
Item: Variable motor. R.M.Young, 18820A/18831A (0 to 300 rpm) **SN:** CA03277
Item: Torque disk device. R.M.Young, 18312 **SN:** NA

PART B: CALIBRATION TEST RESULTS

Sensor Starting Threshold: 0.2 gm-cm ,equal to 0.38 mps **Pass? / Fail?:** Pass ≤ 0.50 mps

Known Input		Observed Data Logger Response					
Motor rpm	Motor mps	Output mps	Error mps	Error %	Limit mps	Limit %	Pass? Fail?
0.0	0.00	0.00	0.00	NA	NA	NA	NA
150	1.72	1.70	-0.02	-1.0	≤ ±0.20	---	PASS
700	8.02	8.01	-0.01	-0.1	---	≤ ±5%	PASS
2,000	22.90	22.90	0.00	0.0	---	≤ ±5%	PASS
4,000	45.80	45.80	0.00	0.0	---	≤ ±5%	PASS
6,000	68.70	68.70	0.00	0.0	---	≤ ±5%	PASS
8,000	91.60	91.60	0.00	0.0	---	≤ ±5%	PASS

COMMENTS

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Wind speed input ≤5.0 mps = ≤ ±0.20 mps error
3) Wind speed input >5.0 mps = ≤ ±5% of input speed

WIND DIRECTION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte **Date:** 12/22/2010 **Check One:**
Location: Wyoming **Start:** 10:35 12/22/2010 **As Found:** √
Technician: Ethan Brown **End:** 11:44 12/22/2010 **As Left:**

SENSOR INFORMATION

Make: RM Young **Propeller SN:**
Model: 05305-5 Wind Monitor - AQ **Operating Range:** 0 to 50 mps
SN: WM106261 **Height Above Ground:** 10 meters

CALIBRATION TEST EQUIPMENT

Item: Brunton pocket transit compass **SN:** 5080610049
Item: R.M.Young, Model 18331, vane torque measurement device **SN:** NA
Item: R.M.Young, Model 18112, vane angle fixture **SN:** NA

PART B: CALIBRATION TEST RESULTS

Local Magnetic Declination: 10 degrees east
(http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp)

Sensor Starting Threshold: 2.0 gm-cm ,equal to 0.23 mps **Pass? / Fail?:** PASS ≤ 0.50 mps

Test Input Deg.	Accuracy Test Response Output Deg.	Error Deg.	Pass? Fail?
0	0	0	PASS
90	90	0	PASS
180	179	-1	PASS
270	271	1	PASS

Test Input Deg.	Linearity Test Response Output Deg.	Nrmlzd* Deg.	Pass? Fail?
0	0	NA	NA
30	30	0	PASS
60	60	0	PASS
90	89	-1	PASS
120	120	1	PASS
150	149	-1	PASS
180	178	-1	PASS
210	211	3	PASS
240	240	-1	PASS
270	270	0	PASS
300	300	0	PASS
330	330	0	PASS

* Normalized error in degrees.

COMMENTS

- The crossarm was measured at 272 degrees to true north on 8/23/2010. The accuracy test response was measured against the crossarm, and therefore is off by 2 degrees. This is reflected in the "Test Input Deg." category.

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Accuracy Test Error = ≤ ±5 degrees per test point
3) Linearity Test Error = ≤ ±3 degrees per test point

TEMPERATURE / ΔTEMPERATURE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 12/23/2010
Start: 13:00 12/23/2010
End: 14:00 12/23/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 062 MP

2-Meter Probe SN: J10798 (2 of 2)
10-Meter Probe SN: J10798 (1 of 2)
Operating Range: -50 to +50 C

CALIBRATION TEST EQUIPMENT

Item: **Item:** Dostmann Electronic GmbH P650-PT **SN:** 65010081147
Item: **Item:** Insulated water baths with mechanical stirring. **SN:** NA

PART B: CALIBRATION TEST RESULTS

Temperature Probe Calibration

Known Input		Observed Data Logger Response					
Water Bath	Temp. °C	2-m °C	2-m Error °C	Pass? Fail?	10-m °C	10-m Error °C	Pass? Fail?
Ice	0.01	0.02	0.01	PASS	-0.02	0.01	PASS
Cool	22.63	22.53	-0.10	PASS	22.47	-0.16	PASS
Hot	49.80	49.43	-0.37	PASS	49.46	-0.34	PASS

Temperature Difference System Calibration

Known Input		Observed Response		
Water Bath	ΔT °C	2-10 ΔT °C	2-10 ΔT Error °C	Pass? Fail?
Ice	0.00	0.00	0.00	PASS
Cool	0.00	0.06	0.06	PASS
Hot	0.00	-0.03	-0.03	PASS

(NOTE: The water baths were constantly agitated with mechanical stirring during the calibration tests.)

(NOTE: During the ΔT calibration, both probes were placed together in the same bath.)

COMMENTS

To PASS, the temperature probes must have... Accuracy error = ≤ ±0.50 °C per test point.
To PASS, the ΔT system must have... Accuracy error = ≤ ±0.10 °C per test point

SOLAR RADIATION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 12/22/2010
Start: 10:25 12/22/2010
End: 10:00 12/09/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: LiCor
Model: 200 Pyranometer
SN: PY57334

Operating Range: 0 to 1,400 W/m^2
Height Above Ground: 1.8 meters

CALIBRATION TEST EQUIPMENT

Item: Kipp & Zonen CM-3 pyranometer **SN:** 58211
Item: Fluke, Model 289, digital multimeter (4.5 digits, True RMS) **SN:** 96210097

PART B: CALIBRATION TEST RESULTS

Known Input		Observed DAS Response				
Period hhmm	Value W/m^2	DAS W/m^2	Error W/m^2	Error %	Error % F.S.	Pass? Fail? [4]
Covered	0.2	0	0	NA	NA	PASS
10:25	173	173	0	-0.2	0.0	PASS
11:03	320	330	10	3.1	0.7	PASS
11:30	413	425	12	2.8	0.8	PASS
11:31	547	558	11	2.1	0.8	PASS
12:35	233	239	5	2.3	0.4	PASS

Calibration Curve Results ⇨

Slope: [1]	1.0259	PASS
Intercept: [2]	-0.938	PASS
Corr. Coeff: [3]	0.9999	PASS

COMMENTS

- It was difficult to get a large range of values due to increasing cloud cover throughout the day.

To PASS, the sensor must have...
[1] Slope = 1.0 ±0.05
[2] Intercept = ≤ 1% of Full Scale
[3] Correlation Coefficient = ≥ 0.9950
[4] Error per test point = ±5% of observed

RELATIVE HUMIDITY SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 12/22/2010
Start: 11:27 12/22/2010
End: 10:00 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Vaisala
Model: HMP45AC
SN: C1920086

Operating Range: 0-100%
Height Above Ground: 2 meters

CALIBRATION TEST EQUIPMENT

Item: Fisher Scientific Traceable Hygrometer, Thermometer, Dew Point **SN:** 72366727

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE		
Test	%RH	DAS %RH	Error %RH	Pass? Fail? [1]
Ambient	64.0	68.0	4.0	PASS
Chmbr.	94.7	95.4	0.7	PASS

COMMENTS

- Could not get chamber higher than 60 % relative humidity. The Vaisala sensor comes with a calibration certificate. Even though it passed this audit, a new chamber will need to be used for the 6 month calibration. Suggest using salts instead of the Fisher Scientific Hygrometer.

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

PRECIPITATION GAUGE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 12/22/2010
Start: 9:00 12/22/2010
End: 10:00 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: TR525USW
SN: 45508-1010

Gauge Type: Tipping Bucket
Operating Range: NA
Height Above Ground: 76.20 cm

CALIBRATION TEST EQUIPMENT

Item: Distilled water, graduated cylinders, drip device
SN: NA

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE			
ml, H_2O	mm	DAS mm	Error mm	Error %	Pass? Fail? [1]
250	7.60	7.37	-0.23	-3.1	PASS

COMMENTS

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

WIND SPEED SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: RM Young
Model: 05305-5 Wind Monitor - AQ
SN: WM106261

Propeller SN:
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Variable motor. R.M.Young, 18820A/18830A (200 to 15,000 rpm) **SN:** CA03277
Item: Variable motor. R.M.Young, 18820A/18831A (0 to 300 rpm) **SN:** CA03277
Item: Torque disk device. R.M.Young, 18312 **SN:** NA

PART B: CALIBRATION TEST RESULTS

Sensor Starting Threshold: 2.0 gm-cm ,equal to 0.38 mps **Pass? / Fail?:** Pass (≤ 0.50 mps)

Known Input		Observed Data Logger Response					
Motor rpm	Motor mph	Output mph	Error mps	Error %	Limit mps	Limit %	Pass? Fail?
0.0	0.00	0.00	0.00	NA	NA	NA	NA
300	3.44	3.44	0.00	0.1	≤ ±0.20	---	PASS
1,000	11.45	11.45	0.00	0.0	---	≤ ±5%	PASS
2,000	22.90	22.90	0.00	0.0	---	≤ ±5%	PASS
4,000	45.80	45.80	0.00	0.0	---	≤ ±5%	PASS
6,000	68.70	68.70	0.00	0.0	---	≤ ±5%	PASS
8,000	91.60	91.60	0.00	0.0	---	≤ ±5%	PASS

COMMENTS

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Wind speed input ≤5.0 mps = ≤ ±0.20 mps error
3) Wind speed input >5.0 mps = ≤ ±5% of input speed

WIND DIRECTION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: RM Young
Model: 05305-5 Wind Monitor - AQ
SN: WM106261

Propeller SN:
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Brunton pocket transit compass — **SN:** 5080610049
Item: R.M.Young, Model 18331, vane torque measurement device — **SN:** NA
Item: R.M.Young, Model 18112, vane angle fixture — **SN:** NA

PART B: CALIBRATION TEST RESULTS

Local Magnetic Declination: 10 degrees east
(http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp)

Sensor Starting Threshold: 7.0 gm-cm ,equal to 0.43 mps **Pass? / Fail?:** PASS ≤ 0.50 mps

Test Input Deg.	Accuracy Test Response: Output Deg.	Error Deg.	Pass? Fail?
0	1	1	PASS
90	91	1	PASS
180	179	-1	PASS
270	271	1	PASS

Test Input Deg.	Linearity Test Response: Output Deg.	Nrmlzd* Deg.	Pass? Fail?
0	1	NA	NA
30	32	1	PASS
60	61	-1	PASS
90	90	-1	PASS
120	120	0	PASS
150	149	-1	PASS
180	179	0	PASS
210	209	1	PASS
240	239	-1	PASS
270	269	1	PASS
300	299	0	PASS
330	329	0	PASS
350	349	-1	PASS

* Normalized error in degrees.

COMMENTS

- The crossarm was measured at 272 degrees to true north on 8/23/2010. The accuracy test response was measured against the crossarm, and therefore is off by 2 degrees. This is reflected in the "Test Input Deg." category.

To PASS, the sensor must have...
1) Starting Torque Threshold = ≤ 0.50 mps
2) Accuracy Test Error = ≤ ±5 degrees per test point
3) Linearity Test Error = ≤ ±3 degrees per test point

TEMPERATURE / ΔTEMPERATURE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 062 MP

2-Meter Probe SN: J10798 (2 of 2)
10-Meter Probe SN: J10798 (1 of 2)
Operating Range: -50 to +50 C

CALIBRATION TEST EQUIPMENT

Item: **Item:** Dostmann Electronic GmbH P650-PT **SN:** 65010081147
Item: **Item:** Insulated water baths with mechanical stirring. **SN:** NA

PART B: CALIBRATION TEST RESULTS

Temperature Probe Calibration

Known Input		Observed Data Logger Response					
Water Bath	Temp. °C	2-m °C	2-m Error °C	Pass? Fail?	10-m °C	10-m Error °C	Pass? Fail?
Ice	-8.60	-8.59	0.01	PASS	-8.51	0.09	PASS
Cool	20.44	20.36	-0.08	PASS	20.37	-0.07	PASS
Hot	38.04	38.04	0.00	PASS	38.04	0.00	PASS

Temperature Difference System Calibration

Known Input		Observed Response		
Water Bath	ΔT °C	2-10 ΔT °C	2-10 ΔT Error °C	Pass? Fail?
Ice	0.00	-0.08	-0.08	PASS
Cool	0.00	-0.02	-0.02	PASS
Hot	0.00	0.00	0.00	PASS

(NOTE: The water baths were constantly agitated with mechanical stirring during the calibration tests.)

(NOTE: During the ΔT calibration, both probes were placed together in the same bath.)

COMMENTS

To PASS, the temperature probes must have... Accuracy error = ≤ ±0.50 °C per test point
To PASS, the ΔT system must have... Accuracy error = ≤ ±0.10 °C per test point

SOLAR RADIATION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: LiCor
Model: 200 Pyranometer
SN: PY57334

Operating Range: 0 to 1,400 W/m^2
Height Above Ground: 1.8 meters

CALIBRATION TEST EQUIPMENT

Item: Kipp & Zonen CM-3 pyranometer **SN:** 58211
Item: Fluke, Model 289, digital multimeter (4.5 digits, True RMS) **SN:** 96210097

PART B: CALIBRATION TEST RESULTS

Known Input		Observed DAS Response				
Period hhmm	Value W/m^2	DAS W/m^2	Error W/m^2	Error %	Error % F.S.	Pass? Fail? [4]
Covered	0.2	0	0	NA	NA	PASS
	718.20	726	8	1.1	0.6	PASS
	766	779	13	1.8	1.0	PASS
	802	819	17	2.1	1.2	PASS
	824	840	16	1.9	1.1	PASS
	856	876	20	2.3	1.4	PASS

Calibration Curve Results ⇨

Slope: [1]	1.0199	PASS
Intercept: [2]	-0.838	PASS
Corr. Coeff: [3]	1.0000	PASS

COMMENTS

- It was difficult to get a large range of values due to increasing cloud cover throughout the day.

To PASS, the sensor must have...
[1] Slope = 1.0 ±0.05
[2] Intercept = ≤ 1% of Full Scale
[3] Correlation Coefficient = ≥ 0.9950
[4] Error per test point = ±5% of observed

RELATIVE HUMIDITY SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Vaisala
Model: HMP45AC
SN: C1920086

Operating Range: 0-100%
Height Above Ground: 2 meters

CALIBRATION TEST EQUIPMENT

Item: Fisher Scientific Traceable Hygrometer, Thermometer, Dew Point **SN:** 72366727

PART B: CALIBRATION TEST RESULTS

		OBSERVED RESPONSE		
KNOWN INPUT		DAS	Error	Pass?
Test	%RH	%RH	%RH	Fail? [1]
Ambient	38.8	32.9	-5.9	PASS
Chmbr.	96.5	91.1	-5.4	PASS

COMMENTS

- Could not get chamber higher than 60 % relative humidity. The Vaisala sensor comes with a calibration certificate. Even though it passed this audit, a new chamber will need to be used for the 6 month calibration. Suggest using salts instead of the Fisher Scientific Hygrometer.

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

PRECIPITATION GAUGE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Ethan Brown

Date: 07/14/2011
Start: 11:20 07/14/2011
End: 10:55 12/22/2010

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: TR525USW
SN: 45508-1010

Gauge Type: Tipping Bucket
Operating Range: NA
Height Above Ground: 76.20 cm

CALIBRATION TEST EQUIPMENT

Item: Distilled water, graduated cylinders, drip device
SN: NA

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE			
ml, H_2O	mm	DAS mm	Error mm	Error %	Pass? Fail? [1]
250	7.60	7.11	-0.49	-6.4	PASS

COMMENTS

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

WIND SPEED SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: RM Young
Model: 05305-5 Wind Monitor - AQ
SN: WM106261

Propeller SN:
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Variable motor. R.M.Young, 18820A/18830A (200 to 15,000 rpm) SN: CA03277
Item: Variable motor. R.M.Young, 18820A/18831A (0 to 300 rpm) SN: CA03277
Item: Torque disk device. R.M.Young, 18312 SN: NA

PART B: CALIBRATION TEST RESULTS

Sensor Starting Threshold: 3.0 gm-cm ,equal to 0.38 mps Pass? / Fail?: Pass ≤ 0.50 mps

Known Input		Observed Data Logger Response					
Motor rpm	Motor mph	Output mph	Error mps	Error %	Limit mps	Limit %	Pass? Fail?
0.0	0.00	0.00	0.00	NA	NA	NA	NA
200	2.29	2.29	0.00	0.0	≤ ±0.20	---	PASS
500	5.73	5.73	0.00	0.0	---	≤ ±5%	PASS
800	9.16	9.16	0.00	0.0	---	≤ ±5%	PASS
1,000	11.45	11.45	0.00	0.0	---	≤ ±5%	PASS
3,000	34.35	34.35	0.00	0.0	---	≤ ±5%	PASS
8,000	91.60	91.60	0.00	0.0	---	≤ ±5%	PASS

COMMENTS

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Wind speed input ≤5.0 mps = ≤ ±0.20 mps error
3) Wind speed input >5.0 mps = ≤ ±5% of input speed

WIND DIRECTION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: RM Young
Model: 05305-5 Wind Monitor - AQ
SN: WM106261

Propeller SN:
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Brunton pocket transit compass **SN:** 5080610049
Item: R.M.Young, Model 18331, vane torque measurement device **SN:** NA
Item: R.M.Young, Model 18112, vane angle fixture **SN:** NA

PART B: CALIBRATION TEST RESULTS

Local Magnetic Declination: 9.46 degrees east
(http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp)

Sensor Starting Threshold: 5.0 gm-cm ,equal to 0.37 mps **Pass? / Fail?:** PASS ≤ 0.50 mps

Test Input Deg.	Accuracy Test Response Output Deg.	Error Deg.	Pass? Fail?
0	0	0	PASS
91	89	-2	PASS
181	181	-1	PASS
271	271	0	PASS

Test Input Deg.	Linearity Test Response Output Deg.	Nrmlzd* Deg.	Pass? Fail?
0	0	NA	NA
30	29	-1	PASS
60	61	1	PASS
90	89	-2	PASS
120	119	1	PASS
150	149	-1	PASS
180	178	-1	PASS
210	208	0	PASS
240	237	-1	PASS
270	269	2	PASS
300	299	0	PASS
330	331	2	PASS
350	349	1	PASS

* Normalized error in degrees.

COMMENTS

Crossarm was measured at 271 degrees. The accuracy test response was measured against the crossarm, and therefore is off by 1 degrees. This is reflected in the "Test Input Deg." category.

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Accuracy Test Error = ≤ ±5 degrees per test point
3) Linearity Test Error = ≤ ±3 degrees per test point

TEMPERATURE / ΔTEMPERATURE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 062 MP

2-Meter Probe SN: J10798 (2 of 2)
10-Meter Probe SN: J10798 (1 of 2)
Operating Range: -50 to +50 C

CALIBRATION TEST EQUIPMENT

Item: **Item:** Dostmann Electronic GmbH P650-PT **SN:** 65010081147
Item: **Item:** Insulated water baths with mechanical stirring. **SN:** NA

PART B: CALIBRATION TEST RESULTS

Temperature Probe Calibration

Known Input		Observed Data Logger Response					
Water Bath	Temp. °C	2-m °C	2-m Error °C	Pass? Fail?	10-m °C	10-m Error °C	Pass? Fail?
Ice	1.71	1.69	-0.02	PASS	1.75	0.04	PASS
Cool	27.99	27.76	-0.23	PASS	27.83	-0.16	PASS
Hot	48.56	48.46	-0.10	PASS	48.52	-0.04	PASS
Subzero	-12.04	-12.26	-0.22	PASS	-12.26	-0.22	PASS

Temperature Difference System Calibration

Known Input		Observed Response		
Water Bath	ΔT °C	2-10 ΔT °C	2-10 ΔT Error °C	Pass? Fail?
Ice	0.00	-0.06	-0.06	PASS
Cool	0.00	-0.07	-0.07	PASS
Hot	0.00	-0.06	-0.06	PASS

(NOTE: The water baths were constantly agitated with mechanical stirring during the calibration tests.)

(NOTE: During the ΔT calibration, both probes were placed together in the same bath.)

COMMENTS

To PASS, the temperature probes must have... Accuracy error = ≤ ±0.50 °C per test point
To PASS, the ΔT system must have... Accuracy error = ≤ ±0.10 °C per test point

SOLAR RADIATION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: LiCor
Model: 200 Pyranometer
SN: PY57334

Operating Range: 0 to 1,400 W/m²
Height Above Ground: 1.8 meters

CALIBRATION TEST EQUIPMENT

Item: Kipp & Zonen CM-3 pyranometer **SN:** 58211
Item: Fluke, Model 289, digital multimeter (4.5 digits, True RMS) **SN:** 96210097

PART B: CALIBRATION TEST RESULTS

Known Input		Observed DAS Response				
Period hhmm	Value W/m²	DAS W/m²	Error W/m²	Error %	Error % F.S.	Pass? Fail? [4]
Covered	0.2	0	0	NA	NA	PASS
11:40	424.33	422	-2	-0.5	-0.1	PASS
12:08	472	485	12	2.6	0.9	PASS
12:40	424	429	5	1.2	0.4	PASS
13:23	383	396	12	3.2	0.9	PASS
14:39	293	301	8	2.7	0.6	PASS
14:42	314	307	-7	-2.1	-0.5	PASS

Calibration Curve Results ⇨		
Slope: [1]	1.0163	PASS
Intercept: [2]	-1.306	PASS
Corr. Coeff: [3]	0.9991	PASS

COMMENTS

- It was difficult to get a large range of values due to increasing cloud cover throughout the day.

To PASS, the sensor must have...
[1] Slope = 1.0 ±0.05
[2] Intercept = ≤ 1% of Full Scale
[3] Correlation Coefficient = ≥ 0.9950
[4] Error per test point = ±5% of observed

RELATIVE HUMIDITY SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Vaisala
Model: HMP45AC
SN: C1920086

Operating Range: 0-100%
Height Above Ground: 2 meters

CALIBRATION TEST EQUIPMENT

Item: Fisher Scientific Traceable Hygrometer, Thermometer, Dew Point **SN:** 72366727

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE		
		DAS	Error	Pass?
Test	%RH	%RH	%RH	Fail?[1]
Ambient	50.5	48.5	-2.0	PASS
Chmbr.	84.1	80.9	-3.2	PASS

COMMENTS

*Difficult reaching 100% saturation. Very cold temperatures would start to freeze the water before the sensors would steady.

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

PRECIPITATION GAUGE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: North Butte
Location: Wyoming
Technician: Will Kaage

Date: 1/11/2012
Start: 11:00 1/11/2012
End: 15:00 1/11/2012

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: TR525USW
SN: 45508-1010

Gauge Type: Tipping Bucket
Operating Range: NA
Height Above Ground: 76.20 cm

CALIBRATION TEST EQUIPMENT

Item: Distilled water, graduated cylinders, drip device
SN: NA

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE			
ml, H_2O	mm	DAS mm	Error mm	Error %	Pass? Fail? [1]
250	7.60	7.36	-0.24	-3.2	PASS

COMMENTS

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

Appendix D

Gas Hills Remote Satellite Meteorological Analysis

(Revised November 2014)

Gas Hills Remote Satellite Uranium Project Meteorology Analysis

Cameco Resources
Casper, Wyoming

May 2012

Prepared by:

INTER-MOUNTAIN LABS

IML Air Science
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(307) 674-7506

Table of Contents

Figures

Tables

Appendices

Introduction

The Gas Hills Remote Satellite in central Wyoming is located in a semi-arid or steppe climate. The area is characterized by abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. The region is characterized seasonally by cold winters, warm dry summers, and cool springs and autumns. Temperature extremes range from roughly -30° F in the winter to 100° F in the summer. There are also large diurnal variations in temperature. The "last freeze" occurs during early to mid June and the "first freeze" in early September due to the high elevation.

Yearly precipitation typically averages from 8 to 12 inches. The Gas Hills District is prone to severe thunderstorm events throughout the spring and early summer months. Spring snowstorms and spring/summer thunderstorm events account for the majority of the precipitation during this time period. In a typical year, the region will see 3 or 4 severe thunderstorm events (as defined by the National Weather Service criteria) and 30 to 40 thunderstorm days. Snow falls in the region throughout late fall, winter and early spring months, totaling around 70 inches per year but varying widely with location and elevation. Snowfall contributes substantially to the annual precipitation totals.

Windy conditions are fairly common to the region. Average annual wind speeds range from 8 mph at lower elevations to 14 mph at higher elevations such as the Gas Hills Remote Satellite area. Higher average wind speeds occur during the fall and winter months at higher elevations, while less seasonal variation is observed in the lowlands. The predominant wind direction is generally from the southwest, with stronger westerly and northwesterly components at Riverton and stronger southerly components in the Gas Hills Remote Satellite area.

For the regional analysis, meteorological data were compiled for five sites surrounding the Gas Hills Remote Satellite area. Hourly average data were acquired from the National Weather Service (NWS) Casper and Riverton airport (AP) sites, through the National Climate Data Center (NCDC, 2012). Data from the South Pass site were acquired from the Wyoming Department of Environmental Quality (WDEQ), and historical data from the Gas Hills 4E site were acquired from the Water Resources Data System (WRDS) managed by the University of Wyoming. Pan evaporation data from the Pathfinder Dam were obtained from the Western Region Climate Center (WRCC). Among these regional sites, the Riverton AP site is the closest NWS weather station to the Gas Hills Remote Satellite (48 miles away). Riverton is also the closest station with available hourly wind data.

For the site-specific analysis, meteorological data from Cameco's Gas Hills Remote Satellite meteorological station were used. These data were collected during an approximately one-year baseline monitoring period extending from

December 8, 2010 through January 27, 2012. Meteorological data from the Gas Hills site include wind speed, wind direction, temperature at 2 meters height, relative humidity, precipitation, solar radiation, and temperature at 10 meters height.

Table 2.5-1 lists the regional and on-site meteorological stations used for this analysis, along with coordinates, elevation, and period of record.

Name	Agency	Long	Lat	Z (ft)	Years of Data
Casper	NWS	-106° 28'	42° 54'	5331	2004 - 2011
Riverton	NWS	-108° 27'	43° 4'	5417	1996 - 2012
South Pass	WDEQ	-108° 43'	42° 32'	8287	2007 - 2011
Gas Hills 4E	WRDC	-107° 31'	42° 50'	6470	1970 - 1989
Pathfinder Dam	WRDC	-107° 31'	42° 50'	6470	1948 - 1991
Gas Hills On-Site	Cameco	-107° 31'	42° 50'	6840	2010 - 2012

Table 2.5-1. Meteorological Stations Included in Climate Analysis.

These sites have been analyzed collectively to provide a regional range of monthly average temperatures, wind speeds and directions, precipitation, relative humidity, evaporation and snowfall. The Casper, Riverton, South Pass and Pathfinder Dam sites form a quadrilateral with the Gas Hills site roughly in the center. Figure 2.5-1 shows the locations of these sites, along with the Gas Hills license/permit boundary. The location of the Gas Hills 4E historical meteorological site, which was removed in 1989 and provided temperature and precipitation data only, is a short distance from the Cameco Gas Hills on-site station. The Pathfinder Dam site provided only evaporation data. On-site evapotranspiration rates were calculated for the Gas Hills project site by applying Penman's equation to available solar radiation, wind speed, temperature and relative humidity data.

Regional and Site Specific Meteorological Characterization

In the information that follows, a regional overview is presented first. This section includes a discussion of the maximum and minimum temperature and relative humidity, annual precipitation including snowfall estimates, and a brief wind speed and direction summary. A combination of monitoring stations is analyzed for the regional overview of temperature, snowfall and total precipitation.

A site specific analysis follows the regional overview. Most of this analysis is based on the on-site monitoring. An in-depth wind analysis summarizes average wind speeds and directions, wind roses, wind speed frequency distributions, and a joint (wind speed and direction) frequency distribution to characterize the wind data for the Gas Hills site by atmospheric stability class. The method of stability class determination is described and illustrated. A discussion of monthly and seasonal data is included for the temperature, precipitation, evapotranspiration and wind parameters. General upper atmosphere data from the National Weather Service station at Lander, Wyoming are used to represent mixing heights at the project site.

The site specific analysis includes a justification for using wind data from the baseline monitoring year to predict meteorological conditions over the long term. This is necessary to validate air sampling locations and MILDOS dispersion modeling inputs. The short and long term wind data from the Riverton AP site are correlated for this purpose. This procedure is repeated for the Casper AP site, yielding similar results.

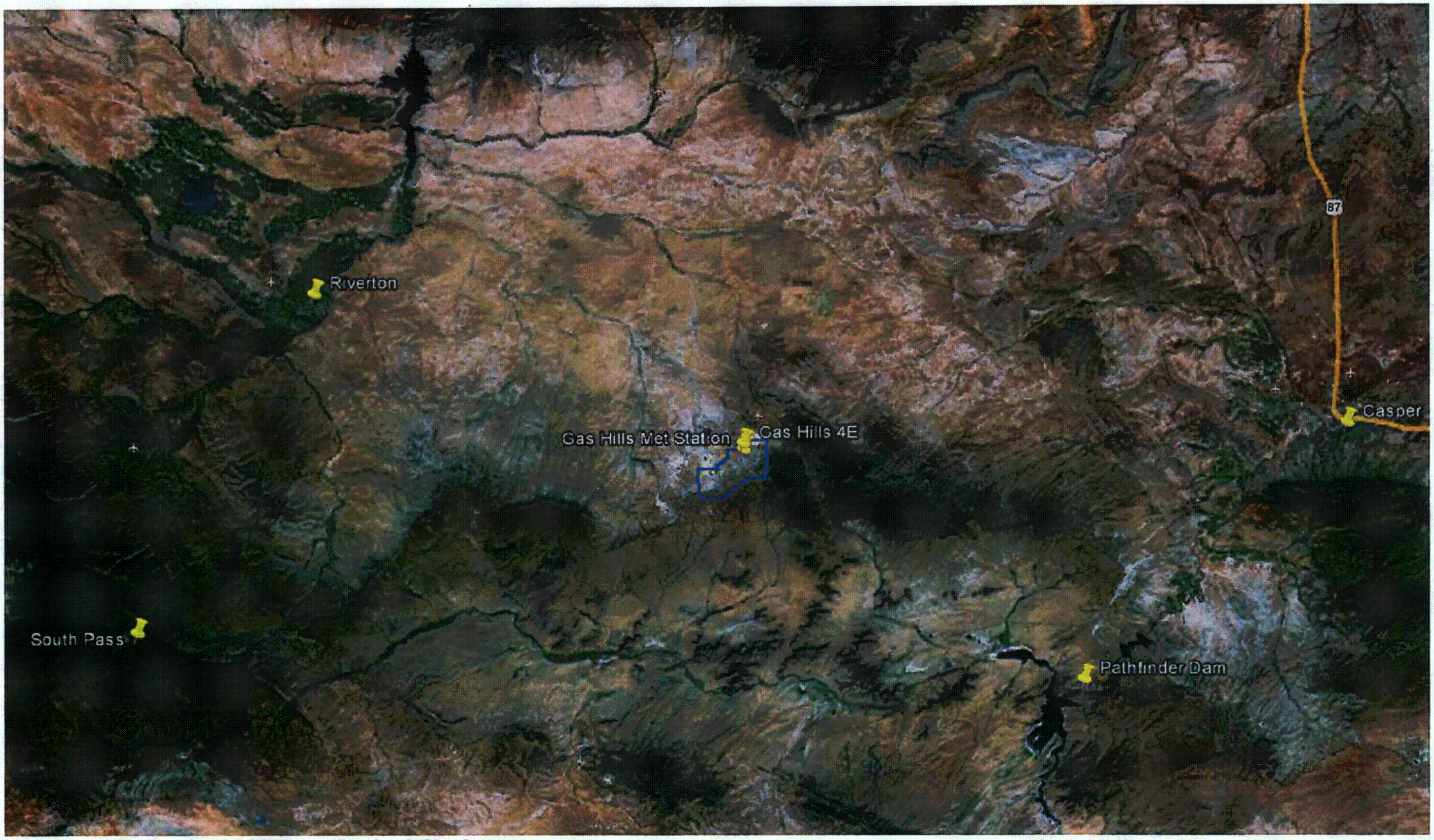


Figure 2.5-1. Regional Meteorological Stations

Regional Overview

Temperature

The annual average temperature for the region containing the Gas Hills ranges from 37.8° F at South Pass (elevation 8,287 ft) to 44.7° at Riverton (elevation 5,417 ft). The Gas Hills 4E meteorological station (elevation 6,470 ft) recorded a 20-year average temperature of 42.6°, slightly less than the Riverton average.

Figure 2.5-2 shows monthly average temperatures for the Riverton (AP) site, monthly average daily highs and lows, and the monthly maximum and minimum temperatures over the last 15 years. July typically has the highest average monthly temperature (73.5° F), followed by August. December typically records the lowest average temperatures for the year (19.7° F), followed by January. Table 2.5-2 shows monthly temperature statistics for the Riverton AP site. Low temperatures in the region can drop to nearly -30° F, while high temperatures can be as high as 102° F.

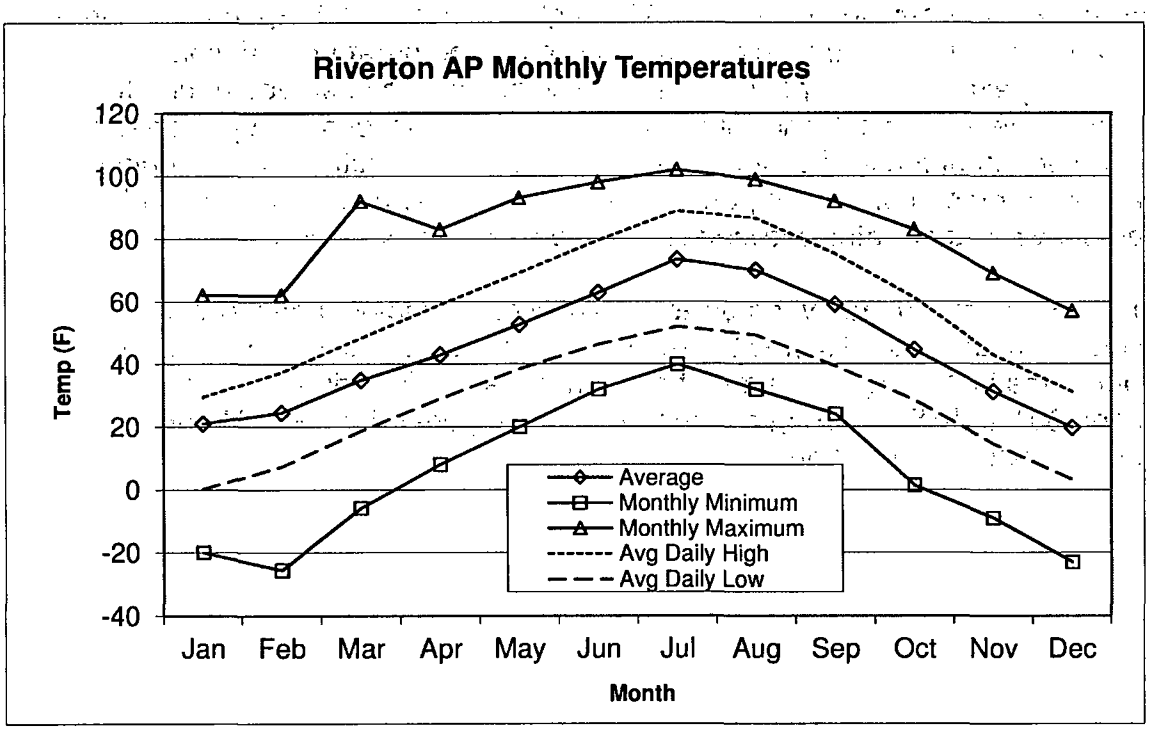
Large diurnal temperature variations occur in the region due in part to its high altitude and low humidity. Figure 2.5-3 depicts the monthly diurnal temperature variation for the Riverton AP site from November, 1996 through January, 2012. Spring and summer daily variations of 25° F are typical, with maximum temperature variations exceeding 40° F during extremely dry periods. Less daily variation is observed during the cooler portions of the year as fall and winter have average variations of approximately 15° F. This can be attributed to the more stable atmospheric conditions in the region during the fall and winter months. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation.

Figure 2.5-4 shows monthly temperature statistics for regional meteorological stations, with the Cameco Gas Hills on-site station included for reference. On a seasonal basis, temperatures in the region average between 20° and 30° F during winter months and between 60° and 75° F during summer months. In general, regional temperatures are inversely related to elevation.

Month	Temperature Statistics (º F)				
	Monthly Average	Monthly Maximum	Monthly Minimum	Average Daily High	Average Daily Low
Jan	21.0	62	-20	29.5	0.3
Feb	24.5	62	-26	37.4	7.3
Mar	34.9	92	-6	48.2	18.6
Apr	42.9	83	8	59.0	29.0
May	52.6	93	20	69.2	38.5
Jun	62.9	98	32	79.5	46.2
Jul	73.5	102	40	88.8	51.9
Aug	70.0	99	32	86.5	49.2
Sep	59.1	92	24	75.3	39.4
Oct	44.5	83	1	61.3	28.5
Nov	31.2	69	-9	42.9	14.5
Dec	19.7	57	-23	31.2	3.2

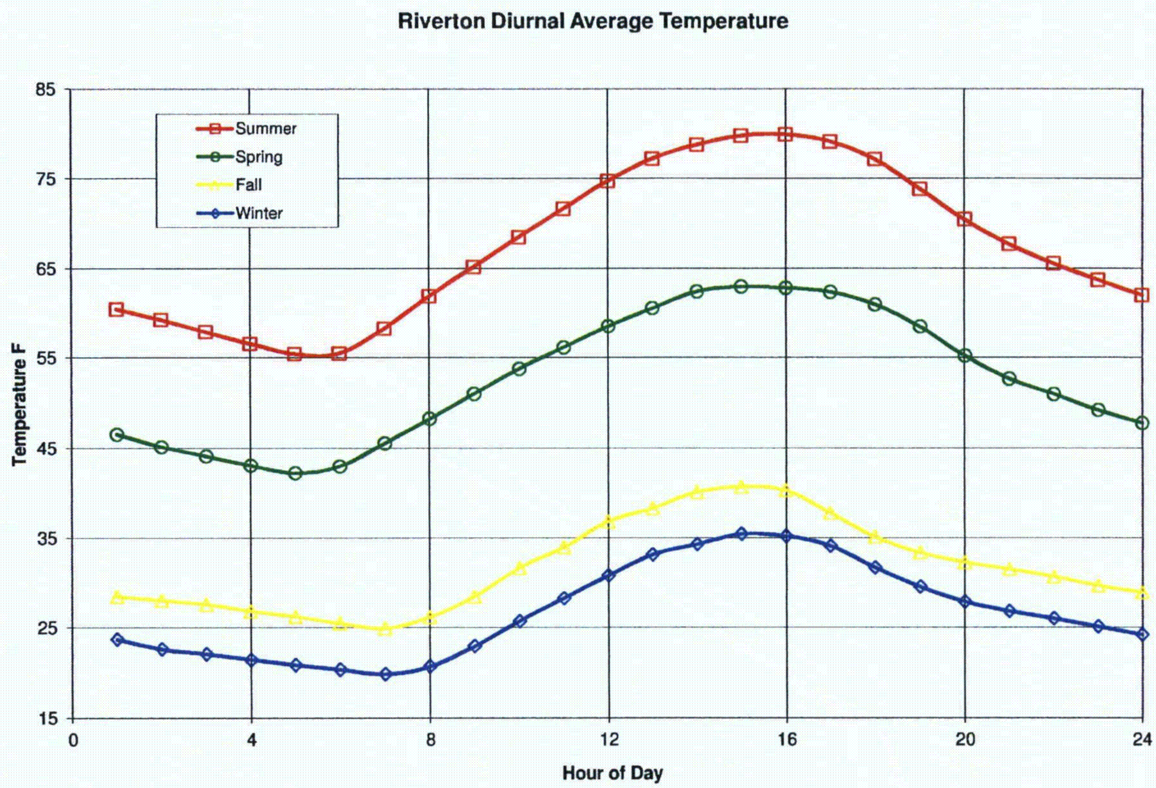
Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Table 2.5-2. Annual and Monthly Temperature Statistics for Riverton AP.



Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-2. Riverton AP Monthly Temperature Statistics



Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-3. Riverton AP Seasonal Diurnal Temperature Variations.

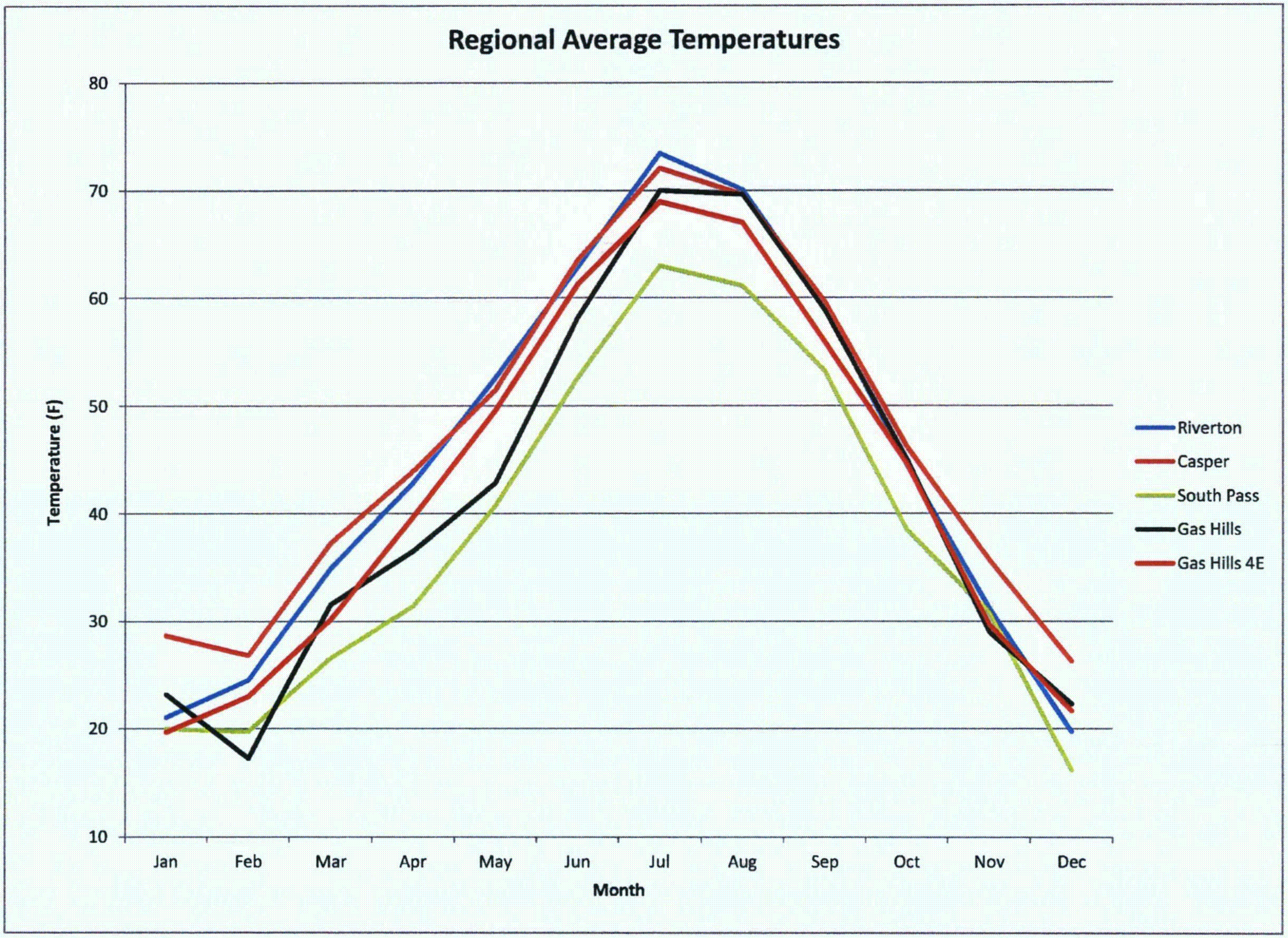
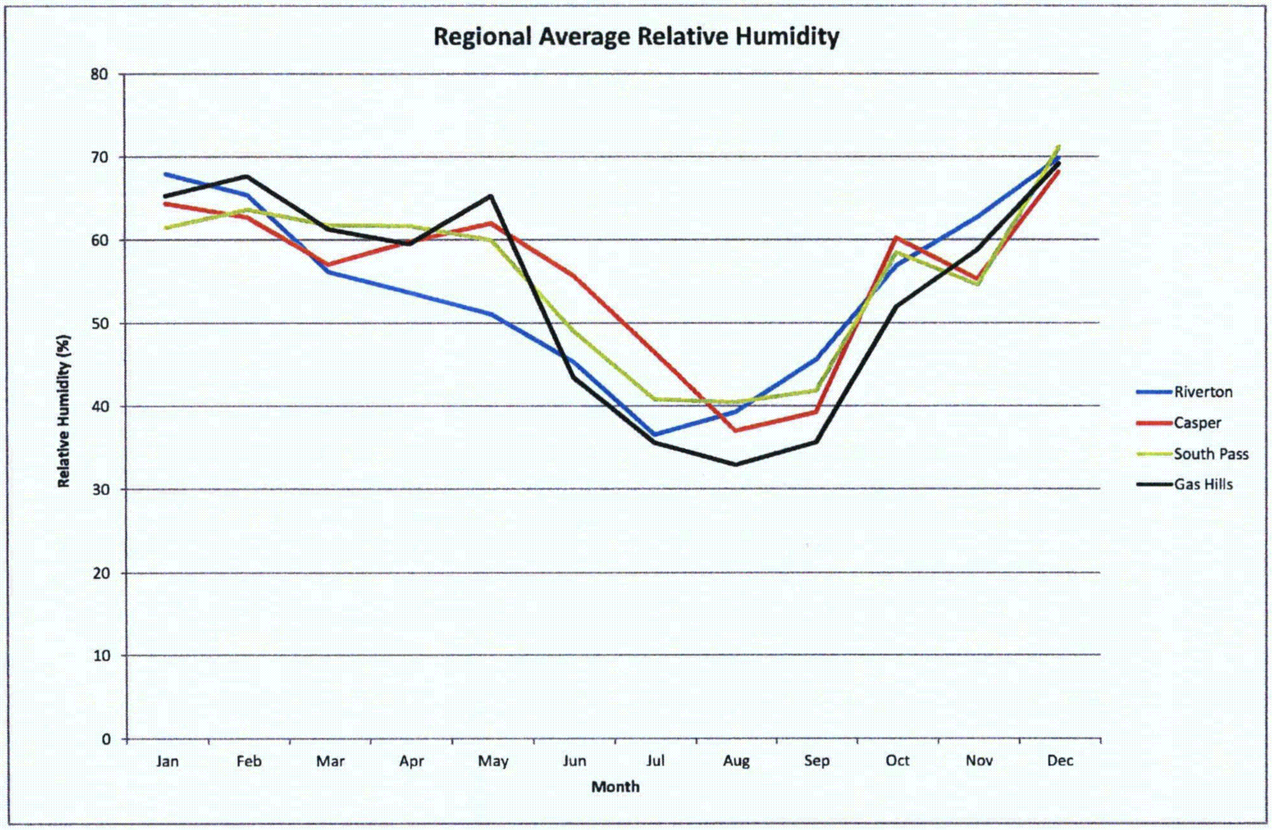


Figure 2.5-4. Regional Monthly Average Temperatures.

Relative Humidity

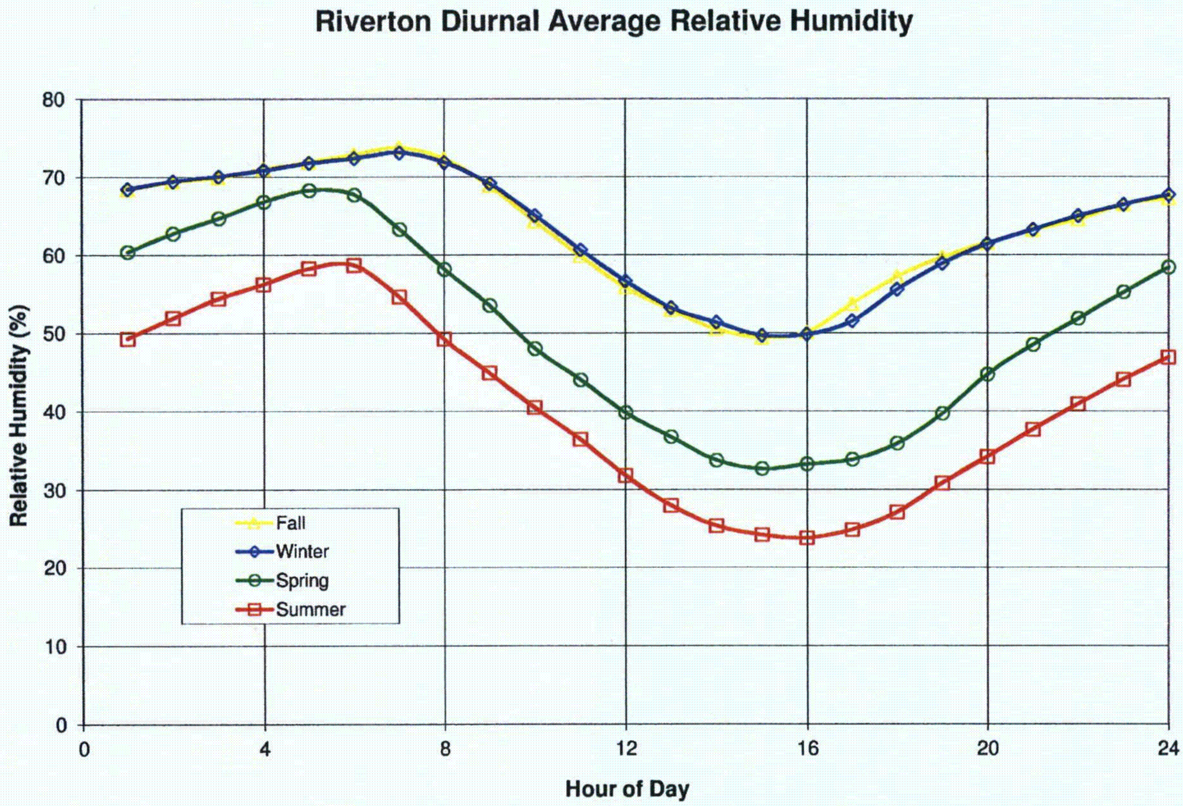
The Riverton, Casper, and South Pass sites record hourly average relative humidity. Figure 2.5-5 charts monthly average relative humidity values for these sites. The Cameco on-site (Gas Hills) relative humidity averages are also shown for reference. It can be seen that July and August have the driest air with relative humidity averaging around 40%. The winter months of December, January and February make up the most humid part of the year, with average relative humidity between 60% and 70%. The annual average relative humidity is 54% at the Riverton AP site.



Sources: NCDC, WDEQ, Cameco Resources

Figure 2.5-5. Monthly Relative Humidity Statistics for the Region

Relative humidity is a temperature based calculation which reflects the fraction of moisture present relative to the amount of moisture for saturated air at that temperature. Warmer air holds more moisture at saturation than colder air. For a given amount of moisture in the air, then, maximum relative humidity values occur more frequently in the early mornings while minimum values typically occur during the mid afternoon hours. The summer months exhibit a much greater variation in relative humidity between morning and afternoon values due to greater temperature variations. Figure 2.5-6 shows the diurnal variations in relative humidity at Riverton, by season.

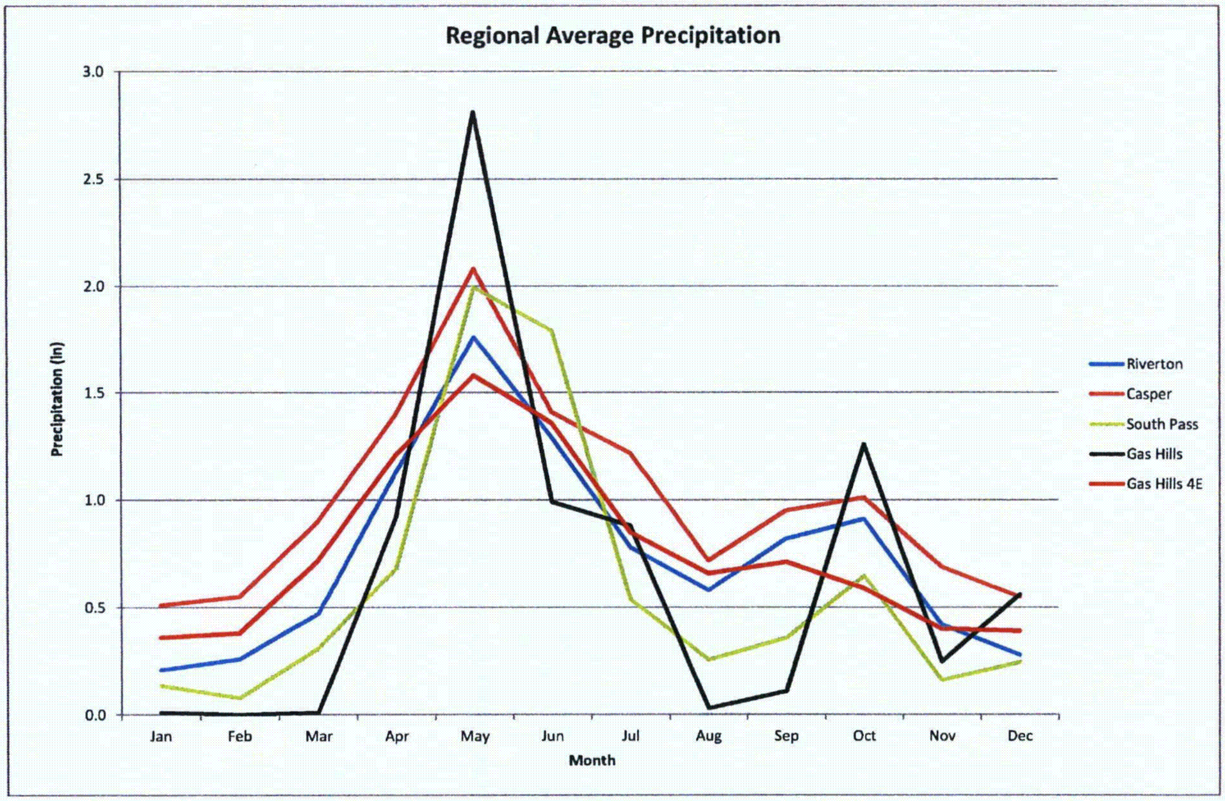


Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-6. Diurnal Variation in Relative Humidity for Riverton by Season

Precipitation

The region is semi-arid and characterized by mostly dry conditions. The Riverton AP site received measurable (>0.01 in) precipitation on an average of 64 days per year between 1997 and 2011 (NCDC, 2012). Average annual precipitation during that period was 8.9 inches per year. In general, the region has an annual precipitation average of approximately 8 to 12 inches. Typical of the region, spring snowstorms, showers and thunderstorms during April through June produce nearly half of the precipitation at the historical Gas Hills 4E site (Figure 2.5-7). May is typically the wettest month of the year; with most of the region receiving an average of approximately 2 inches for that month. January, in contrast, is the driest month of the year with precipitation typically averaging one half inch or less. The winter months (Dec-Feb) typically account for less than 15% of the yearly precipitation totals. Only moderate precipitation occurs in late summer, when atmospheric conditions are more stable and the absence of convective activity limits storm development.

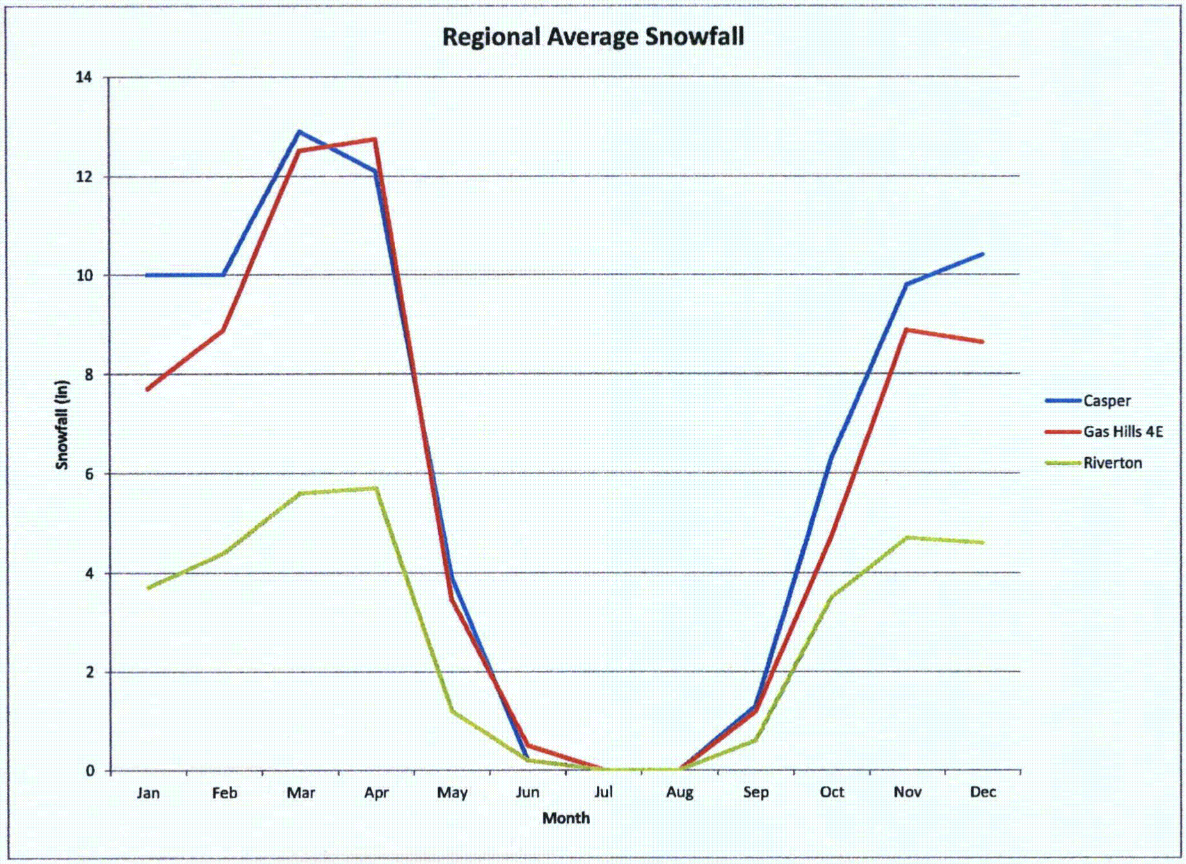


Sources: NCDC, WDEQ, WRDS, Cameco Resources

Figure 2.5-7. Monthly Average Precipitation in Region

Severe weather does occur throughout the region, but is limited on average to 5 or 6 severe events per year. These severe events are generally split between hail, blizzards and damaging wind events.

Average annual snowfall varies widely throughout the region, as depicted in Figure 2.5-8. Major snowstorms (more than 5 in/day) are relatively infrequent in the region, which typically experiences less than three major snowstorms per year. Casper has the highest annual snowfall of the sites recording snowfall, with an average of 76.9 inches, while Riverton has the lowest average at 34.2 inches per year. Monthly average snow amounts in Figure 2.5-8 show the highest snowfall in March and April.



Sources: NCDC, WDEQ, WRDS

Figure 2.5-8. Regional Average Monthly Snowfall.

Wind Patterns

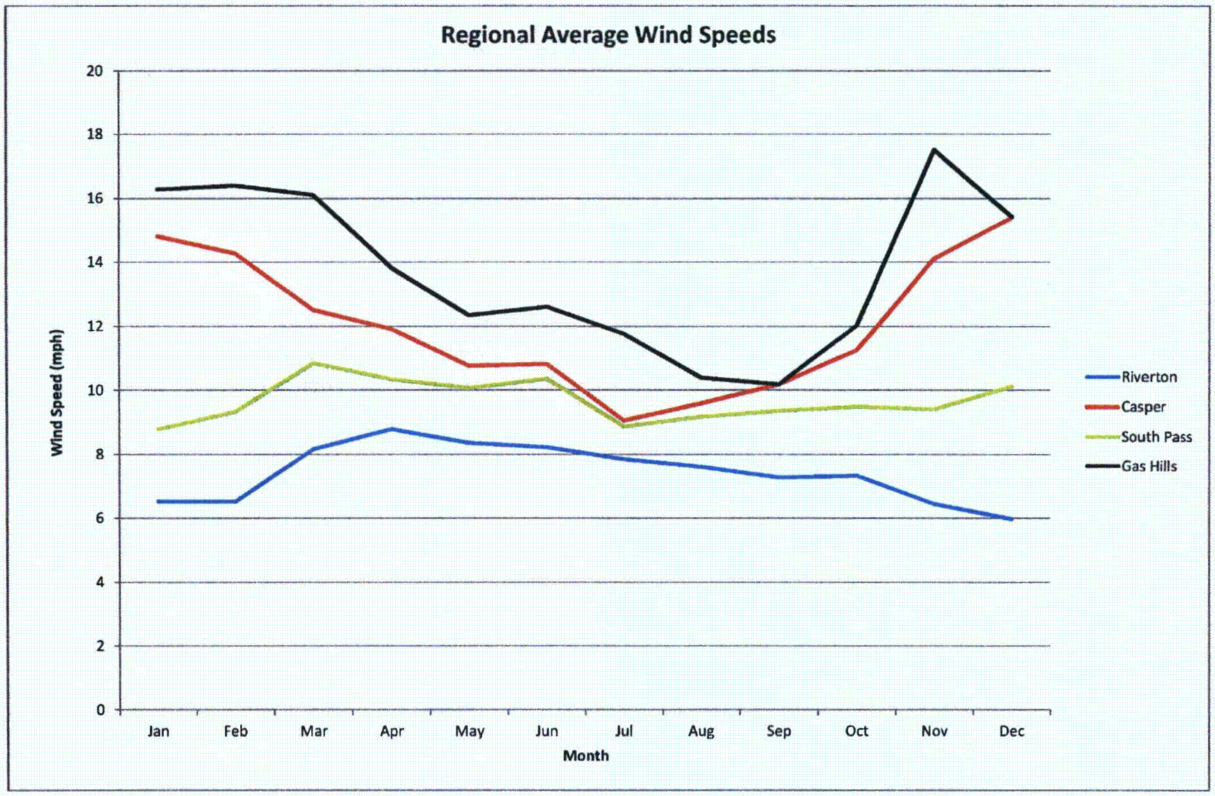
Year-round wind speeds in the area average between 8 and 14 mph. Table 2.5-3 shows monthly averages for the Riverton AP site. The overall average wind speed at this site was 7.4 mph for the 1996-2012 period analyzed in this study. Mean monthly average wind speeds are lowest in the winter months and highest in April at nearly 9 mph. This is atypical of the region, however, as winds at Riverton are moderated by the proximity of the Wind River mountain range.

Month	Hourly Average Wind Speeds (mph)		
	Monthly Average	Monthly Maximum	Monthly Minimum
Jan	6.5	43	0
Feb	6.5	41	0
Mar	8.2	39	0
Apr	8.8	39	0
May	8.4	46	0
Jun	8.2	43	0
Jul	7.8	41	0
Aug	7.6	44	0
Sep	7.3	37	0
Oct	7.3	46	0
Nov	6.4	40	0
Dec	6.0	41	0

Source: National Climate Data Center, 2011, hourly data from 1996 through 2011

Table 2.5-3. Riverton AP Monthly Wind Parameters Summary.

Figure 2.5-9 shows regional monthly average wind speeds. Like Riverton, the South Pass site also experiences a wind sheltering effect from the Wind River mountain range. Farther east, however, high wind events are fairly common from November to April. Winds at Casper average more than 12 mph, with hourly averages exceeding 20 mph nearly 15% of the time (NCDC 2012).



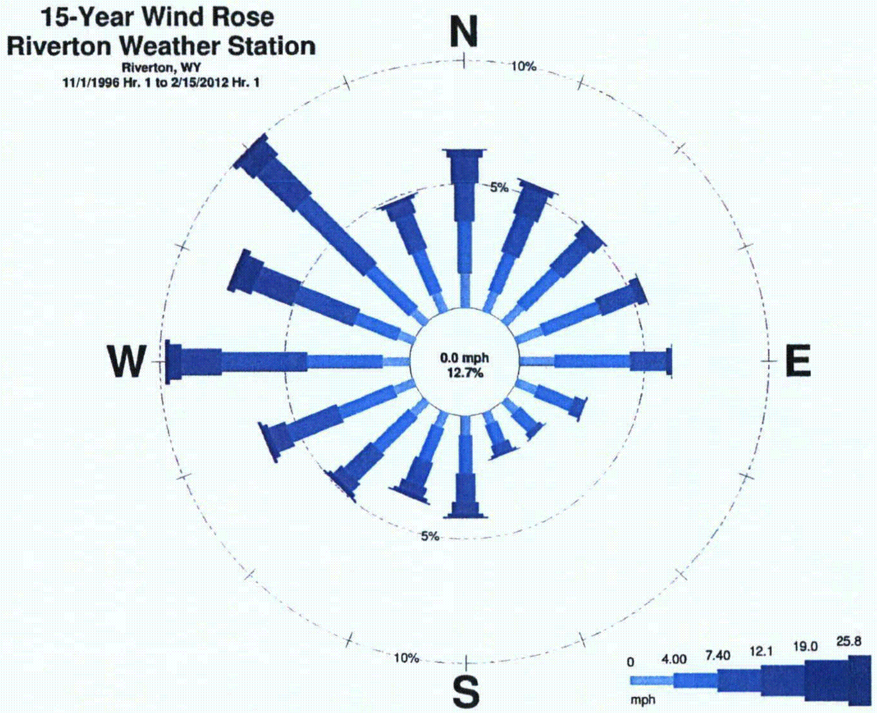
Sources: NCDC, WDEQ, Cameco Resources

Figure 2.5-9. Regional Average Wind Speeds

Figure 2.5-10 shows the 15-year wind rose for the Riverton AP site. Predominant winds are generally from the west to northwesterly direction. These winds are often associated with storm fronts during the late fall, winter, and spring seasons. Otherwise light breezes trend more or less evenly from all directions except the southeasterly sector.

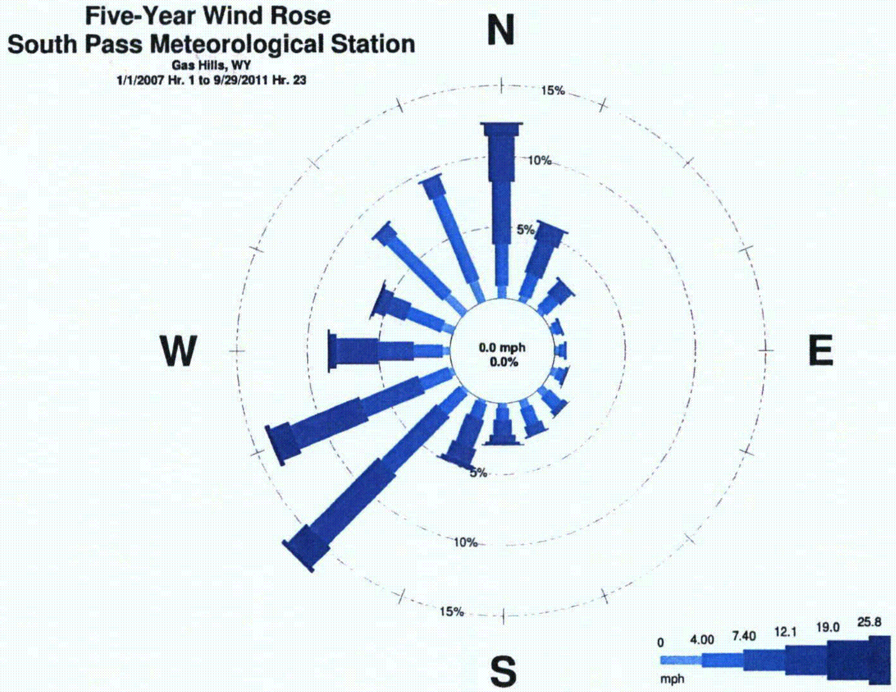
Figure 2.5-11 shows a 5-year wind rose for the South Pass site. Here, southwesterly winds dominate, with a secondary node from the northerly direction. Figure 2.5-12 shows an 8-year wind rose for the Casper site. Winds are much stronger at Casper than at South Pass and Riverton, with dominant southwesterly winds influenced by the nearby Casper Mountain.

Dramatic differences in terrain and elevation across the region make it impossible to assign a single wind pattern to all locations. Southwesterly flow emerges as the common wind characteristic in high and unobstructed areas. As discussed below in justifying the on-site baseline year as representative of the long term, spatial variations in wind patterns across the region are pronounced, while temporal variations for any given site are relatively minor.



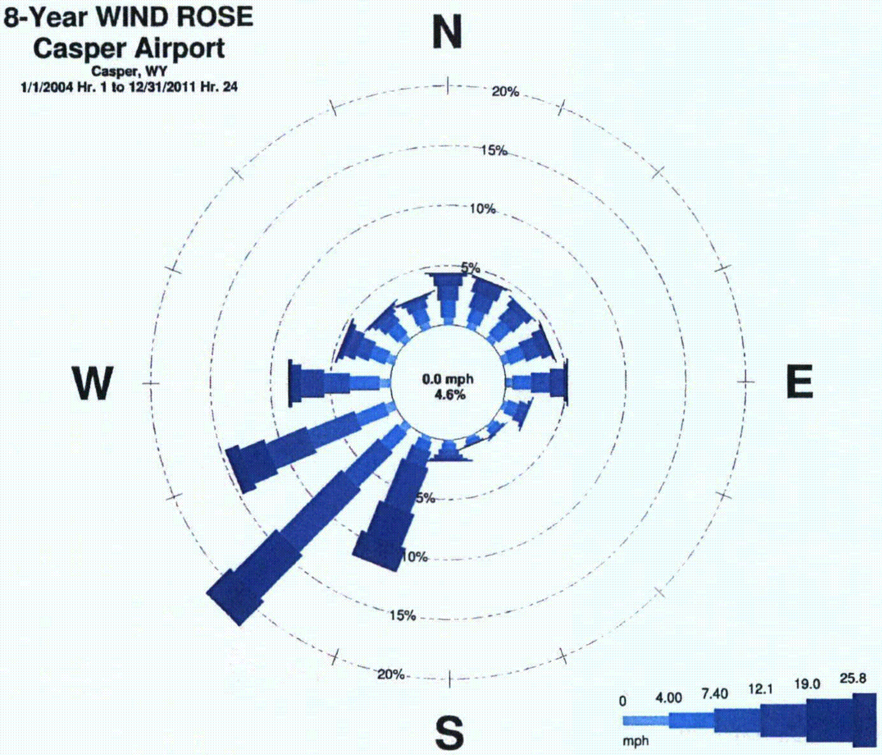
Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-10. Riverton AP 15-Year Wind Rose



Source: WDEQ, hourly data from 2007 through 2011

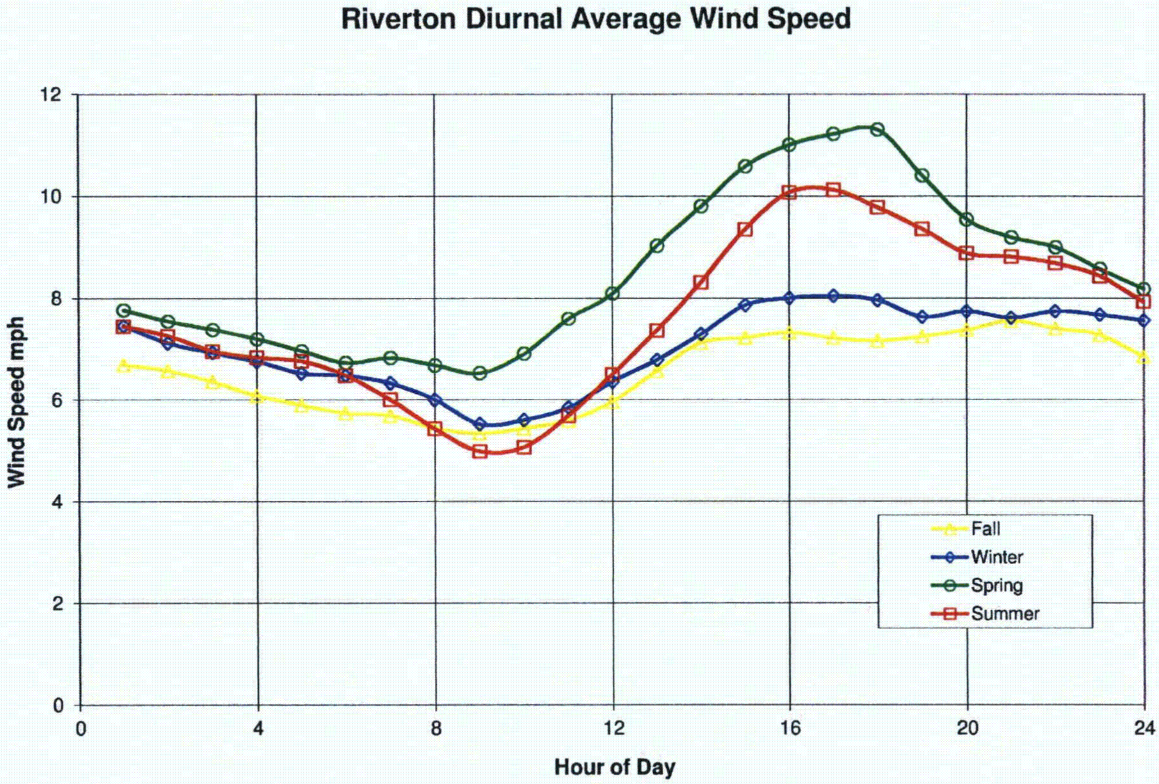
Figure 2.5-11. South Pass 5-Year Wind Rose



Source: NCDC, hourly data from 2004 through 2011

Figure 2.5-12. Casper 8-Year Wind Rose

Winds throughout the region exhibit a diurnal pattern. Figure 2.5-13 shows this pattern at Riverton for each season of the year. While the diurnal variation is less pronounced during the fall months, wind speeds peak during the late afternoon for winter, spring and summer seasons. This is largely due to the predominant effect of solar heating on wind patterns. Figure 2.5-13 also shows that the highest average wind speeds occur during the spring season, when the atmosphere tends to be least stable and storm systems are the strongest. The lowest wind speeds occur during fall, when the atmosphere is the most stable.



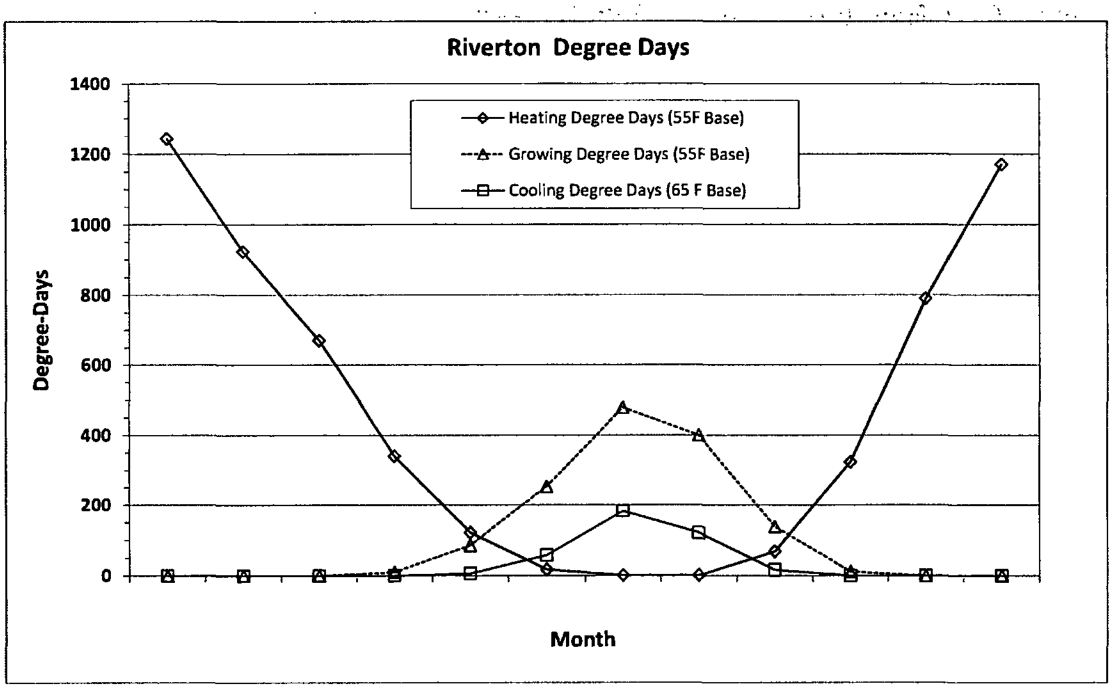
Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-13. Riverton AP Diurnal Wind Speeds by Season

Heating, Cooling and Growing Degree Days

Figure 2.5-14 summarizes the monthly cooling, heating, and growing degree days for Riverton. The heating and cooling degree days are included to show deviation of the average daily temperature from a predefined base temperature. In this case, 55° F has been selected as the base temperature for computation of heating and growing degree days. The base temperature for computing cooling degree days is 65° F. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The calculation for growing and cooling degree days is the same, except that the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

As expected, the graphs of heating degree days and cooling degree days are inversely related and the growing and cooling degree days are directly related. The maximum number of heating degree days occurs in December and January, at roughly 1,200 degree days per month. This coincides with the months having the lowest minimum average temperatures. Conversely, July registers the most growing degree days with nearly 500, and the most cooling degree days at less than 200. This also corresponds to July having the highest average temperature. The The Gas Hills Remote Satellite area is expected to exhibit a higher value for heating degree days and lower values for cooling and growing degree days, due to its higher elevation relative to Riverton.



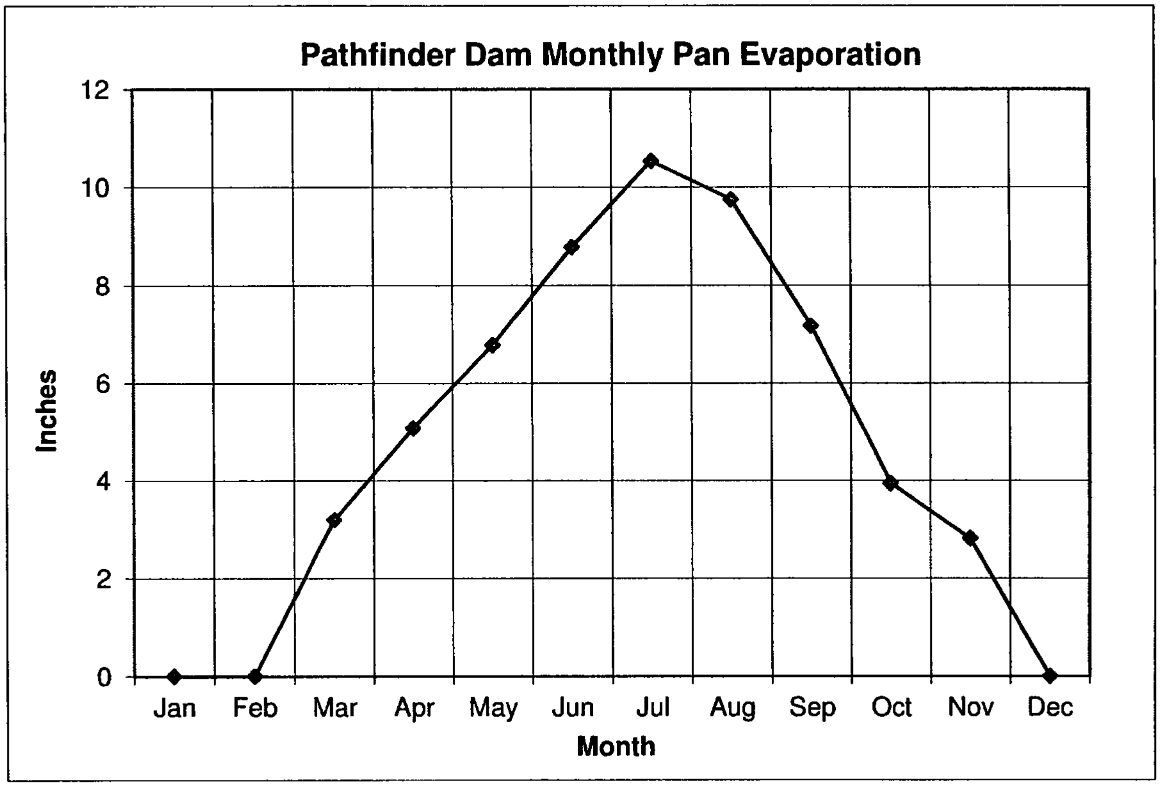
Source: Western Regional Climate Center, 2011, data from 1893 to 2010

Figure 2.5-14. Riverton Airport Cooling, Heating, and Growing Degree Days.

Evapotranspiration

The region is characterized by high evaporative demand during much of the year. This demand is related to dry air (low dew points), warm daytime temperatures and moderate to high wind speeds. The Pathfinder Dam, roughly 40 miles east-southeast of the Gas Hills project site, is the closest station with historical evaporation data. With an elevation of 5,860 ft. and average annual precipitation of 9.8 inches, this site is believed to have average evaporation rates representative of the Gas Hills Remote Satellite area.

Figure 2.5-15 graphs monthly pan evaporation rates, measured in inches of water per month, at the Pathfinder Dam site. Evaporation rates are highest in July, at over 10 inches, and lowest in December through February. Annual evaporation at Pathfinder Dam averages 58 inches per year.



Source: WRCC, 1948-1991

Figure 2.5-15. Pathfinder Dam Pan Evaporation.

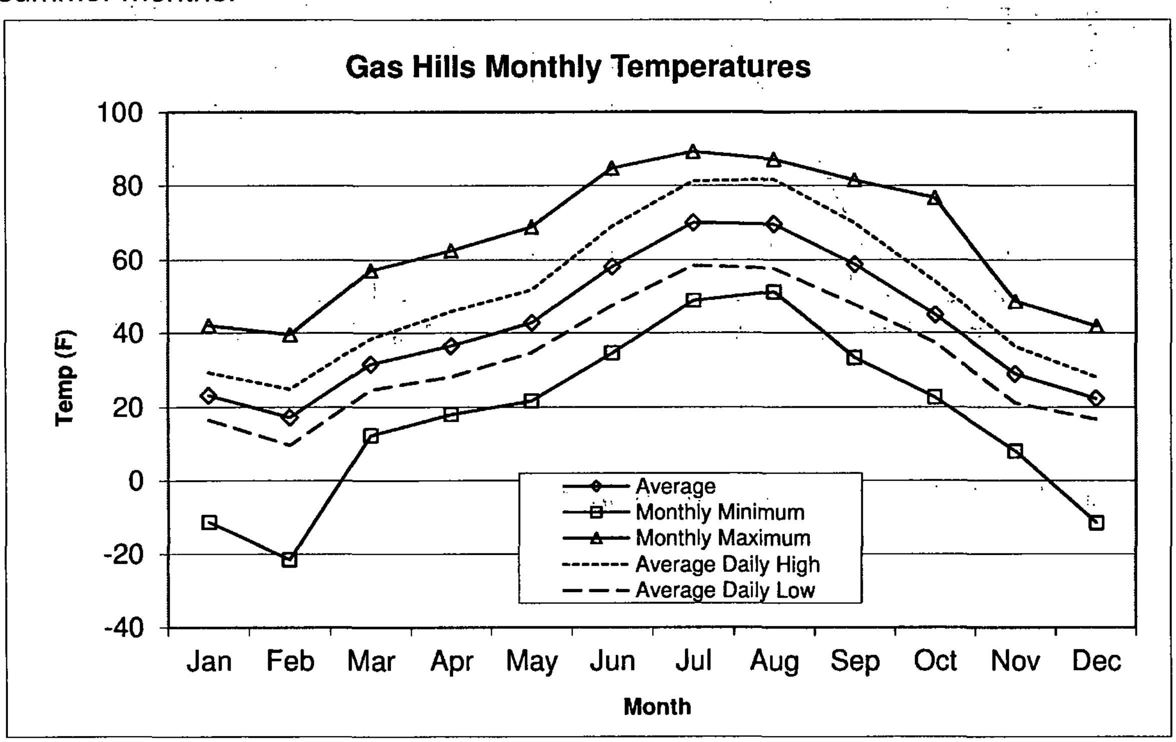
Site Specific Analysis

Background

The site specific discussion is limited to on-site meteorological data collected for the baseline monitoring period of December 8, 2010 through January 27, 2012. These on-site data are supplemented by meteorological data from the nearby Riverton AP site, collected during the 15-year period from late 1996 through early 2012. The Riverton site is included to incorporate wind monitoring results from a longer period of record and to demonstrate that for this region, winds during the baseline monitoring period are representative of the longer term. As the closest NWS weather station, the Riverton site is located less than 50 miles west-northwest of the Gas Hills Remote Satellite. Notwithstanding its proximity, Riverton is over a thousand feet lower in elevation than the satellite area, and is surrounded by farmland in contrast to the generally dry and broken terrain of the satellite area.

Temperature

The annual average site temperature is similar to the regional average temperature at approximately 42° F. The maximum temperature for the baseline monitoring year was 89° F and the minimum temperature was -21° F. Figure 2.5-16 shows the monthly average, minimum and maximum temperatures for the project site. Table 2.5-4 provides the same data in tabular form. Daily average temperatures range from near 20° F in the winter months to near 70° in the summer months.



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

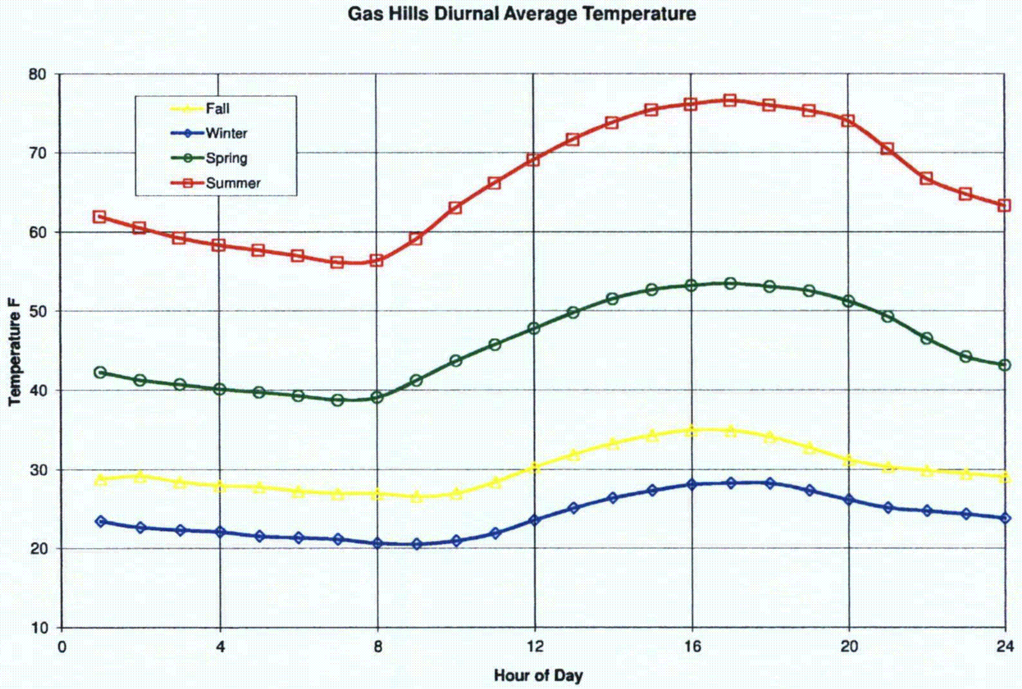
Figure 2.5-16. Gas Hills Monthly Temperatures.

Month	Temperature Statistics (º F)				
	Monthly Average	Monthly Maximum	Monthly Minimum	Average Daily High	Average Daily Low
Jan	23.2	42	-11	29.4	16.5
Feb	17.2	40	-21	24.9	9.6
Mar	31.6	57	12	38.5	24.6
Apr	36.5	63	18	45.9	28.2
May	42.8	69	22	51.8	34.7
Jun	58.2	85	35	69.1	47.6
Jul	70.0	89	49	81.2	58.5
Aug	69.6	87	51	81.7	57.6
Sep	58.8	81	33	69.9	47.7
Oct	45.0	77	23	54.2	37.4
Nov	29.0	49	8	36.4	21.1
Dec	22.3	42	-12	28.1	16.7

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-4. Gas Hills Max, Min, and Avg Monthly Temperatures

Diurnal temperature variations at the Gas Hills Remote Satellite site are slightly less pronounced than at Riverton. Figure 2.5-17 shows diurnal swings ranging from 20° F in the summer to less than 10° F in the winter.



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-17. Gas Hills Monthly Temperatures.

Relative Humidity

The annual average site relative humidity is 55.4%. On-site monthly average relative humidity values are graphed along with regional averages in Figure 2.5-5. The graph shows relative humidity at the Gas Hills site to mirror regional trends.

Relative humidity is a temperature based calculation which reflects the fraction of moisture present relative to the amount of moisture for saturated air at that temperature. Warmer air holds more moisture at saturation than colder air. For a given amount of moisture in the air, then, maximum relative humidity values occur more frequently in the early morning hours while minimum values typically occur during the mid afternoon hours. The summer months exhibit a much greater variation in relative humidity between morning and afternoon values due to greater temperature variations. Summer and Spring also exhibit lower overall relative humidity values due to higher average temperatures. This is confirmed by Figure 2.5-18, which graphs average relative humidity by time of day and season.

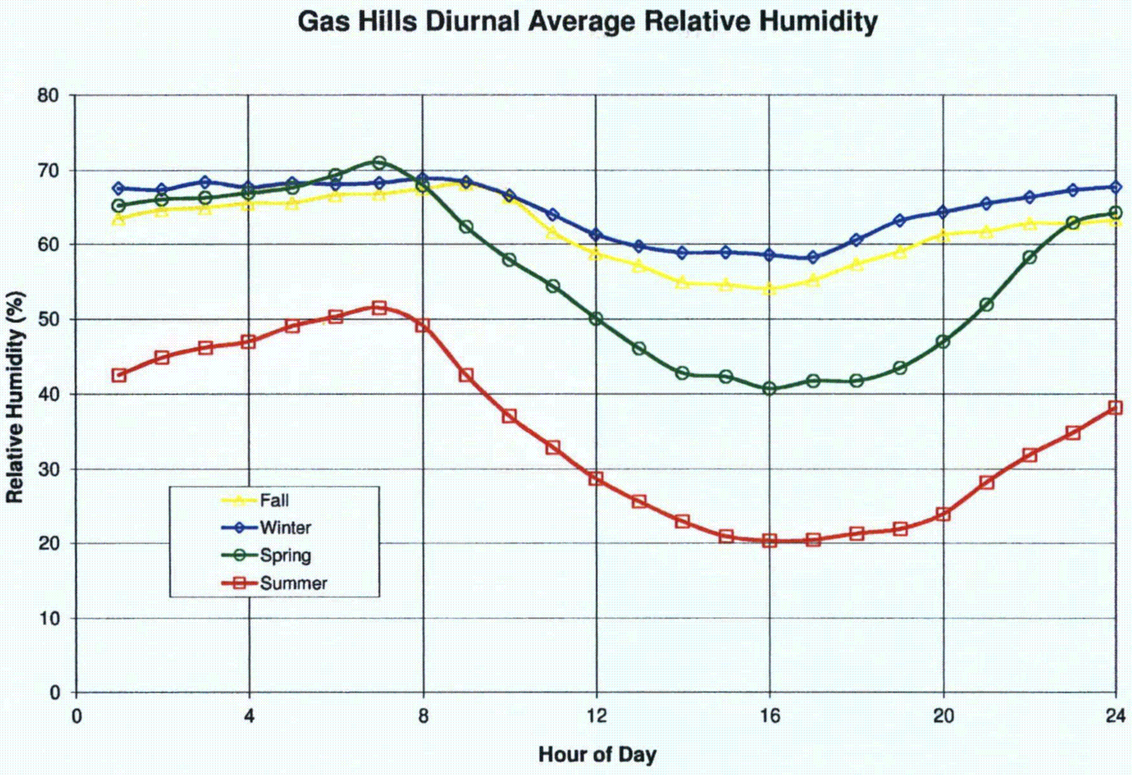


Figure 2.5-18. Gas Hills Diurnal Relative Humidity.

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-19 provides a meteorological summary for the Gas Hills Remote Satellite site for the baseline monitoring year. The averages, maximums, and minimums are specified for each parameter recorded at the site along with the data recovery rate for each. The recovery rates were nearly 100% for all parameters.

Cameco Gas Hills

Meteorological Data Summary

12/8/2010 - 1/27/2012

Hourly Data

	Average/Total	Max	Min
Wind Speed (mph)	14.0	43.7	0.3
Sigma-Theta (°)	16.8	98.3	1.0
Temperature (F)	39.8	89.2	-21.4
10m Temperature (F)	40.1	87.6	-18.7
Relative Humidity (%)	55.4	100.0	6.6
Precipitation (mm)	247.65	14.48	
Solar Radiation (w/m^2)	184.7	1,013.0	

Predominant wind direction was from the SSW sector, accounting for 20.7% of the possible winds

Data Recovery

Parameter	Possible (hours)	Reported (hours)	Recovery
Wind Speed	9962	9957	99.95%
Wind Direction	9962	9955	99.93%
Sigma-Theta	9962	9957	99.95%
Temperature	9962	9957	99.95%
10m Temperature	9962	9957	99.95%
Relative Humidity	9962	9957	99.95%
Precipitation	9962	9957	99.95%
Solar Radiation	9962	9957	99.95%

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-19. Gas Hills Meteorological Summary.

Wind Patterns

Figures 2.5-20 presents a wind rose for the project site during the 13-month baseline monitoring period. The predominant wind directions are south-southwesterly and southwesterly, with the highest wind speeds also coming from those directions. Figure 2.5-21 shows seasonal wind roses for the Gas Hills Remote Satellite area. Spring and summer experience the greatest variability in wind direction with secondary modes as a result of the synoptic scale transition period that occurs during this time. During periods of fair weather, particularly in late spring and summer months, high pressure located over the northern plains produces east-northeasterly breezes at the site. Synoptic weather systems generally interrupt this pattern, producing northwesterly winds.

Figure 2.5-22 presents a diurnal graph of wind speeds at the site by season. During the fall season, very little diurnal variation is observed. For the rest of the year, wind speeds peak during the late afternoon. Summer winds exhibit a secondary peak around midnight, possibly associated with downslope convection winds. Winds during the fall plateau at an average of 15 mph, while winter wind speeds average 16 mph and peak at 18 mph. The spring season exhibits the greatest average diurnal variation, from 11 mph at night to 16 mph in the afternoon.

Figure 2.5-23 shows the time distribution of wind speeds at the site. Half of the time wind speeds are more than 12 mph, while winds exceed 20 mph 16% of the time.

The average wind speed for the project site was 14 mph over the 13 months of monitoring. The monthly average and maximum hourly wind speeds at the project site are summarized in Figure 2.5-24. The graph shows lower wind speeds in the summer.

Figure 2.5-25 provides a breakdown of wind speeds by wind direction. Wind speeds average more than 15 mph when the wind blows from the south, south-southwest, and southwest directions. A secondary maximum occurs for east-northeasterly winds, averaging over 14 mph. Southeast wind speeds average less than 9 mph.

The Joint Frequency Distribution (JFD) provides more detail on wind speed distribution by wind direction and atmospheric stability class. The distribution shows the frequencies of hourly average wind speed for each direction based on stability class. Tables 2.5-5 and 2.5-6 list the annual JFD for the Gas Hills meteorological station. Tables 2.5-7 through 2.5-14 list the seasonal JFD's. A majority of the winds at the project site fall into stability class D which represents near neutral to slightly unstable conditions. The light-to-calm winds which accompany stable environments are reflected in the stability class F summary.

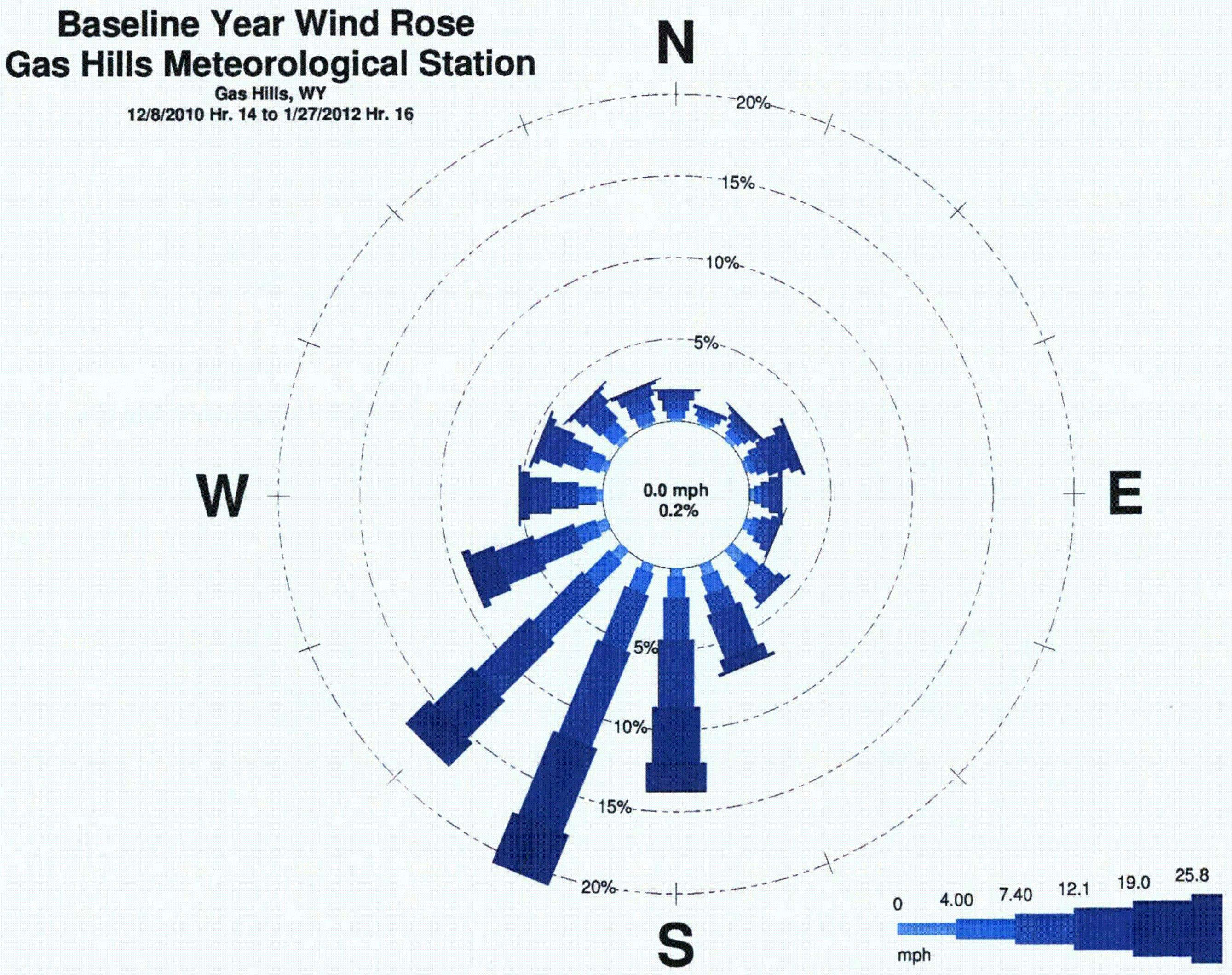


Figure 2.5-20. Gas Hills Wind Rose.

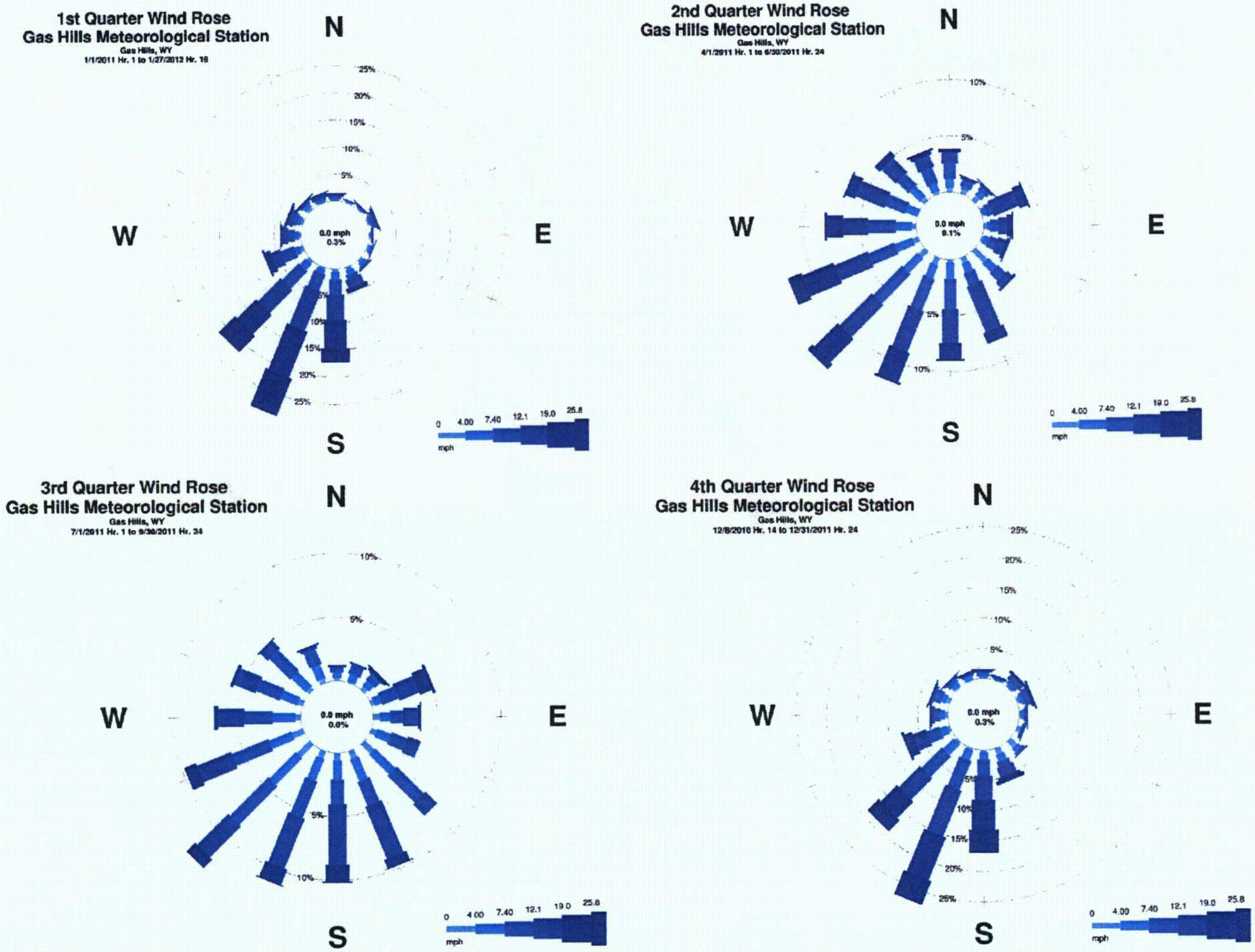
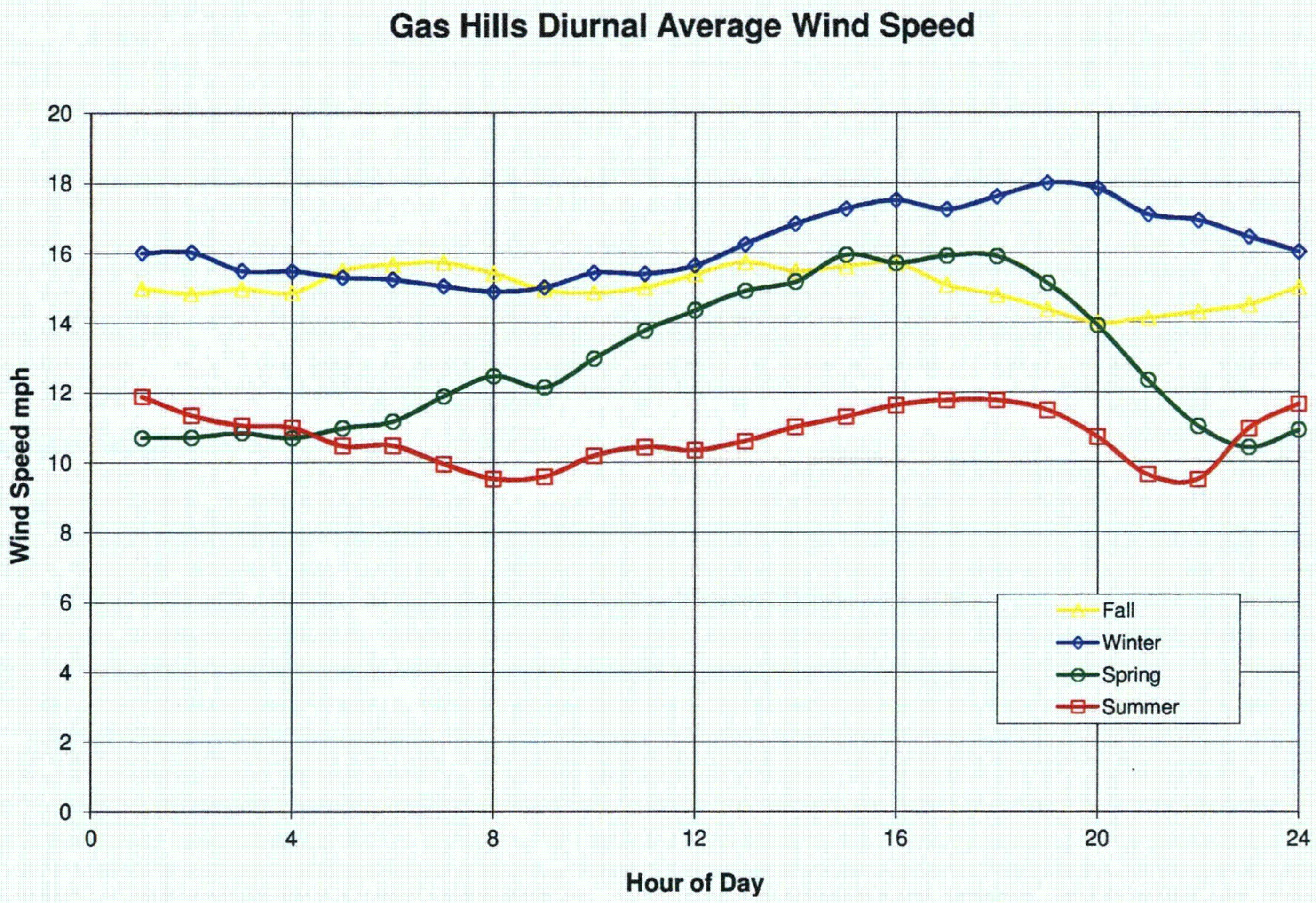
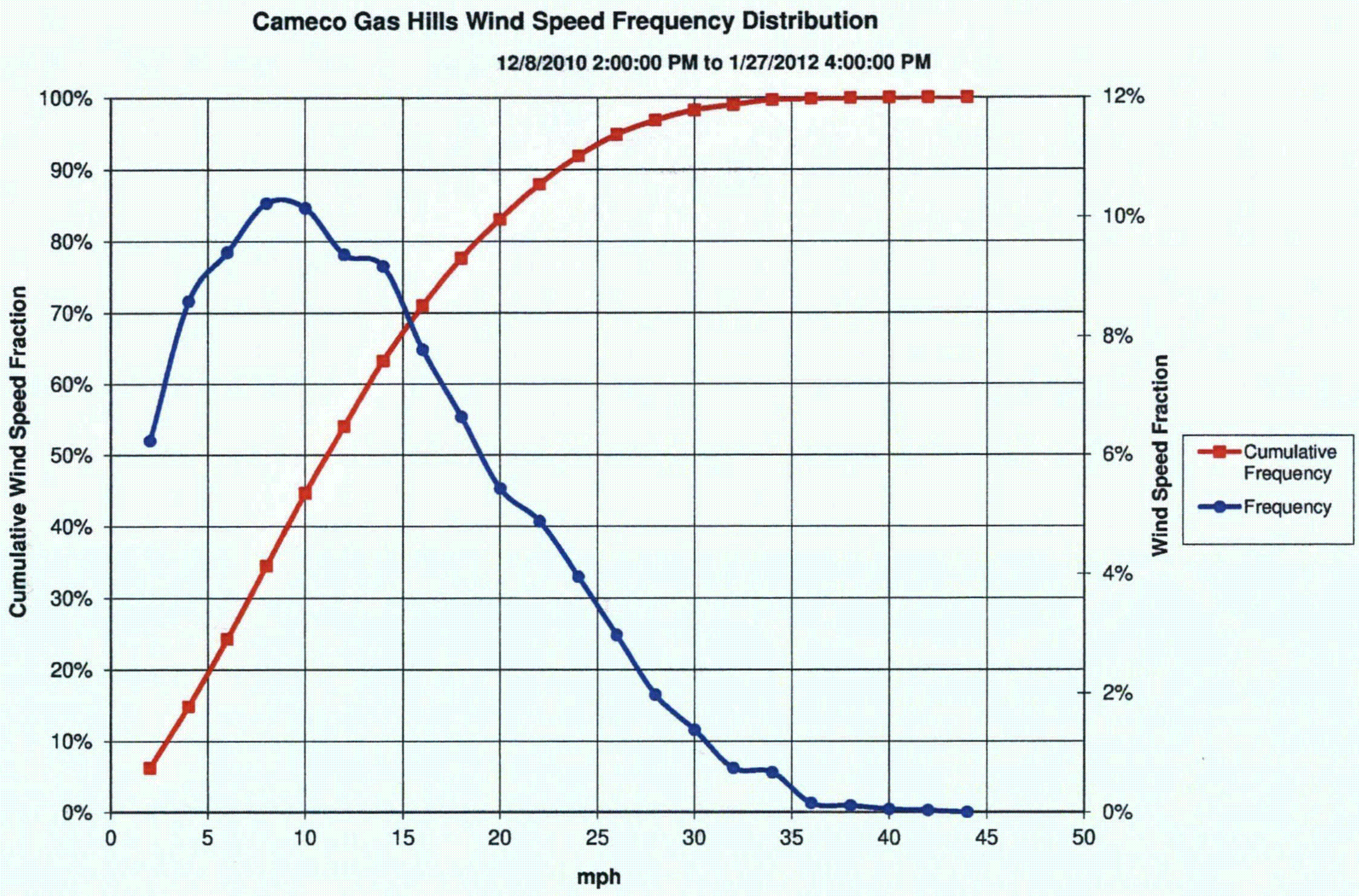


Figure 2.5-21. Gas Hills Seasonal Wind Roses.



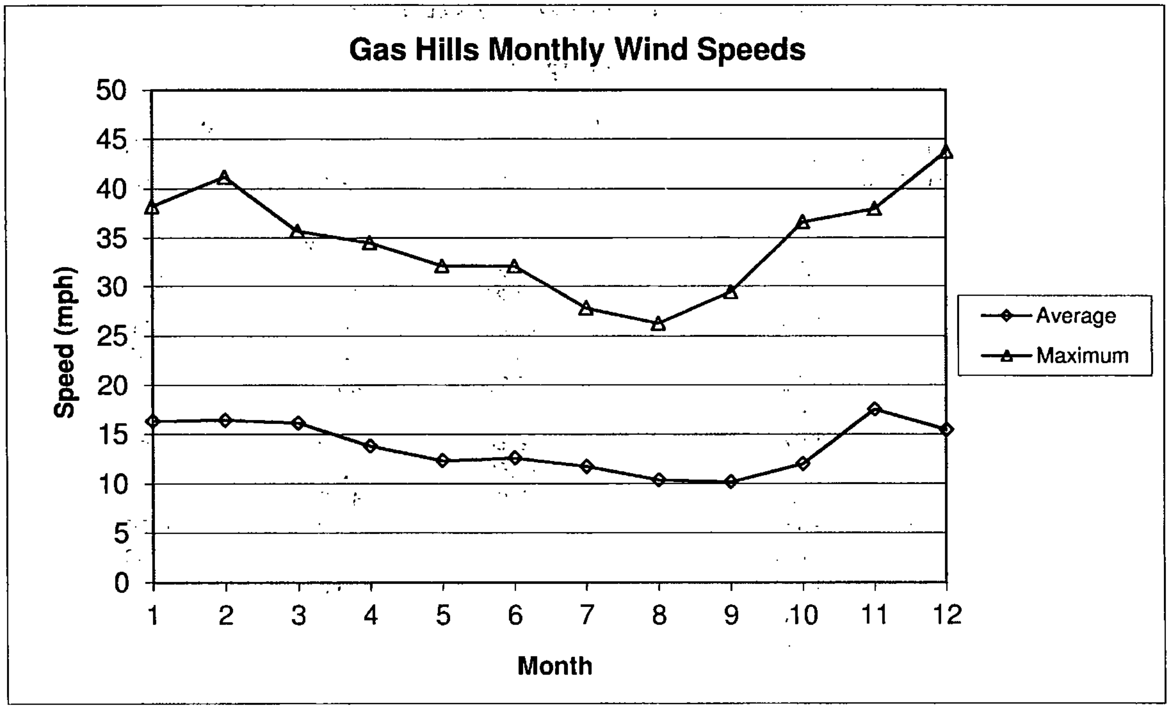
Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-22. Gas Hills Diurnal Wind Speeds.



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-23. Gas Hills Wind Speed Distribution.



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-24. Gas Hills Monthly Average Wind Speeds

Wind Data Summary

12/8/2010 2:00:00 PM - 1/27/2012 4:00:00 PM

Hourly Data

	Average	Max	Min
Wind Speed (mph)	13.97	43.73	0.28
Sigma Theta (º)	16.84	98.30	1.03
Wind Direction			
N	9.90	23.69	1.04
NNE	8.33	19.40	0.66
NE	10.25	29.19	0.28
ENE	14.04	30.86	1.20
E	10.85	34.82	1.35
ESE	9.25	26.61	0.78
SE	7.43	24.75	1.01
SSE	12.26	36.30	0.65
S	16.59	43.73	1.31
SSW	17.65	42.31	0.96
SW	15.17	42.94	0.55
WSW	13.13	39.08	0.93
W	11.24	33.34	0.66
WNW	11.29	32.71	1.51
NW	9.75	31.97	0.66
NNW	10.39	29.13	1.15

Predominant wind direction was from the SSW sector, accounting for 20.7% of the winds, the average wind direction was 210°.

Data Recovery

	Possible (hours)	Reported (hours)	Recovery
Wind Speed	9986	9957	99.71%
Sigma Theta	9986	9957	99.71%
Wind Direction	9986	9955	99.69%

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-25. Gas Hills Wind Summary.

Stability Class	Wind Direction	Wind Speed (mph) - Baseline Year						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.000490	0.000464					0.000953
	NNE	0.000490						0.000490
	NE	0.000979	0.000464					0.001443
	ENE	0.000490	0.000928					0.001417
	E		0.001391					0.001391
	ESE	0.000979	0.001855					0.002834
	SE	0.000979	0.000464					0.001443
	SSE	0.001469	0.000928					0.002396
	S	0.000979	0.001855					0.002834
	SSW	0.000490	0.000464					0.000953
	SW	0.001469	0.001855					0.003324
	WSW	0.001958	0.002319					0.004277
	W	0.002448	0.002319					0.004767
	WNW	0.001469	0.001391					0.002860
	NW	0.001958						0.001958
	NNW	0.001469						0.001469
B	N		0.000928					0.000928
	NNE		0.000464					0.000464
	NE		0.000464					0.000464
	ENE		0.000464					0.000464
	E							
	ESE		0.000464					0.000464
	SE		0.000464					0.000464
	SSE		0.001391					0.001391
	S		0.000928	0.000464				0.001391
	SSW	0.000490	0.001391					0.001881
	SW		0.000928					0.000928
	WSW		0.000464					0.000464
	W							
	WNW		0.001855					0.001855
	NW		0.000928					0.000928
	NNW		0.000928	0.000464				0.001391
C	N		0.000464					0.000464
	NNE			0.000464				0.000464
	NE			0.000928				0.000928
	ENE		0.000464	0.000928				0.001391
	E							
	ESE							
	SE			0.001391				0.001391
	SSE							
	S		0.001391	0.002783				0.004174
	SSW	0.000490	0.000464	0.007421				0.008375
	SW		0.001391	0.004638				0.006030
	WSW	0.000490	0.000928	0.006030				0.007447
	W		0.002783	0.003247				0.006030
	WNW		0.000464	0.002319				0.002783
	NW		0.000464	0.001391				0.001855
	NNW			0.000464				0.000464

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-5. Gas Hills Annual Joint Frequency Distribution.

Stability Class	Wind Direction	Wind Speed (mph) - Baseline Year						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.002783	0.001855	0.001391			0.006030
	NNE			0.001391	0.000464			0.001855
	NE			0.002783	0.001855	0.000464	0.000464	0.005566
	ENE		0.001391	0.006494	0.006030	0.003247	0.000464	0.017625
	E		0.000464	0.000464	0.002783	0.000928		0.004638
	ESE		0.002783	0.001855		0.001391		0.006030
	SE	0.000490	0.005102	0.001855	0.003711			0.011157
	SSE	0.000979	0.003711	0.010204	0.020872	0.005102		0.040868
	S	0.000490	0.005102	0.028293	0.067718	0.033395	0.012987	0.147985
	SSW	0.000979	0.006494	0.035250	0.088126	0.083952	0.043135	0.257937
	SW		0.010668	0.044991	0.054731	0.043599	0.015770	0.169759
	WSW	0.000490	0.006494	0.022727	0.013915	0.007421	0.001391	0.052438
	W	0.000490	0.004174	0.015770	0.005102	0.002783	0.000464	0.028783
	WNW	0.000490	0.003711	0.004638	0.007885	0.003247	0.002319	0.022289
	NW		0.004174	0.002319	0.004174	0.000928	0.000928	0.012523
	NNW			0.006494	0.003711	0.000464		0.010668
E	N		0.000464					0.000464
	NNE							
	NE		0.000928					0.000928
	ENE							
	E		0.000464					0.000464
	ESE		0.000464					0.000464
	SE	0.000979	0.000928					0.001907
	SSE	0.000979	0.001855	0.000928				0.003762
	S		0.002783	0.003711				0.006494
	SSW		0.000928	0.002783				0.003711
	SW	0.000490	0.005102	0.002319				0.007911
	WSW	0.000490	0.000928	0.004174				0.005592
	W		0.001391	0.000464				0.001855
	WNW	0.000979	0.000464					0.001443
	NW		0.001391					0.001391
	NNW		0.001391					0.001391
F	N	0.000490	0.001391					0.001881
	NNE	0.001958	0.000928					0.002886
	NE	0.001958						0.001958
	ENE	0.001958	0.000464					0.002422
	E	0.001469	0.001391					0.002860
	ESE	0.001958	0.002783					0.004741
	SE	0.003917	0.001391					0.005308
	SSE	0.003427	0.003711					0.007138
	S	0.003917	0.007421					0.011338
	SSW	0.001958	0.003247					0.005205
	SW	0.006365	0.002319					0.008684
	WSW	0.004896	0.002783					0.007679
	W	0.002448	0.001391					0.003839
	WNW	0.001958	0.002783					0.004741
	NW	0.003427	0.001391					0.004819
	NNW	0.000490						0.000490

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-6. Gas Hills Annual Joint Frequency Distribution (continued).

Stability Class	Wind Direction	Wind Speed (mph) - 1st Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.000490	0.000464					0.000953
	NNE	0.000490						0.000490
	NE	0.000979	0.000464					0.001443
	ENE	0.000490	0.000928					0.001417
	E		0.001391					0.001391
	ESE	0.000979	0.001855					0.002834
	SE	0.000979	0.000464					0.001443
	SSE	0.001469	0.000928					0.002396
	S	0.000979	0.001855					0.002834
	SSW	0.000490	0.000464					0.000953
	SW	0.001469	0.001855					0.003324
	WSW	0.001958	0.002319					0.004277
	W	0.002448	0.002319					0.004767
	WNW	0.001469	0.001391					0.002860
	NW	0.001958						0.001958
	NNW	0.001469						0.001469
B	N		0.000928					0.000928
	NNE		0.000464					0.000464
	NE		0.000464					0.000464
	ENE		0.000464					0.000464
	E							
	ESE		0.000464					0.000464
	SE		0.000464					0.000464
	SSE		0.001391					0.001391
	S		0.000928	0.000464				0.001391
	SSW	0.000490	0.001391					0.001881
	SW		0.000928					0.000928
	WSW		0.000464					0.000464
	W							
	WNW		0.001855					0.001855
	NW		0.000928					0.000928
	NNW		0.000928	0.000464				0.001391
C	N		0.000464					0.000464
	NNE			0.000464				0.000464
	NE			0.000928				0.000928
	ENE		0.000464	0.000928				0.001391
	E							
	ESE							
	SE			0.001391				0.001391
	SSE							
	S		0.001391	0.002783				0.004174
	SSW	0.000490	0.000464	0.007421				0.008375
	SW		0.001391	0.004638				0.006030
	WSW	0.000490	0.000928	0.006030				0.007447
	W		0.002783	0.003247				0.006030
	WNW		0.000464	0.002319				0.002783
	NW		0.000464	0.001391				0.001855
	NNW			0.000464				0.000464

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-7. Gas Hills Winter Joint Frequency Distribution.

Stability Class	Wind Direction	Wind Speed (mph) - 1st Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.002783	0.001855	0.001391			0.006030
	NNE			0.001391	0.000464			0.001855
	NE			0.002783	0.001855	0.000464	0.000464	0.005566
	ENE		0.001391	0.006494	0.006030	0.003247	0.000464	0.017625
	E		0.000464	0.000464	0.002783	0.000928		0.004638
	ESE		0.002783	0.001855		0.001391		0.006030
	SE	0.000490	0.005102	0.001855	0.003711			0.011157
	SSE	0.000979	0.003711	0.010204	0.020872	0.005102		0.040868
	S	0.000490	0.005102	0.028293	0.067718	0.033395	0.012987	0.147985
	SSW	0.000979	0.006494	0.035250	0.088126	0.083952	0.043135	0.257937
	SW		0.010668	0.044991	0.054731	0.043599	0.015770	0.169759
	WSW	0.000490	0.006494	0.022727	0.013915	0.007421	0.001391	0.052438
	W	0.000490	0.004174	0.015770	0.005102	0.002783	0.000464	0.028783
	WNW	0.000490	0.003711	0.004638	0.007885	0.003247	0.002319	0.022289
	NW		0.004174	0.002319	0.004174	0.000928	0.000928	0.012523
	NNW			0.006494	0.003711	0.000464		0.010668
E	N		0.000464					0.000464
	NNE							
	NE		0.000928					0.000928
	ENE							
	E		0.000464					0.000464
	ESE		0.000464					0.000464
	SE	0.000979	0.000928					0.001907
	SSE	0.000979	0.001855	0.000928				0.003762
	S		0.002783	0.003711				0.006494
	SSW		0.000928	0.002783				0.003711
	SW	0.000490	0.005102	0.002319				0.007911
	WSW	0.000490	0.000928	0.004174				0.005592
	W		0.001391	0.000464				0.001855
	WNW	0.000979	0.000464					0.001443
	NW		0.001391					0.001391
	NNW		0.001391					0.001391
F	N	0.000490	0.001391					0.001881
	NNE	0.001958	0.000928					0.002886
	NE	0.001958						0.001958
	ENE	0.001958	0.000464					0.002422
	E	0.001469	0.001391					0.002860
	ESE	0.001958	0.002783					0.004741
	SE	0.003917	0.001391					0.005308
	SSE	0.003427	0.003711					0.007138
	S	0.003917	0.007421					0.011338
	SSW	0.001958	0.003247					0.005205
	SW	0.006365	0.002319					0.008684
	WSW	0.004896	0.002783					0.007679
	W	0.002448	0.001391					0.003839
	WNW	0.001958	0.002783					0.004741
	NW	0.003427	0.001391					0.004819
	NNW	0.000490						0.000490

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-8. Gas Hills Winter Joint Frequency Distribution (continued).

Stability Class	Wind Direction	Wind Speed (mph) - 2nd Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.000933	0.001832					0.002765
	NNE	0.001399	0.000458					0.001857
	NE	0.003265	0.000916					0.004181
	ENE	0.000466	0.001832					0.002299
	E	0.000933	0.000458					0.001391
	ESE							
	SE	0.001399						0.001399
	SSE	0.000466	0.001374					0.001841
	S	0.000466	0.002290					0.002757
	SSW	0.001399	0.002749					0.004148
	SW	0.001866	0.003665					0.005530
	WSW	0.000466	0.005039					0.005505
	W	0.001399	0.004123					0.005522
	WNW		0.002749					0.002749
	NW	0.001866	0.004581					0.006447
	NNW		0.003207					0.003207
B	N		0.003207	0.000458				0.003665
	NNE		0.002749					0.002749
	NE		0.000458					0.000458
	ENE			0.000458				0.000458
	E		0.000458					0.000458
	ESE	0.000466	0.001374					0.001841
	SE	0.000466	0.000916	0.000458				0.001841
	SSE		0.000458					0.000458
	S		0.002749					0.002749
	SSW		0.001832	0.000916				0.002749
	SW		0.001374	0.000458				0.001832
	WSW	0.000933	0.001374					0.002307
	W		0.005955					0.005955
	WNW		0.004123	0.000916				0.005039
	NW		0.004123	0.000458				0.004581
	NNW		0.004581	0.000458				0.005039
C	N			0.007787				0.007787
	NNE			0.001374				0.001374
	NE		0.000916	0.000458				0.001374
	ENE		0.000458	0.001832				0.002290
	E			0.002749				0.002749
	ESE			0.002290				0.002290
	SE	0.000933	0.000916	0.002290				0.004139
	SSE			0.000916				0.000916
	S			0.004581				0.004581
	SSW		0.001374	0.009162				0.010536
	SW		0.000916	0.007329				0.008246
	WSW		0.001832	0.008704				0.010536
	W		0.002290	0.009162				0.011452
	WNW		0.001832	0.008704				0.010536
	NW	0.000466	0.001832	0.009162				0.011460
	NNW		0.000458	0.004123				0.004581

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-9. Gas Hills Spring Joint Frequency Distribution.

Stability Class	Wind Direction	Wind Speed (mph) - 2nd Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.004123	0.007329	0.007329	0.000916		0.019698
	NNE		0.001374	0.003207	0.001832			0.006413
	NE		0.000916	0.003665	0.001374	0.000458		0.006413
	ENE		0.000458	0.008704	0.022446	0.003207	0.000458	0.035273
	E			0.006871	0.006871	0.002749	0.000458	0.016949
	ESE		0.001832	0.005039	0.005497	0.001374		0.013743
	SE	0.002332	0.002290	0.007787	0.002749	0.001832		0.016991
	SSE	0.002332	0.004581	0.027943	0.026569	0.005039		0.066464
	S		0.005497	0.025195	0.028401	0.007329	0.000458	0.066880
	SSW		0.008246	0.025195	0.036189	0.016491	0.001832	0.087952
	SW	0.000466	0.013284	0.029317	0.036647	0.022446	0.002290	0.104452
	WSW		0.006871	0.020156	0.029317	0.025195	0.008246	0.089785
	W	0.000466	0.003207	0.020614	0.019240	0.006871	0.001374	0.051772
	WNW	0.000466	0.004581	0.017407	0.020156	0.003665	0.000916	0.047191
	NW		0.003207	0.011910	0.010078	0.002749		0.027943
	NNW	0.000466	0.004581	0.007329	0.007329	0.003207		0.022913
E	N		0.000458					0.000458
	NNE							
	NE		0.000916					0.000916
	ENE		0.000916					0.000916
	E		0.000458					0.000458
	ESE		0.002290					0.002290
	SE	0.000933	0.003665	0.000458				0.005056
	SSE		0.001832	0.003207				0.005039
	S		0.004123	0.002749				0.006871
	SSW		0.002749	0.001832				0.004581
	SW	0.000466	0.005955	0.003665				0.010086
	WSW	0.000466	0.004581	0.001374				0.006422
	W		0.001374	0.000458				0.001832
	WNW		0.001374					0.001374
	NW		0.000916					0.000916
	NNW		0.000916					0.000916
F	N	0.003265	0.000916					0.004181
	NNE	0.002332	0.000458					0.002790
	NE	0.002798	0.001374					0.004173
	ENE	0.000466	0.000916					0.001383
	E	0.002332	0.001832					0.004164
	ESE	0.001866	0.002749					0.004614
	SE	0.009328	0.004581					0.013909
	SSE	0.002798	0.002749					0.005547
	S	0.002798	0.003665					0.006463
	SSW	0.005597	0.002749					0.008345
	SW	0.004664	0.002290					0.006955
	WSW	0.003731	0.003207					0.006938
	W	0.002332	0.002749					0.005081
	WNW		0.000916					0.000916
	NW	0.002332	0.000916					0.003248
	NNW	0.002332	0.001374					0.003706

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-10. Gas Hills Spring Joint Frequency Distribution (continued).

Stability Class	Wind Direction	Wind Speed (mph) - 3rd Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.001822	0.002266					0.004087
	NNE	0.000911	0.001812					0.002723
	NE	0.002277	0.001812					0.004089
	ENE	0.000911	0.000453					0.001364
	E	0.002277	0.001812					0.004089
	ESE	0.000911	0.002266					0.003176
	SE	0.002732	0.002719					0.005451
	SSE	0.002277	0.003625					0.005902
	S	0.001822	0.004531					0.006353
	SSW	0.001822	0.004984					0.006806
	SW	0.002732	0.007250					0.009982
	WSW	0.005009	0.005890					0.010900
	W	0.002732	0.009062					0.011794
	WNW	0.003188	0.005890					0.009078
	NW	0.002277	0.006343					0.008620
	NNW	0.002732	0.005890					0.008623
B	N		0.000906	0.000453				0.001359
	NNE		0.004078	0.000453				0.004531
	NE		0.002266					0.002266
	ENE	0.000455	0.001359					0.001815
	E	0.000455	0.000906					0.001362
	ESE		0.001359					0.001359
	SE		0.002266					0.002266
	SSE	0.000455	0.000453	0.000453				0.001362
	S		0.002719					0.002719
	SSW		0.004531					0.004531
	SW		0.004984	0.000906				0.005890
	WSW		0.010874	0.002266				0.013140
	W		0.011328	0.000906				0.012234
	WNW	0.000455	0.009062					0.009517
	NW	0.000455	0.008156	0.001812				0.010424
	NNW		0.004078	0.000453				0.004531
C	N			0.001359				0.001359
	NNE			0.003625				0.003625
	NE			0.001812				0.001812
	ENE		0.000453	0.004531				0.004984
	E		0.000906	0.002719				0.003625
	ESE		0.000906	0.002719				0.003625
	SE		0.000453	0.002266				0.002719
	SSE		0.000906	0.002719				0.003625
	S		0.000453	0.003625				0.004078
	SSW		0.000906	0.007250				0.008156
	SW	0.000455	0.000906	0.013593				0.014955
	WSW		0.000453	0.012234				0.012687
	W		0.001359	0.014046				0.015406
	WNW	0.000455	0.001359	0.015859				0.017673
	NW			0.011328				0.011328
	NNW			0.004531				0.004531

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-11. Gas Hills Summer Joint Frequency Distribution.

Stability Class	Wind Direction	Wind Speed (mph) - 3rd Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.000906	0.002266				0.003172
	NNE		0.001359	0.001359	0.000453			0.003172
	NE		0.000906	0.003172	0.001812	0.000453	0.000453	0.006797
	ENE		0.002266	0.011328	0.014499	0.008156	0.000453	0.036701
	E	0.000455	0.002266	0.008156	0.009515	0.000906	0.000453	0.021751
	ESE		0.004984	0.009968	0.005890			0.020843
	SE	0.000455	0.007703	0.021296	0.006343			0.035797
	SSE	0.000911	0.006797	0.025374	0.032623	0.002719		0.068423
	S	0.000455	0.006797	0.028092	0.038514	0.005437		0.079295
	SSW	0.000455	0.009968	0.021749	0.041686	0.003625	0.000453	0.077936
	SW	0.000911	0.014499	0.021749	0.026280	0.004078		0.067517
	WSW	0.000455	0.004984	0.018124	0.021749	0.005437		0.050750
	W		0.000906	0.009515	0.013140	0.000906		0.024468
	WNW		0.000906	0.007250	0.011781	0.000453		0.020390
	NW		0.002719	0.006797	0.004984	0.000453		0.014952
	NNW		0.002719	0.003625	0.001359	0.000453		0.008156
E	N	0.000455	0.001359					0.001815
	NNE		0.000906					0.000906
	NE		0.001359					0.001359
	ENE		0.000453					0.000453
	E	0.000455	0.002266					0.002721
	ESE	0.000911	0.002719	0.000453				0.004082
	SE		0.007250	0.004078				0.011328
	SSE		0.004531	0.004531				0.009062
	S	0.000455	0.001359	0.001359				0.003174
	SSW		0.005890	0.000906				0.006797
	SW	0.000455	0.009515	0.005890				0.015861
	WSW	0.000911	0.002266					0.003176
	W		0.002266					0.002266
	WNW		0.000453					0.000453
	NW		0.002266					0.002266
	NNW		0.002266					0.002266
F	N	0.000455	0.000453					0.000908
	NNE		0.001359					0.001359
	NE	0.001366	0.000906					0.002272
	ENE	0.001366	0.004078					0.005444
	E	0.001822	0.002266					0.004087
	ESE	0.003643	0.003172					0.006815
	SE	0.007741	0.009968					0.017710
	SSE	0.003643	0.005890					0.009533
	S	0.003188	0.003172					0.006359
	SSW	0.004098	0.003172					0.007270
	SW	0.009108	0.005890					0.014998
	WSW	0.003188	0.004078					0.007266
	W	0.001822	0.000453					0.002275
	WNW	0.000455	0.001359					0.001815
	NW	0.000455	0.003172					0.003627
	NNW	0.000911	0.002719					0.003629

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-12. Gas Hills Summer Joint Frequency Distribution (continued).

Stability Class	Wind Direction	Wind Speed (mph) - 4th Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.000352	0.000683					0.001035
	NNE	0.001055	0.000342					0.001397
	NE	0.001407	0.001025					0.002432
	ENE	0.001055						0.001055
	E	0.001055	0.000342					0.001397
	ESE	0.000352						0.000352
	SE	0.001055	0.000683					0.001738
	SSE	0.001055	0.000683					0.001738
	S	0.001055	0.003415					0.004471
	SSW		0.002732					0.002732
	SW	0.000703	0.002732					0.003436
	WSW	0.002814	0.002732					0.005546
	W	0.002110	0.003757					0.005867
	WNW	0.002110	0.002732					0.004843
	NW	0.002462	0.002391					0.004853
	NNW	0.000703	0.001708					0.002411
B	N		0.000342					0.000342
	NNE		0.001366	0.000342				0.001708
	NE		0.001366					0.001366
	ENE		0.001025					0.001025
	E		0.000683	0.000342				0.001025
	ESE		0.000683					0.000683
	SE		0.001025					0.001025
	SSE	0.000352	0.001025					0.001376
	S		0.001366					0.001366
	SSW		0.002732	0.000342				0.003074
	SW	0.000352	0.004098					0.004450
	WSW		0.004440	0.000683				0.005123
	W	0.000352	0.004098	0.000342				0.004792
	WNW		0.004098	0.000683				0.004781
	NW	0.000352	0.003415					0.003767
	NNW		0.003074					0.003074
C	N			0.001366				0.001366
	NNE		0.000683	0.002391				0.003074
	NE		0.001366	0.001025				0.002391
	ENE		0.000683	0.002732				0.003415
	E		0.000683	0.002049				0.002732
	ESE			0.001366				0.001366
	SE			0.000683				0.000683
	SSE		0.000342	0.000342				0.000683
	S		0.000342	0.001708				0.002049
	SSW		0.000342	0.003074				0.003415
	SW	0.000703	0.001366	0.003074				0.005143
	WSW	0.000352	0.002732	0.005464				0.008548
	W		0.000683	0.005806				0.006489
	WNW	0.000703	0.001708	0.007172				0.009583
	NW		0.000342	0.004781				0.005123
	NNW		0.000342	0.000683				0.001025

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-13. Gas Hills Fall Joint Frequency Distribution.

Stability Class	Wind Direction	Wind Speed (mph) - 4th Quarter						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.001708	0.003074	0.003074	0.000342		0.008197
	NNE		0.001366	0.002049	0.001708			0.005123
	NE		0.002049	0.004440	0.008880	0.001708	0.000342	0.017418
	ENE		0.002049	0.007514	0.014344	0.005806	0.000683	0.030396
	E		0.002049	0.004098	0.004781	0.000683	0.000342	0.011954
	ESE	0.000352	0.001708	0.004098	0.003074			0.009232
	SE	0.003517	0.002049	0.010929	0.000683			0.017179
	SSE	0.001759	0.005464	0.017760	0.011612	0.002391	0.002732	0.041718
	S	0.000703	0.009563	0.023224	0.037568	0.033811	0.021175	0.126045
	SSW		0.011270	0.047131	0.074112	0.043033	0.021175	0.196721
	SW	0.001055	0.017760	0.038251	0.037568	0.018784	0.016393	0.129812
	WSW	0.000352	0.005806	0.021858	0.020833	0.010587	0.002391	0.061827
	W		0.002049	0.007855	0.004098	0.002391	0.000342	0.016735
	WNW	0.000352	0.001366	0.006831	0.003415	0.001025		0.012988
	NW		0.002391	0.004440	0.002391	0.000683		0.009904
	NNW		0.001025	0.002732	0.003074	0.000683	0.000342	0.007855
E	N	0.000352	0.001708					0.002059
	NNE		0.000342					0.000342
	NE		0.001025	0.000342				0.001366
	ENE	0.000352	0.000342	0.000342				0.001035
	E	0.000352	0.001366					0.001718
	ESE	0.001055	0.001366					0.002421
	SE	0.001055	0.003415	0.002049				0.006520
	SSE	0.001055	0.003415	0.004098				0.008569
	S	0.000352	0.002391	0.005123				0.007865
	SSW	0.000352	0.008880	0.003757				0.012988
	SW	0.000703	0.009904	0.006489				0.017097
	WSW	0.000352	0.001366	0.000683				0.002401
	W	0.000352	0.001366					0.001718
	WNW	0.000352	0.000342					0.000693
	NW		0.001708	0.000342				0.002049
	NNW	0.000352	0.001708					0.002059
F	N	0.000703	0.001366					0.002070
	NNE	0.000703	0.001025					0.001728
	NE	0.000703	0.001025					0.001728
	ENE	0.002110	0.001708					0.003818
	E	0.002814	0.002049					0.004863
	ESE	0.004221	0.002391					0.006612
	SE	0.006683	0.005806					0.012489
	SSE	0.004924	0.004098					0.009023
	S	0.003517	0.002391					0.005908
	SSW	0.003517	0.003757					0.007274
	SW	0.004573	0.006148					0.010720
	WSW	0.003517	0.001708					0.005225
	W	0.001759	0.001708					0.003466
	WNW	0.003166	0.001366					0.004532
	NW	0.001055	0.001366					0.002421
	NNW	0.000703	0.002049					0.002753

Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Table 2.5-14. Gas Hills Fall Joint Frequency Distribution (continued).

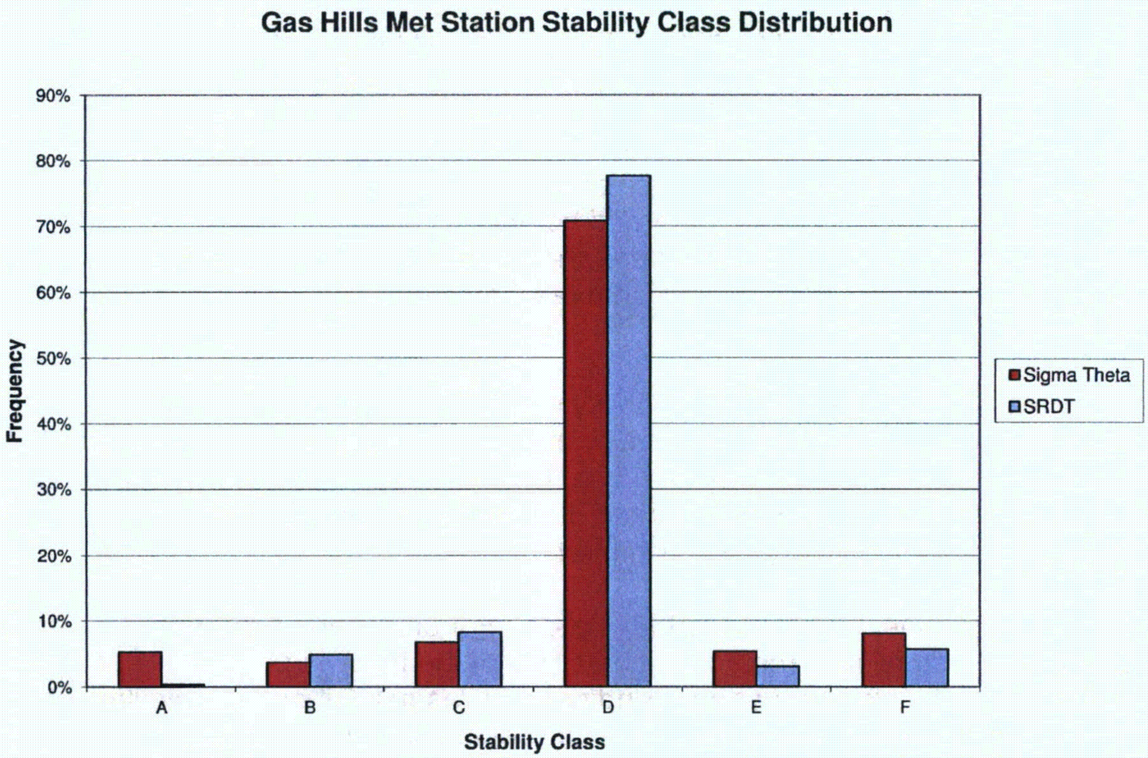
Atmospheric Stability Class

The σ_θ method was used to determine the Pasquill-Gifford stability class, where σ_θ refers to the standard deviation of the horizontal wind azimuth angle in degrees. This method is also referred to as the σ_A method (EPA 2000). It is a lateral turbulence based method which uses the standard deviation of the wind direction in combination with the scalar mean horizontal wind speed. Wind speed and direction data are recorded hourly at a height of 10 meters. To minimize the effects of wind meander, the 1-hour σ_θ is defined using 15-minute σ_θ values which are in turn based on more frequent sampling of wind direction (e.g. every five seconds).

According to this method, initial stability classes are assigned based solely on standard deviation of wind direction, or σ_θ. The initial assignments are then adjusted for horizontal wind speed. The magnitude of this adjustment depends on whether the measurement is taken during daylight or nighttime hours, a diurnal dependency that varies with the time of year.

Regulatory Guide 3.63 (NRC, 1988) states: "For obtaining an indication of the atmospheric stability, a method such as one of the following (Refs. 1-4) may be used: insolation cloud cover and wind speed (Pasquill-Gifford and similar methods), temperature lapse rate method, wind fluctuation method, split-sigma method, or Richardson Number." The σ_θ method is based on wind fluctuation and therefore qualifies as an appropriate method for the Gas Hills Remote Satellite.

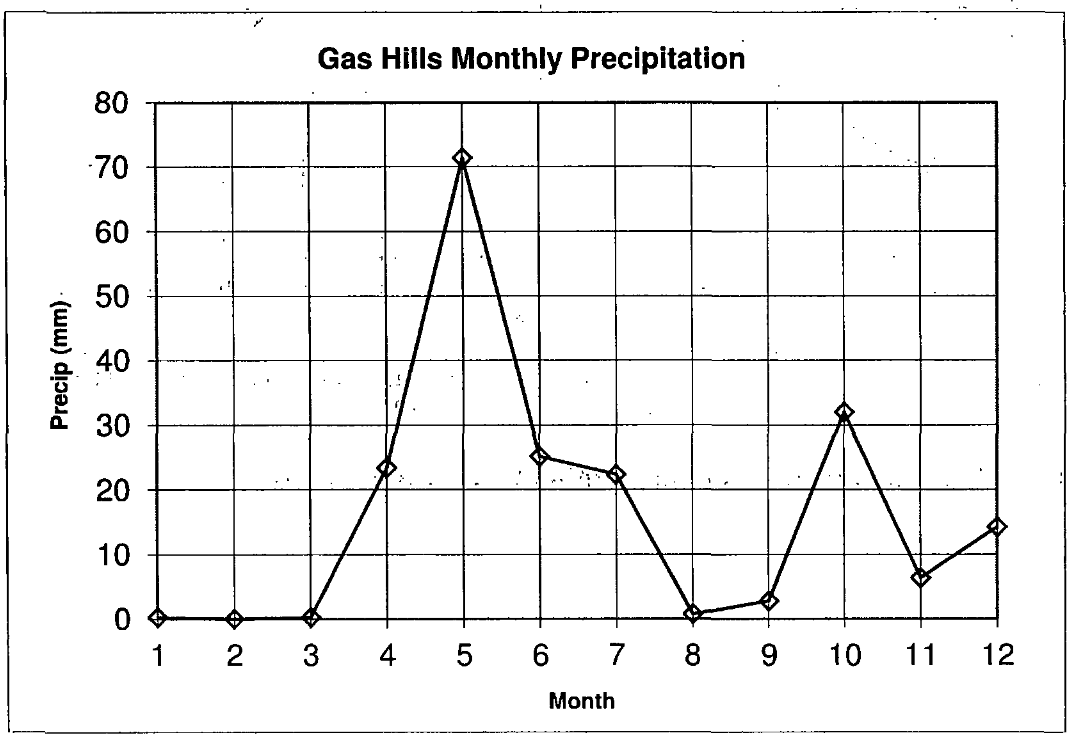
In order to demonstrate its reliability, a comparison was made between the σ_θ method and the SRDT (Solar Radiation Delta Temperature) method at the Gas Hills site. Figure 2.5-26 shows this comparison. It can be seen that the two methods yield similar distributions. The percent of time characterized by stable air classes (E and F) is slightly higher for the σ_θ method. Given that stable air is less subject to dispersion than neutral or unstable air, it is expected that for Gas Hills the σ_θ method will result in more conservative modeling predictions than the SRDT method.



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-26. Gas Hills Stability Class Method Comparison.

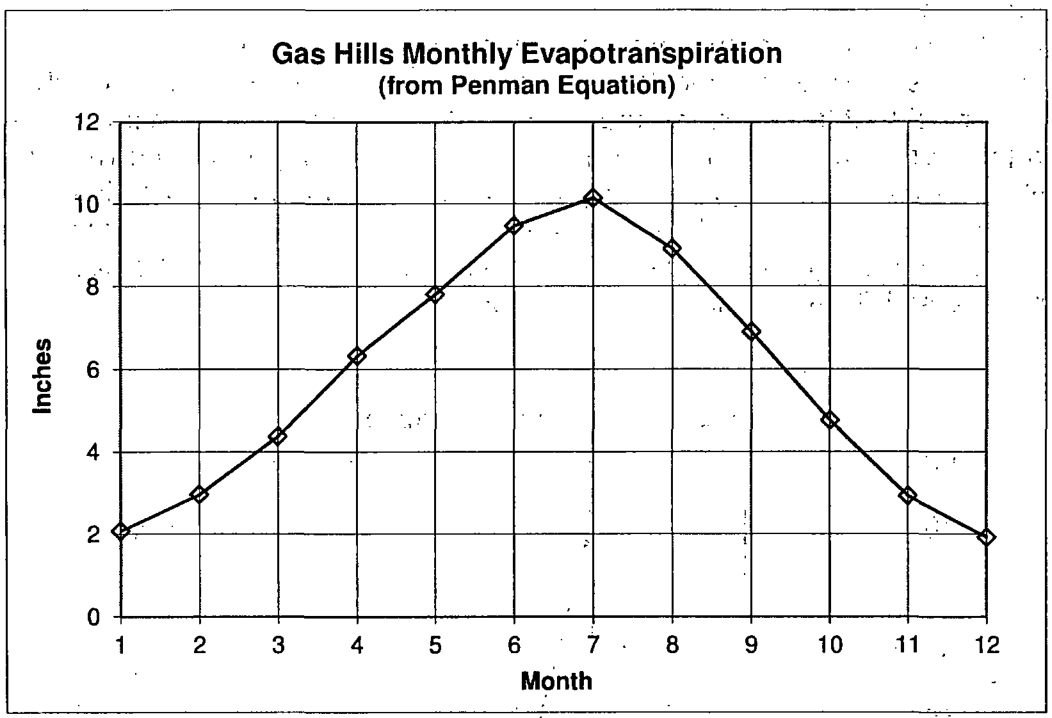
Precipitation
Figure 2.5-27 shows monthly precipitation at the site during the baseline monitoring year. Total precipitation was slightly less than 200 mm (7.8 inches), with a third of that falling during the month of May. Very little precipitation fell during the late summer and winter months. Based on long-term records at other weather stations in the region, precipitation recorded during the baseline monitoring year may be slightly less than that expected over the long term. A 20-year, annual average precipitation of 9.2 inches was recorded at the nearby historical Gas Hills 4E station (1970 to 1989).



Source: Cameco Resources, 2012, data from 12/8/2010 to 1/27/2012

Figure 2.5-27. Gas Hills Monthly Precipitation.

Evapotranspiration
No pan evaporation measurements were available at Cameco's Gas Hills station. Daily evapotranspiration rates were calculated for the site by applying Penman's equation to recorded solar radiation, wind speed, temperature and relative humidity data. These calculations were then summed for each month. Figure 2.5-28 shows projected monthly evapotranspiration at the project site during the baseline monitoring period. From these calculations, annual evapotranspiration is approximately 68 inches. Excluding the months of December through February, the total of 61 inches compares favorably to the long-term average pan evaporation of 58 inches at the Pathfinder Dam site 40 miles away (no pan evaporation was measured for December through February).



Sources: Calculation based on Penman Equation, from data supplied by Cameco Resources, from 12/8/2010 to 1/27/2012

Figure 2.5-28. Gas Hills Potential Monthly Evapotranspiration.

Justification of Baseline Year as Representative of Long Term

The Gas Hills Remote Satellite is situated in west-central Wyoming. The baseline meteorological monitoring period extended approximately one year, from December 8, 2010 through January 27, 2012. To demonstrate that this baseline year is representative of the longer term wind conditions, the Riverton AP site was analyzed. Among the weather stations in this region with available wind data, the Riverton AP was selected as the closest to Gas Hills. Riverton is less than 50 miles south of the project site, with an elevation roughly 1,000 ft lower than the licensed area. It is also the closest NWS station to the project site. Available hourly data from Riverton span from November, 1996 to the January, 2012 and therefore represent slightly more than 15 years.

Figure 2.5-29 shows wind roses for Riverton AP. The wind rose on the left reflects 15 years of monitoring, while the one on the right reflects the Gas Hills site baseline monitoring period only. It can be seen that wind speeds and directions are very similar between the 15-year and one-year monitoring periods.

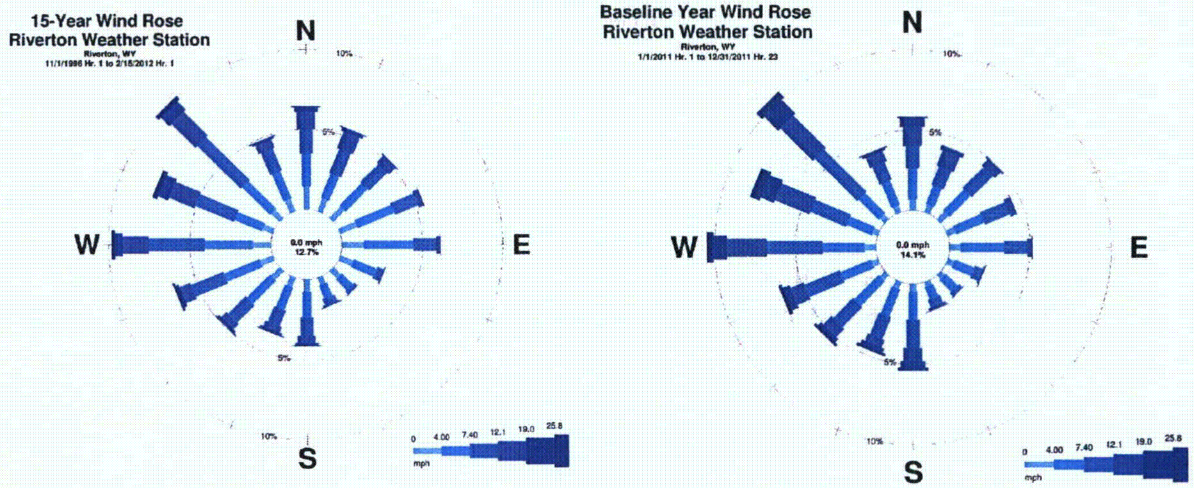
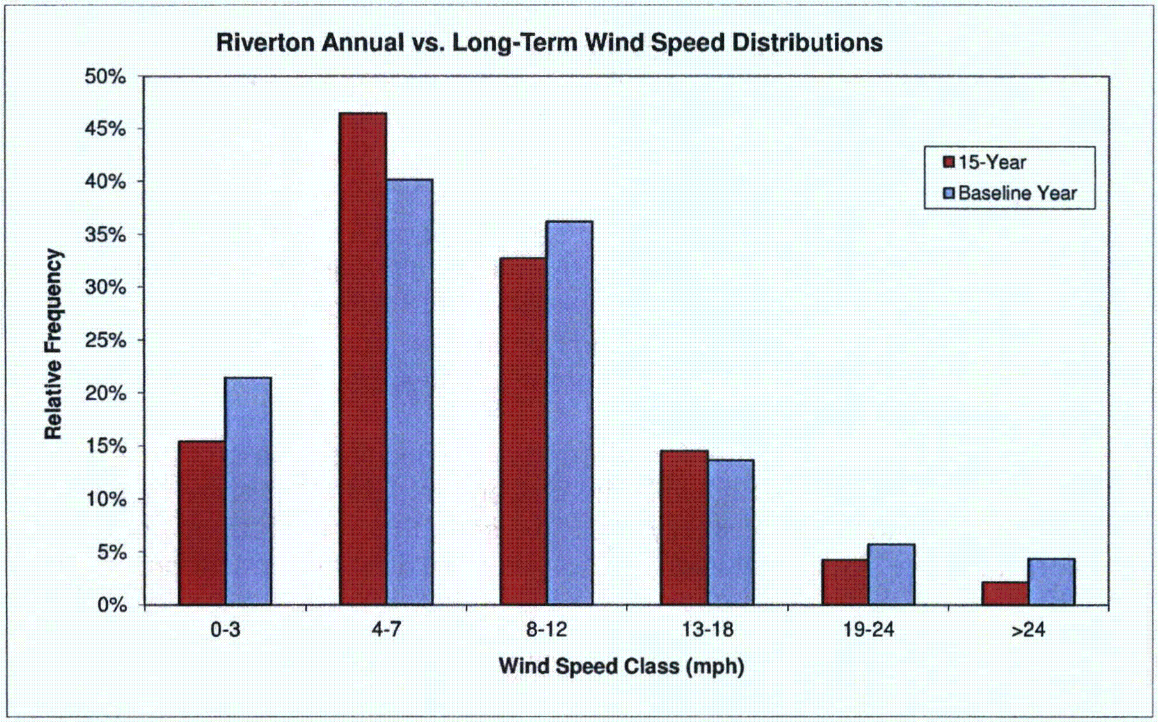


Figure 2.5-29. Riverton 15-Year vs Baseline Year Wind Roses.

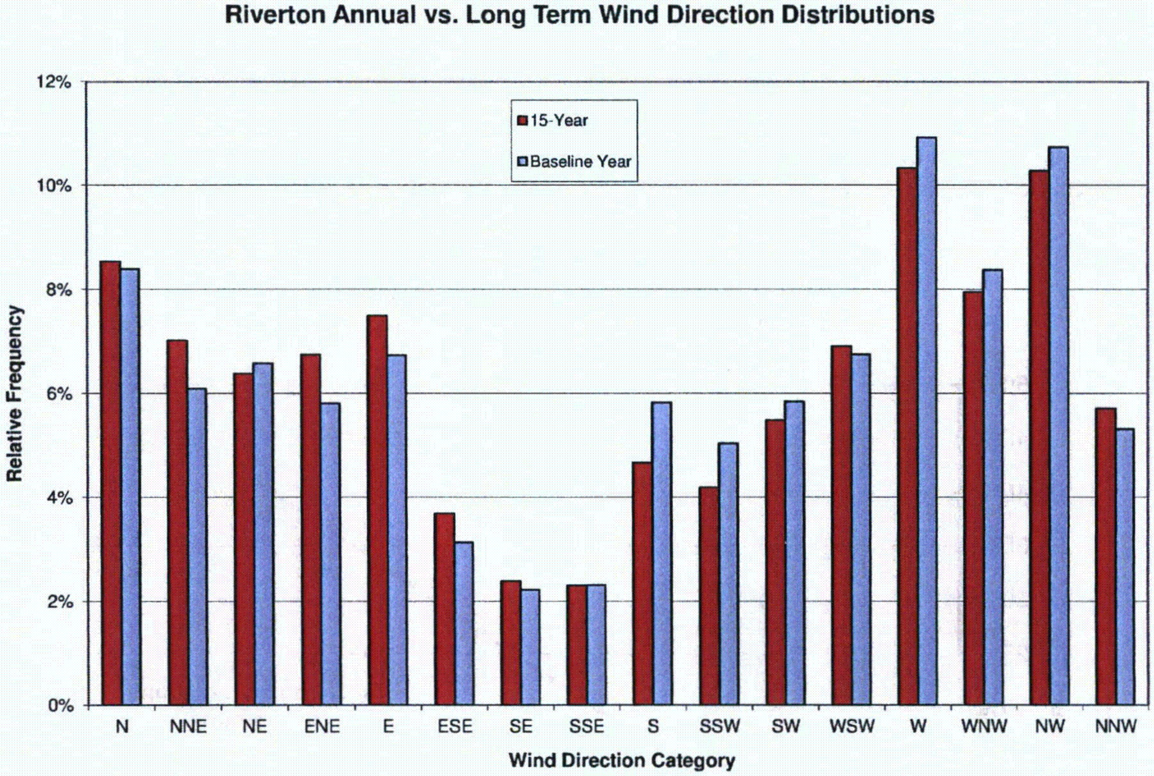
Figure 2.5-30 compares the wind speed frequency distributions between the 15-year and baseline periods at Riverton. The percent of the time the wind blows in each of the six wind speed categories shown, is quite similar for the two monitoring periods.



Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

Figure 2.5-30. Riverton 15-Year vs Baseline Year Wind Speeds.

Figure 2.5-31 compares the wind direction frequency distributions of the 15-year and baseline periods at Riverton. The percent of the time the wind blows from each of the sixteen wind directions shown, is quite similar for the two monitoring periods.



Source: National Climate Data Center, 2012, hourly data from 1996 through 2012

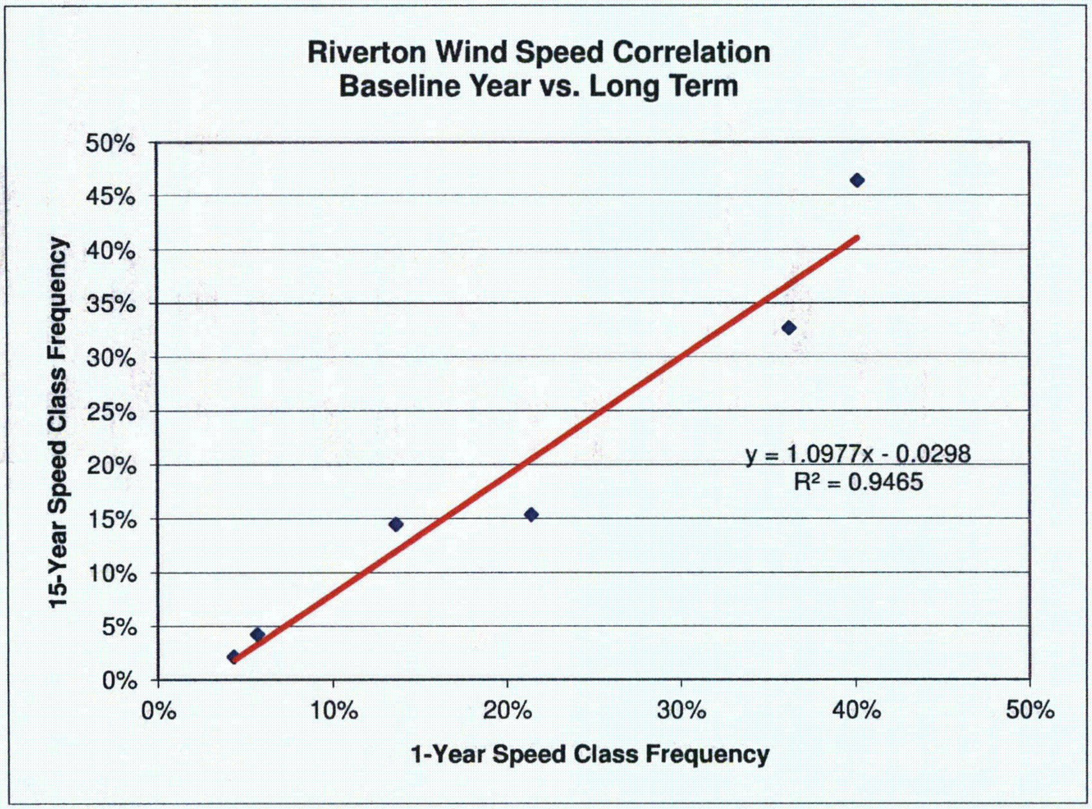
Figure 2.5-31. Riverton 15-Year vs Baseline Year Wind Speeds.

In order to quantify this similarity, it is useful to isolate wind speed and wind direction variables and to correlate short-term and long-term frequency distributions. This constitutes a statistical methodology for assessing the degree to which the distributions of wind speed class and wind direction frequencies from one year of monitoring at a particular location represent the long-term distributions at that same location.

For the joint frequency wind distribution used in the MILDOS-AREA model, wind speeds are divided into six classifications ranging from mild (0 – 3 mph) to strong (> 24 mph), as illustrated in Table 2.5-5 and Figure 2.5-30 above. Likewise, wind directions are divided into 16 categories corresponding to the compass directions illustrated in the wind roses presented above and in Figure 2.5-31.

The percent of the time that winds occur in each of the six wind speed categories can be calculated to produce a wind speed frequency distribution. The percent of the time that winds blow from each of the sixteen directions can be calculated to produce a wind direction frequency distribution. For each parameter, the one-year and 15-year distributions can then be compared. Linear regression analysis provides a useful tool to assess the degree of correlation between short and long-term distributions.

Figure 2.5-32 presents this correlation for the wind speed distributions at Riverton. Each point represents one of the six wind speed classes. The x coordinate corresponds to the percent of the one-year period during which the wind speed fell in a given class, while the y coordinate corresponds to the percent of the 15-year period during which the wind speed fell in that same class.



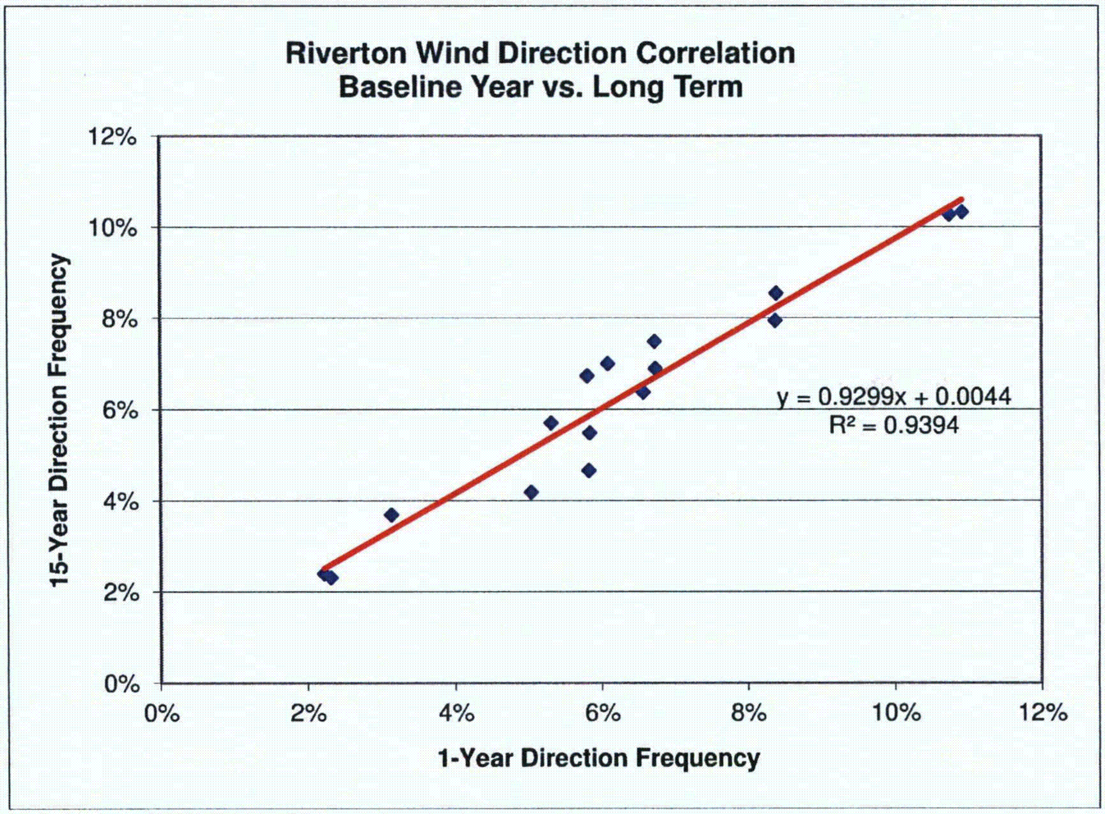
Sources: Analysis by IML Air Science using hourly data supplied by National Climate Data Center from 1996 to 2012

Figure 2.5-32. Riverton 15-Year vs Baseline Year Wind Speed Distributions.

The regression line (red) in Figure 2.5-32 represents the least-squares fit to the six data points. The corresponding R^2 value of 94.7% implies very strong linear correlation.

A similar analysis can be performed for wind direction frequencies. Figure 2.5-33 presents this correlation, again for the Riverton AP site. Each point represents one of the sixteen wind direction categories. The x coordinate corresponds to the percent of the one-year period during which the wind blew from a given direction, while the y coordinate corresponds to the percent of the 15-year period during which the wind blew from that same direction.

The regression line (red) in Figure 2.5-33 represents the least-squares fit to the sixteen data points. The corresponding R^2 value of 93.9% implies very strong linear correlation. This correlation would likely be even stronger except for low resolution provided in the wind direction data from the Riverton AP site. The NWS records hourly average wind directions, or azimuth angles, to the nearest 10°. Given that each wind direction category spans only 22.5°, this coarse resolution compromises the correlation analysis between short and long-term wind directions.



Sources: Analysis by IML Air Science using hourly data supplied by National Climate Data Center from 1996 to 2012

Figure 2.5-33. Riverton 15-Yr vs Baseline Yr Wind Direction Distributions.

Despite this limitation, Figures 2.5-32 and 2.5-33 offer conclusive evidence that the 2011 baseline monitoring year adequately represents the last 15 years at Riverton.

The same argument can be made for the Casper site. Although 10 miles farther from the project site than Riverton, Casper has higher wind speeds that more closely match Gas Hills on-site wind speeds. Moreover, the dominant southwesterly winds at Casper resemble the prevailing south-southwesterly winds at Gas Hills. Figure 2.5-34 shows 8-year and baseline-year wind roses at Casper to be nearly identical. Figures 2.5-35 and 2.5-36 show the Casper wind speed and direction frequency correlations, respectively, between the baseline year of 2011 and the 8-year period for which data were obtained.

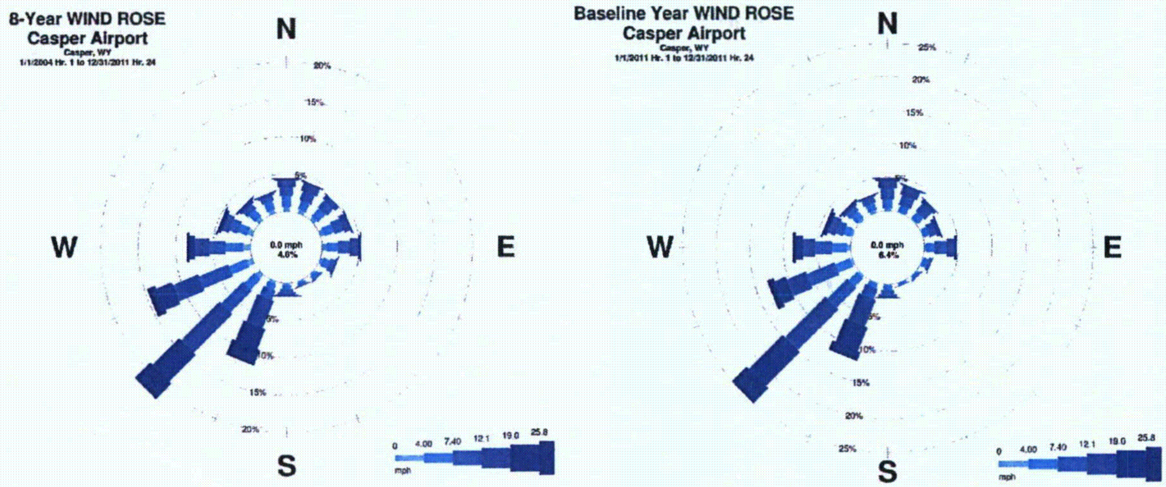
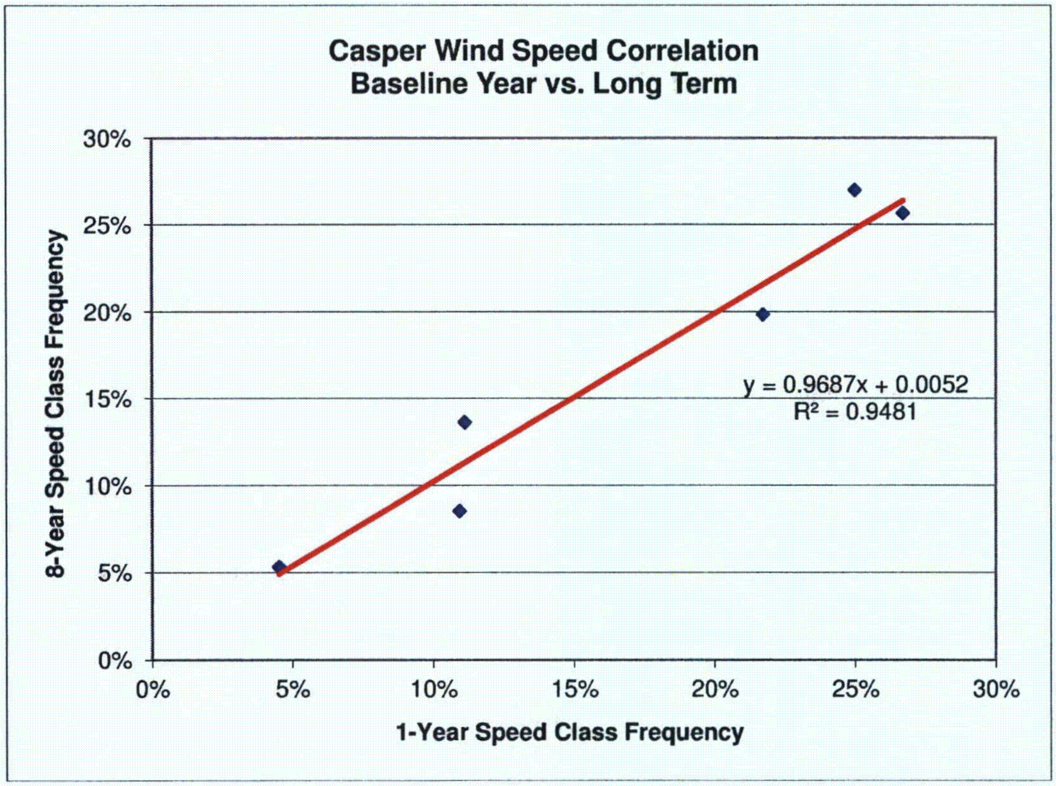
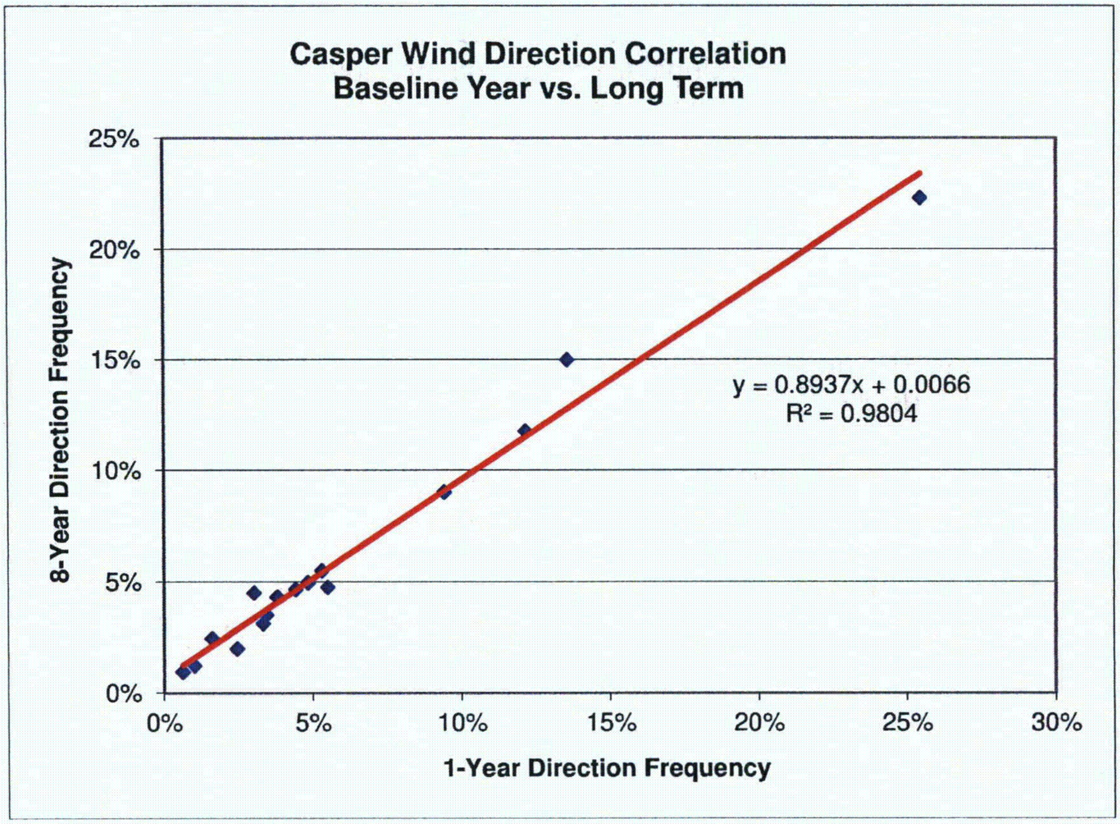


Figure 2.5-34. Casper 8-Yr vs Baseline Yr Wind Roses.



Sources: Analysis by IML Air Science using hourly data supplied by National Climate Data Center from 2004 to 2011

Figure 2.5-35. Casper 8-Yr vs Baseline Yr Wind Speed Distributions.



Sources: Analysis by IML Air Science using hourly data supplied by National Climate Data Center from 2004 to 2011

Figure 2.5-36. Casper 8-Yr vs Baseline Yr Wind Direction Distributions.

The R^2 values of 94.8% for wind speed and 98.0% for wind direction indicate even stronger correlation between the short and long term winds at Casper. Although the Casper long term data span only 8 years (vs. 15 for Riverton), a very strong linear correlation is evident.

Since the one-year wind data serve as reliable predictors of the long-term wind conditions at Riverton and Casper, and since the Gas Hills site experiences similar regional weather patterns, it is proposed here that the one-year baseline monitoring represents long-term meteorological conditions at the Gas Hills Remote Satellite site.

On-Site Meteorological Instrument Specifications

Table 2.5-15 lists the meteorological instruments employed at the Gas Hills meteorological monitoring station. The table shows instrument models, accuracy specifications, and instrument heights above the ground. Calibration records for the meteorological instruments are contained in Appendix A to this document.

Meteorological data collection, management and reporting methods at the project site conform to NRC atmospheric dispersion modeling requirements for uranium milling operations, and meet the acceptance criteria established in the NRC's NUREG-1569. The on-site monitoring program was developed according to NRC Regulatory Guide 3.63, "Onsite Meteorological Measurement Program For Uranium Recovery Facilities – Data Acquisition and Reporting." Hourly average values for wind speed, wind direction, sigma theta, temperature, relative humidity, precipitation and solar radiation are generated by field instruments and recorded by continuous data loggers. Data recovery exceeded 99% for the 13-month monitoring period. All hourly data have been downloaded to a relational database for quality assurance, statistical analysis and reporting purposes.

Table 2.5-15. Gas Hills Monitoring Details

Parameter	Measurement Method	Manufacturer and Model Number	Sampling Frequency	Averaging Period	Measurement Range	Instrument Reading Accuracy	Monitoring Height
Horizontal Wind Speed	Frequency	RM Young 05305-AQ	1 second	Minute/Hourly	0 – 50 m/s	±0.2 m/s	10 meters
Wind Direction	Precision potentiometer	RM Young 05305-AQ	1 second	Minute/Hourly	0 - 360°	±3°	10 meters
Ambient Temperature	Thermistor	Met One 062	1 second	Minute/Hourly	-50° to +50° C	±0.05° C	10 meters
Ambient Temperature	Thermistor	Met One 062	1 second	Minute/Hourly	-50° to +50° C	±0.05° C	2 meters
Ambient Temperature	Thermistor	Vaisala HMP45C	1 second	Minute/Hourly	-45° to +60° C	±0.5° C	2 meters
Dew Point Temperature	Calculated	Calculated	Calculated	Minute/Hourly Calculated	N/A	N/A	2 meters
Differential Temperature	Calculated	Calculated	1 second	Minute/Hourly	N/A	N/A	2 -10 meters
Relative Humidity	Capacitive polymer H-chip	Vaisala HMP45C	1 second	Minute/Hourly	0.8% to 100%	±2% (0-90%RH) ±3% (90-100%RH)	2 meters
Solar Radiation	Silicon photovoltaic detector	Campbell LI200X	1 second	Minute/Hourly	0-2000 W/m^2	±5%	2 meters
Precipitation	Tipping Bucket	Texas Instruments TE525WS	Event Data	Minute/Hourly	Finite increments of tip of rainfall	±1%	75 cm

Source: Cameco Resources, 2012

Upper Atmosphere Characterization

Mixing height is the height of the atmosphere above the ground that is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. Higher mixing heights are associated with greater dispersion, all other parameters being the same. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. The MILDOS-AREA model uses mixing height, along with other wind parameters, to predict pollutant dispersion. Unstable air leads to more dispersion, which leads to lower predicted impacts on ambient air quality. The default mixing height used by MILDOS-AREA is 100 meters, a very conservative value.

The nearest upper-air data available from the National Weather Service are from Lander, Wyoming, approximately 70 miles west of the site. Average mixing heights were derived from the AERMOD calculations used for dispersion modeling, based on hourly data obtained from the National Weather Service station in Lander (upper air). The AERMOD calculation is based on a combination of mechanically and convectively driven boundary layer processes. The results of these calculations are provided for morning and afternoon periods in Table 2.5-16. The 24-hour annual average mixing height is 916 meters.

Time Period (Filtered)	Average Mixing / Inversion Height
Morning (2 am – 7 am)	579 meters
Afternoon (2 pm – 7 pm)	1,123 meters

Sources: IML computation based on data from National Climate Data Center, 2011

Table 2.5-16. Lander Mixing Heights.

The mixing or inversion heights are entered as inputs to the MILDOS-AREA model for pollutant dispersion modeling. For the Gas Hills Remote Satellite, the 1997 MILDOS modeling run used 400 meters for the morning mixing height and 2,400 meters for the afternoon mixing height.

Bodies of Water and Special Terrain Features

The nearest significant body of water to the proposed Gas Hills project is the Sweetwater River, approximately 20 miles south of the Gaas Hills Remote Satellite site. This is a relatively small tributary flowing into the North Platte River approximately 40 miles southeast of the site. It is highly unlikely that the influence of such a small stream could be measured 20 miles away with a standard humidity probe.

The nearest mountain ranges to the Gas Hills site are:

- the Rattlesnake Mountains, approximately 10 miles to the east

- the southern extreme of the Bighorn Mountains, approximately 35 miles to the north

It is believed that the Bighorn Mountains have little if any impact on meteorology at the site. The Rattlesnake Mountains rise to over 8,000 ft. in elevation and may block relatively uncommon easterly winds or redirect them to a more northeasterly direction (Figure 2.5-20). Since the prevailing winds in the region are southwesterly, the Rattlesnake Mountains exert only a peripheral impact on the dominant wind pattern, introducing a more southerly component to the southwesterly flow observed in other parts of the region.

The Beaver Rim is a prominent erosional escarpment extending from the Rattlesnake Mountains westward to the Wind River Mountains. Rising several hundred feet, it cuts through the southern portion of the Gas Hills site. It is likely that this geographic feature exerts some influence on local meteorology, especially differentiating wind patterns atop the rim from those below the rim.

Conclusion

The Gas Hills Remote Satellite in west-central Wyoming is located in a semi-arid or steppe climate. The area is characterized by abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. The region has large diurnal and annual variations in temperature.

Five meteorological stations were used to characterize regional weather patterns. The region experiences average daily maximum temperatures near 80° in July and average daily minimum temperatures around 10° F in January. There are large diurnal and annual variations in temperature. The region has cold harsh winters, warm dry summers, and cool springs and autumns. Temperature extremes range from approximately -30° F in the winter to over 100° F in the summer. The on-site average temperature during the baseline monitoring year at Gas Hills was 42° F with extremes of -21° to +89° F. The region generally receives little precipitation with annual averages between 8 and 12 inches. Spring and early summer precipitation events are responsible for the majority of the yearly average.

The region is characterized by annual average wind speeds of 8 to 15 mph. Winds at the Gas Hills site are expected to average 14 mph annually, with summer averages dipping to near 10 mph and winter averages exceeding 16 mph. The predominant wind directions are from the south-southwest and southwest.

The Riverton AP And Casper AP meteorological stations were included in the site specific analysis to validate the temporal representativeness of on-site wind data by incorporating wind monitoring results from a longer period of record. The Riverton site is located 48 miles west-northwest of the Gas Hills site while the Casper site is 58 miles east of the Gas Hills site. The distributions of wind speeds and directions at Riverton during the baseline monitoring period have been shown to closely represent Riverton's 15-year distributions of wind speeds and directions. The same has been shown for Casper's 8-year distributions. The evidence strongly supports the assertion that winds during the baseline year of 2011 at the Gas Hills Remote Satellite site are representative of the long term.

References

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Appendix A

Gas Hills Meteorological Station Calibration

WIND SPEED SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 05305-5 Wind Monitor - AQ
SN: WM106265

Propeller SN: NA
Operating Range: 0 to 50 mps
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Variable motor. R.M.Young, 18820A/18830A (200 to 15,000 rpm) **SN:** CA03277
Item: Variable motor. R.M.Young, 18820A/18831A (0 to 300 rpm) **SN:** CA03277
Item: Torque disk device. R.M.Young, 18312 **SN:** NA

PART B: CALIBRATION TEST RESULTS

Sensor Starting Threshold: 0.2 gm-cm ,equal to 0.38 mps **Pass? / Fail?:** Pass ≤ 0.50 mps

Known Input		Observed Data Logger Response					
Motor rpm	Motor mps	Output mps	Error mps	Error %	Limit mps	Limit %	Pass? Fail?
0.0	0.00		0.00	NA	NA	NA	NA
150	1.72	1.72	0.00	0.0	≤ ±0.20	---	PASS
700	8.02	8.02	0.00	0.0	---	≤ ±5%	PASS
2,000	22.90	22.90	0.00	0.0	---	≤ ±5%	PASS
4,000	45.80	45.80	0.00	0.0	---	≤ ±5%	PASS
6,000	68.70	68.70	0.00	0.0	---	≤ ±5%	PASS
8,000	91.60	91.60	0.00	0.0	---	≤ ±5%	PASS

COMMENTS

To PASS, the sensor must have...
1) Starting Torque Threshold = ≤ 0.50 mps
2) Wind speed input ≤5.0 mps = ≤ ±0.20 mps error
3) Wind speed input >5.0 mps = ≤ ±5% of input speed

WIND DIRECTION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 034B
SN: K15391

Operating Range: 0 to 360 degrees
Height Above Ground: 10 meters

CALIBRATION TEST EQUIPMENT

Item: Brunton pocket transit compass — **SN:** 5080610049
Item: R.M.Young, Model 18331, vane torque measurement device — **SN:** NA
Item: R.M.Young, Model 18112, vane angle fixture — **SN:** NA

PART B: CALIBRATION TEST RESULTS

Local Magnetic Declination: 8.4 degrees east
(http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp)

Sensor Starting Threshold: 9.0 gm-cm ,equal to 0.49 mps **Pass? / Fail?:** PASS ≤ 0.50 mps

Test Input Deg.	Accuracy Test Response Output Deg.	Error Deg.	Pass? Fail?
358	360	2	PASS
88	92	3	PASS
178	181	2	PASS
268	269	1	PASS

Test Input Deg.	Linearity Test Response Output Deg.	Nrmlzd* Deg.	Pass? Fail?
0	0	NA	NA
30	31	1	PASS
60	62	1	PASS
90	93	1	PASS
120	122	-1	PASS
150	151	-1	PASS
180	180	-1	PASS
210	209	-1	PASS
240	239	-1	PASS
270	268	-1	PASS
300	298	0	PASS
330	328	1	PASS
350	349	2	PASS

* Normalized error in degrees.

COMMENTS

- The crossarm was measured at 88.4 degrees to true north on 6/13/2011. The accuracy test response was measured against the crossarm. This is reflected in the "Test Input Deg." category.

To PASS, the sensor must have... 1) Starting Torque Threshold = ≤ 0.50 mps
2) Accuracy Test Error = ≤ ±5 degrees per test point
3) Linearity Test Error = ≤ ±3 degrees per test point

TEMPERATURE / ΔTEMPERATURE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: 062 MP

2-Meter Probe SN: K13983 (2 of 2)
10-Meter Probe SN: K13983 (1 of 2)
Operating Range: -50 to +50 C

CALIBRATION TEST EQUIPMENT

Item: Dostmann Electronic GmbH P650-PT — **SN:** 65010081147
Item: Insulated water baths with mechanical stirring. — **SN:** NA

PART B: CALIBRATION TEST RESULTS

Temperature Probe Calibration

Known Input		Observed Data Logger Response					
Water Bath	Temp. °C	2-m °C	2-m Error °C	Pass? Fail?	10-m °C	10-m Error °C	Pass? Fail?
Ice	0.00	0.00	0.00	PASS	-0.02	-0.02	PASS
Cool	23.00	22.91	-0.09	PASS	22.87	-0.13	PASS
Hot	40.05	40.05	0.00	PASS	40.05	0.00	PASS

Temperature Difference System Calibration

Known Input		Observed Response		
Water Bath	ΔT °C	2-10 ΔT °C	2-10 ΔT Error °C	Pass? Fail?
Ice	0.00	0.02	0.02	PASS
Cool	0.00	0.05	0.05	PASS
Hot	0.00	0.00	0.00	PASS

(NOTE: The water baths were constantly agitated with mechanical stirring during the calibration tests.)

(NOTE: During the ΔT calibration, both probes were placed together in the same bath.)

COMMENTS

To PASS, the temperature probes must have... Accuracy error = ≤ ±0.50 °C per test point
To PASS, the ΔT system must have... Accuracy error = ≤ ±0.10 °C per test point

SOLAR RADIATION SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: LiCor
Model: 200 Pyranometer
SN: PY69340

Operating Range: 0 to 1,400 W/m^2
Height Above Ground: 1.8 meters

CALIBRATION TEST EQUIPMENT

Item: Kipp & Zonen CM-3 pyranometer **SN:** 58211
Item: Fluke, Model 289, digital multimeter (4.5 digits, True RMS) **SN:** 96210097

PART B: CALIBRATION TEST RESULTS

Known Input		Observed DAS Response				
Period hhmm	Value W/m^2	DAS W/m^2	Error W/m^2	Error %	Error % F.S.	Pass? Fail? [4]
Covered	0.0	0	0	NA	NA	PASS
1347	112	112	-1	-0.5	0.0	PASS
1456	181	176	-5	-2.9	-0.4	PASS
1435	1034	1070	36	3.5	2.6	PASS
14.42	975	1010	35	3.6	2.5	PASS
1450	162	154	-8	-5.1	-0.6	FAIL
1454	210	203	-7	-3.2	-0.5	PASS

Calibration Curve Results ⇨

Slope: [1]	1.0435	PASS
Intercept: [2]	-9.412	PASS
Corr. Coeff: [3]	0.9999	PASS

COMMENTS

- It was difficult to get a large range of values due to increasing cloud cover throughout the day.

To PASS, the sensor must have...
[1] Slope = 1.0 ±0.05
[2] Intercept = ≤ 1% of Full Scale
[3] Correlation Coefficient = ≥ 0.9950
[4] Error per test point = ±5% of observed

RELATIVE HUMIDITY SENSOR CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Vaisala
Model: HMP45AC
SN: F3630128

Operating Range: 0-100%
Height Above Ground: 2 meters

CALIBRATION TEST EQUIPMENT

Item: Fisher Scientific Traceable Hygrometer, Thermometer, Dew Point **SN:** 102060060

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE		
Test	%RH	DAS %RH	Error %RH	Pass? Fail? 1
Ambient	30.8	27.8	-3.0	PASS
Chmbr.	93.0	94.5	1.5	PASS

COMMENTS

To PASS, the sensor must have... 1) Percent Error = ≤ 10%

Prepared 8/5/2010

PRECIPITATION GAUGE CALIBRATION REPORT

PART A: ANCILLARY INFORMATION

Project: Gas Hills
Location: Wyoming
Technician: Ethan Brown

Date: 7/13/2011
Start: 13:00 7/13/2011
End: 16:00 7/13/2011

Check One:
As Found: √
As Left:

SENSOR INFORMATION

Make: Met One
Model: TR525USW
SN: 45573-1010

Gauge Type: Tipping Bucket
Operating Range: NA
Height Above Ground: 76.20 cm

CALIBRATION TEST EQUIPMENT

Item: Distilled water, graduated cylinders, drip device

SN: NA

PART B: CALIBRATION TEST RESULTS

KNOWN INPUT		OBSERVED RESPONSE			
		DAS	Error	Error	Pass? Fail? [1]
ml, H_2O	mm	mm	mm	%	
500	15.10	14.48	-0.62	-4.1	PASS

COMMENTS

To PASS, the sensor must have... 1) Percent Error = ≤ 10%