

OREGON ANEMOMETER LOAN PROGRAM

Wind Resource Evaluation: Stack Wind



Prepared By:
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1.0 SITE DESCRIPTION

Site Name: Stack Wind LLC
Latitude: 45-31-2.46 (NAD 27)
Longitude: 117-54-16.87
Elevation: 3150 ft.
County: Union
Tower Height: 50 meter
Types of Sensors: NRG Maximum #40 wind speed
NRG 200 series2 wind vane
Instrumentation: 165 ft. – Wind Speed (2), Wind Direction
120 ft. – Wind Speed
90 ft. – Wind Speed
Types of Data: 10 min. average wind speed (mph)
10 min. mean wind direction (deg)
10 min temperature (Deg F)
Standard Deviation, maximum and minimum over 10 min.
period also available for each data type.
Installation Date: June 16, 2005
Data Available to: April 1, 2007

Site Location: The site is located on the top of a hill approximately 5 miles south of the town of Elgin in Northeastern Oregon. The hill looks out over a valley that extends south to the City of La Grande and is at a location where the valley narrows near its northern end. The valley containing this hill is bordered on the east by the Wallowa Mountains. The tower location is marked on the map included in Appendix A.

Project Description: The owner of the site is interested in evaluating the site for possible installation of a small wind project.

2.0 WIND DATA PROCESSING

NRG equipment was used at this site including #40 anemometers and a Symphony data logger. Data from 16 June 2005 through 17 January 2007 was provide on a CD and consisted of both scaled text files and raw Symphony data files. Raw Symphony files were obtained by email for the additional period of January 22, 2007 through April 1, 2007. NRG Symphony software was used to read these files and produce monthly files of wind speed, direction and standard deviation of direction. These files were then converted to an internal ERRL format to accommodate data checking and to perform analysis using existing programs. In this process each level/site combination is assigned a two digit site code. Theses codes are listed in Table 1.

Table 1: Site codes and information for the Stack Wind site location.

Site ID	Site Name	Latitude dd-mm-ss	Longitude dd-mm-ss	Elev. (ft)	Sensor Ht (ft)	Period of Record
E1	Stackwind LLC	45-31-2.46	117-54-16.87	3150	165	June 16 2005 - April 1, 2007
E2	Stackwind LLC	45-31-2.46	117-54-16.87	3150	120	June 16 2005 - April 1, 2007
E3	Stackwind LLC	45-31-2.46	117-54-16.87	3150	90	June 16 2005 - April 1, 2007

In addition to the filter available for use with the NRG Symphony software, data files were also scanned manually to identify any sustained periods in which ice was might be present and to identify any additional problems. No icing was identified in the records. Data recovery for the three levels is shown in Figure 1. A large gap in data availability is present for the period between November 3, 2005 and February 7, 2006 associated with tower problems at the site. There is also a small gap between January 17, 2007 and January 22 2007. Data files for this period were not provided.

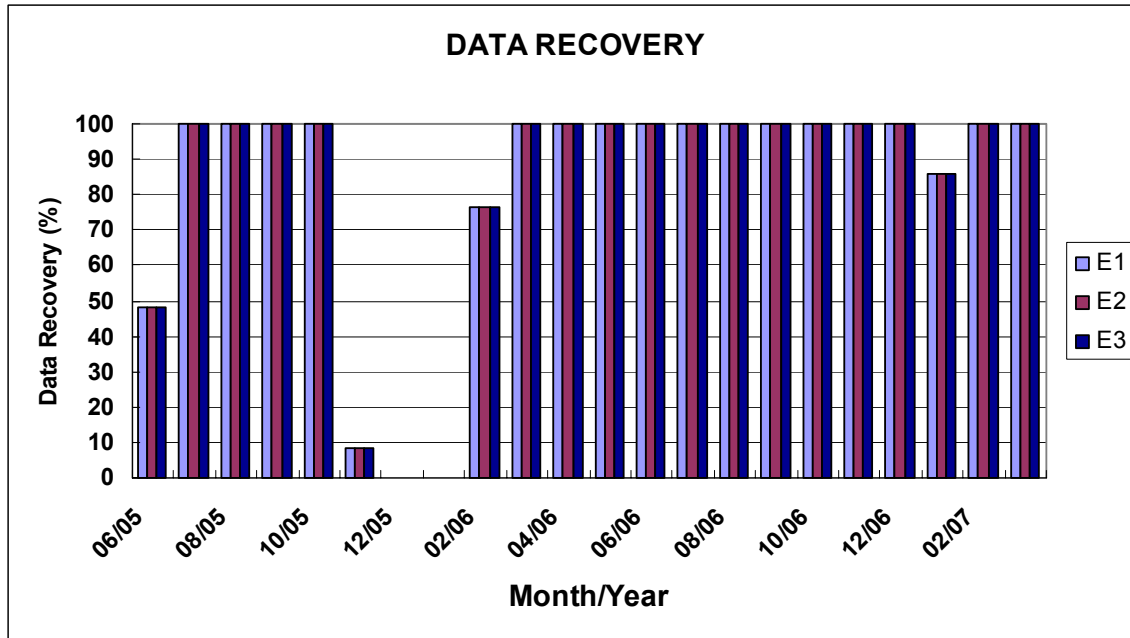


Figure 1: Data recovery at the Stack Wind site:

3.0 WIND CHARACTERISTICS

In the following sections, several characteristics of the winds at the Stack Wind site are examined and discussed. The goals are to evaluate the characteristics that can help explain the physical processes at work at the site and to highlight the properties that are important to assessing the wind energy potential. These evaluations are done using hourly averaged means that have been constructed using the 10 minute means recorded at the site. This is done so that existing analysis programs can be used and is not expected to have any appreciable influence on the interpretation of data. This analysis is also confined to a single annual period. This is done so that the results are not biased by the addition of data from only a single season or a portion of a year. *The period analysed here is for April 2006 to March 2007.*

Monthly Means:

Table 2: Monthly Mean Wind Speed Values and data recovery rates for the annual study period.

Month	E1 (165')		E2 (120')		E3 (90')	
	Mean (mph)	Rec. (%)	Mean (mph)	Rec. (%)	Mean (mph)	Rec. (%)
APR	9.8	100.0	9.3	100.0	9.2	100.0
MAY	9.0	100.0	8.5	100.0	8.4	100.0
JUN	7.5	100.0	7.0	100.0	7.1	100.0
JUL	8.1	100.0	7.7	100.0	7.7	100.0
AUG	8.0	100.0	7.7	100.0	7.6	100.0
SEP	7.5	100.0	7.2	100.0	7.2	100.0
OCT	8.9	100.0	8.4	100.0	8.5	100.0
NOV	16.9	100.0	16.2	100.0	15.8	100.0
DEC	14.8	100.0	14.3	100.0	13.9	100.0
JAN	14.9	86.0	14.4	86.0	14.1	86.0
FEB	11.5	100.0	11.2	100.0	10.6	100.0
MAR	11.1	100.0	10.6	100.0	10.4	100.0
ANN	10.6	98.8	10.2	98.8	10.0	98.8

Diurnal Means:

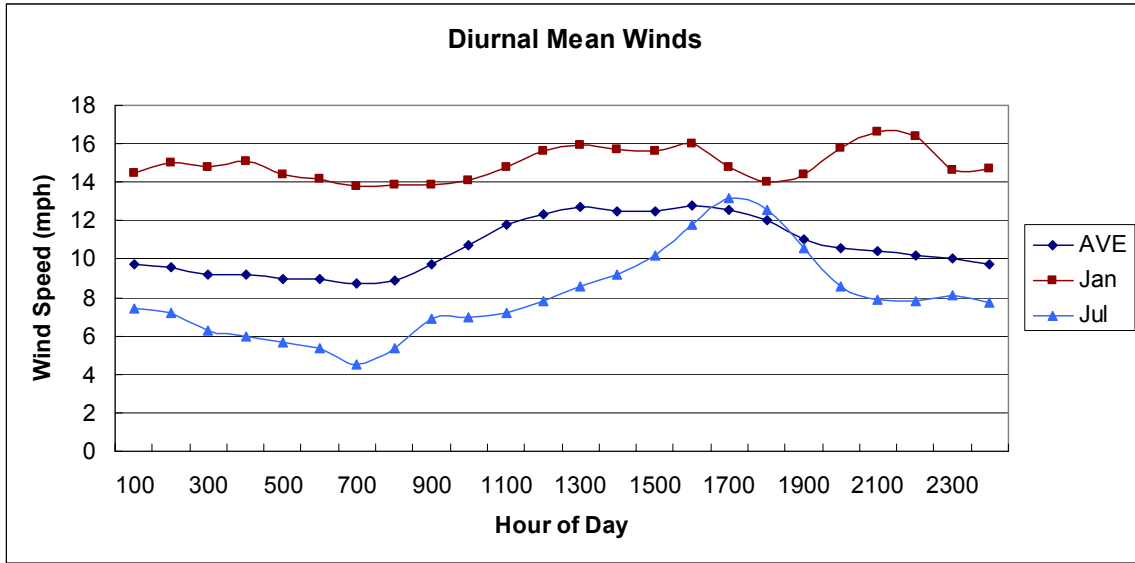


Figure 2: Diurnal mean wind speed values for the 165 ft. level at the Stack Wind site.

Frequency Distribution:

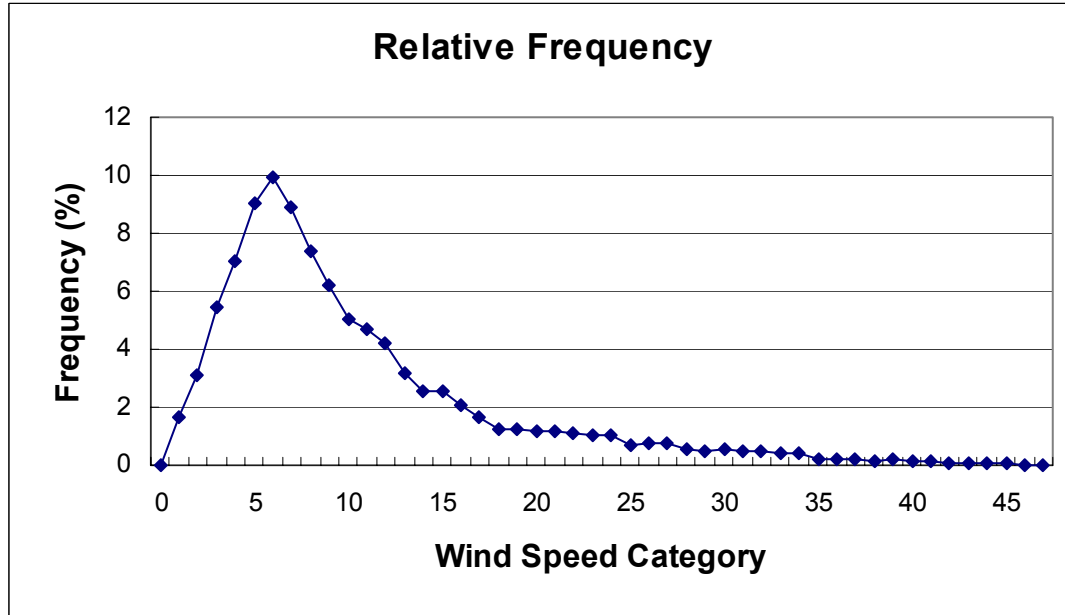


Figure 3: Wind speed frequency distribution for the 165 ft. level at the Stack Wind site.

Wind Rose:

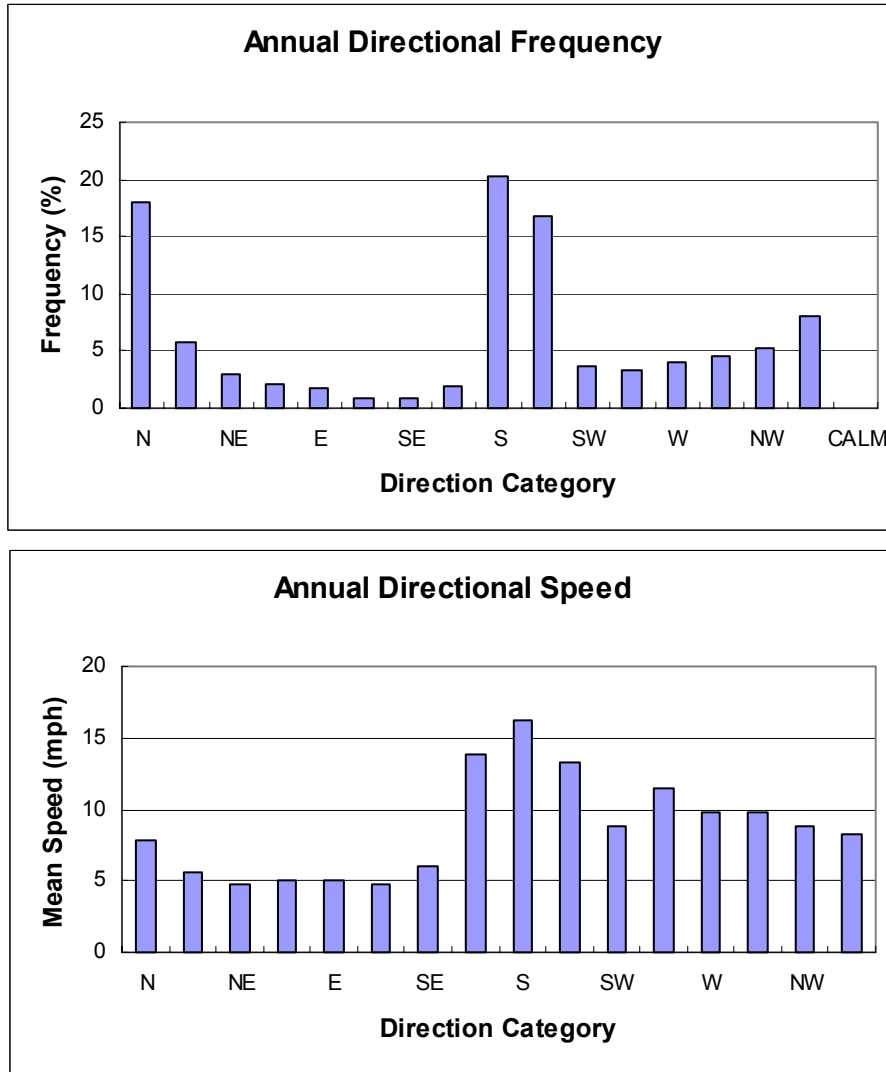


Figure 4a-b: Frequency (%) and average wind speed (mph) for each of 16 wind direction categories from the 165 ft. level of the Stack Wind site.

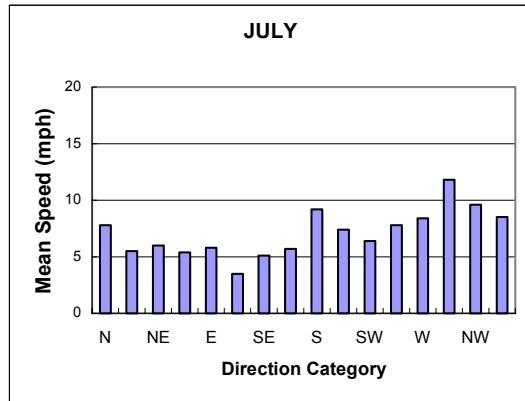
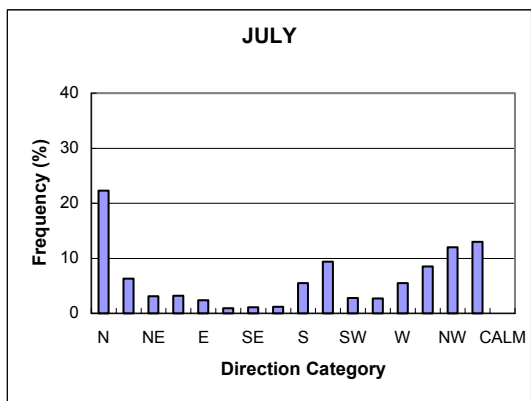
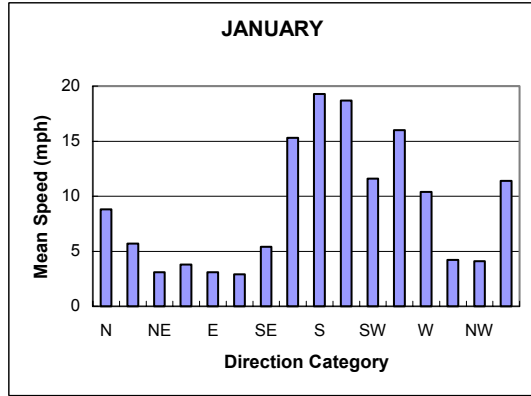
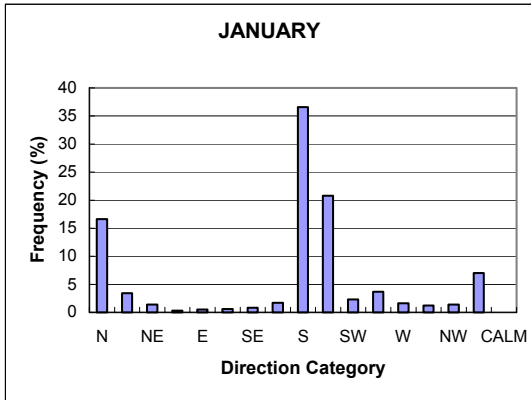


Figure 5a-d: Frequency (%) and average wind speed (mph) for each of 16 wind direction categories for the months of January and July from the 165 ft. level of the Stack Wind site.

4.0 *SITE POWER CHARACTERISTICS*

In order to evaluate the wind power potential at this site a number of quantities were computed using the collected wind data. As with the wind characteristics, hourly wind data was used to complete this work. The power density calculation requires air density. This is estimated assuming a standard atmosphere and the site elevation. The computed quantities include the mean and standard deviation of the hourly values, the recovery rate, the maximum one hour average, the available power, the frequency that the wind was observed within a wind speed range (12 mph to 60 mph) and the shear coefficient (alpha). These quantities are shown in Table 2 and reveal a number of things about the potential for generating energy at the site.

Table 2: Observed and computed power quantities for the Stack Wind site. Values shown are for the 156 ft. level. The shear factor is for the 90 ft. to 165 ft. levels.

Month	Mean	Std.	Recovery	Max 1-Hr	Time in Range (12-60)	Available Energy	Shear Factor	Shape	Scale
	(mph)	(mph)	Rate (%)	(mph)	mph (%)	KWh/m**2		Factor	Factor
Apr	9.8	6.2	100.0	33.1	26.7	84	0.095	4.64	10.8
May	9.0	4.8	100.0	30.9	23.9	55	0.103	1.97	10.1
Jun	7.5	3.3	100.0	23.1	9.3	25	0.102	2.48	8.5
Jul	8.1	4.1	100.0	39.8	14.7	38	0.073	2.10	9.1
Aug	8.0	3.9	100.0	28.2	16.4	35	0.082	2.17	9.0
Sep	7.5	4.0	100.0	30.4	11.8	32	0.065	1.98	8.5
Oct	8.9	5.7	100.0	31.0	23.8	66	0.069	1.63	9.9
Nov	16.9	10.9	100.0	53.3	59.2	423	0.115	1.61	18.9
Dec	14.8	11.3	100.0	51.8	49.2	369	0.103	1.35	16.2
Jan	14.9	11.3	86.0	45.6	47.7	375	0.095	1.35	16.3
Feb	11.5	7.8	100.0	34.1	38.4	136	0.132	1.52	12.8
Mar	11.1	7.0	100.0	37.4	34.5	124	0.098	1.65	12.4
ANN	10.6	7.9	98.8	53.3	29.4	1729	0.097	1.39	11.6

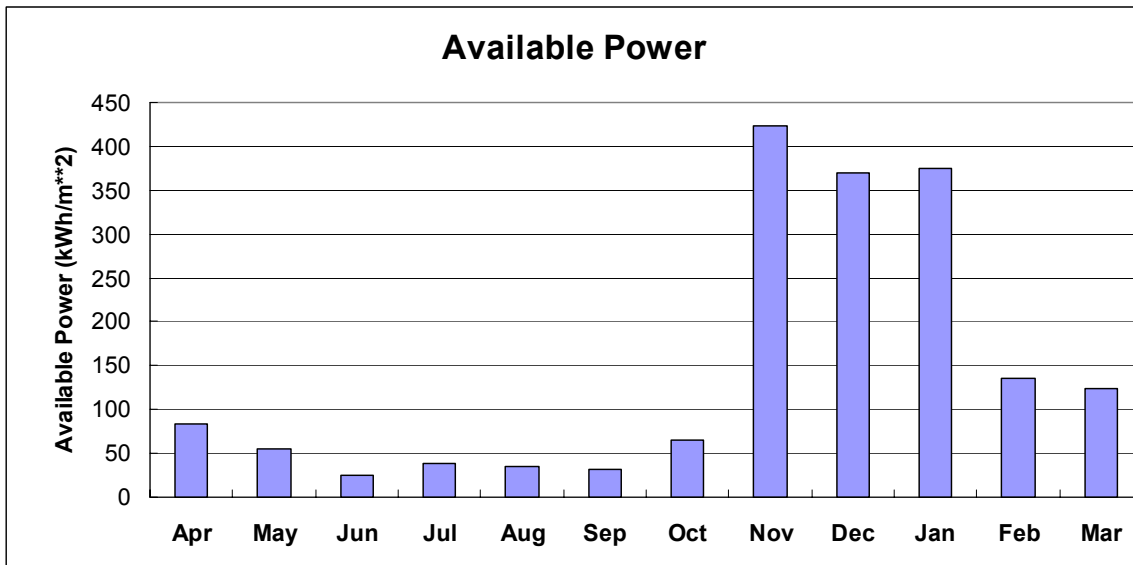


Figure 6: Monthly and annual available power for the Stack Wind site.

An analysis program was run to evaluate the energy that could be produced by two separate wind turbine types. To do this an analysis program was run that adjusts the site weibull distribution using the shear coefficient (alpha) calculated from the hourly values (from 90 ft. to 165 ft.). Density variations are approximated using the site elevation and a standard atmosphere.

Table 3: Monthly and annual capacity factors for two wind turbine types.

Turbine	Vestas 47	GE Wind 70.5
Size (kW)	660	1500
Hub Ht. (ft.)	131	210
Apr	0.101	0.110
May	0.062	0.068
Jun	0.021	0.025
Jul	0.036	0.039
Aug	0.036	0.039
Sep	0.032	0.035
Oct	0.079	0.083
Nov	0.332	0.365
Dec	0.282	0.307
Jan	0.284	0.311
Feb	0.166	0.187
Mar	0.139	0.153
ANN	0.129	0.141

5.0 CLIMATOLOGICAL ANALYSIS

Measurements taken over a single one-year period can provide a good estimation of the winds and wind energy potential of a site. However, this is a fairly limited period and is only meaningful if we can place the period into a larger climatological context. There are several long-term weather sites in the area surrounding the Stack Wind site but the wind records from most are unsuitable for this type of analysis. The only site that has adequate data for this process is the National Weather Service site at the airport in LaGrande.

The LaGrande Airport is located approximately 20 miles south from the wind site through a broad valley. The airport site is an official National Weather Service site and hourly wind speed values were obtained from the National Climate Data Center (NCDC). Information about the site and the monthly means and departures for this annual study period can be found in Table 5.1. What is clear from this table is that the airport site does exhibit the same seasonal winter peak observed at the Stack Wind site and is likely in the same wind regime.

From Table 5.1 we can see that this particular winter was somewhat lower than the longer period at LaGrande. However, when taken over a complete annual period, this comparison shows the winds were only very close to normal (+3.0%). If this number had been higher then an adjustment could be made to account for the variation and bring the observed mean into line with what we would estimate to be the long-term mean. A 3.0% difference does not justify adding the uncertainty that comes along with this process.

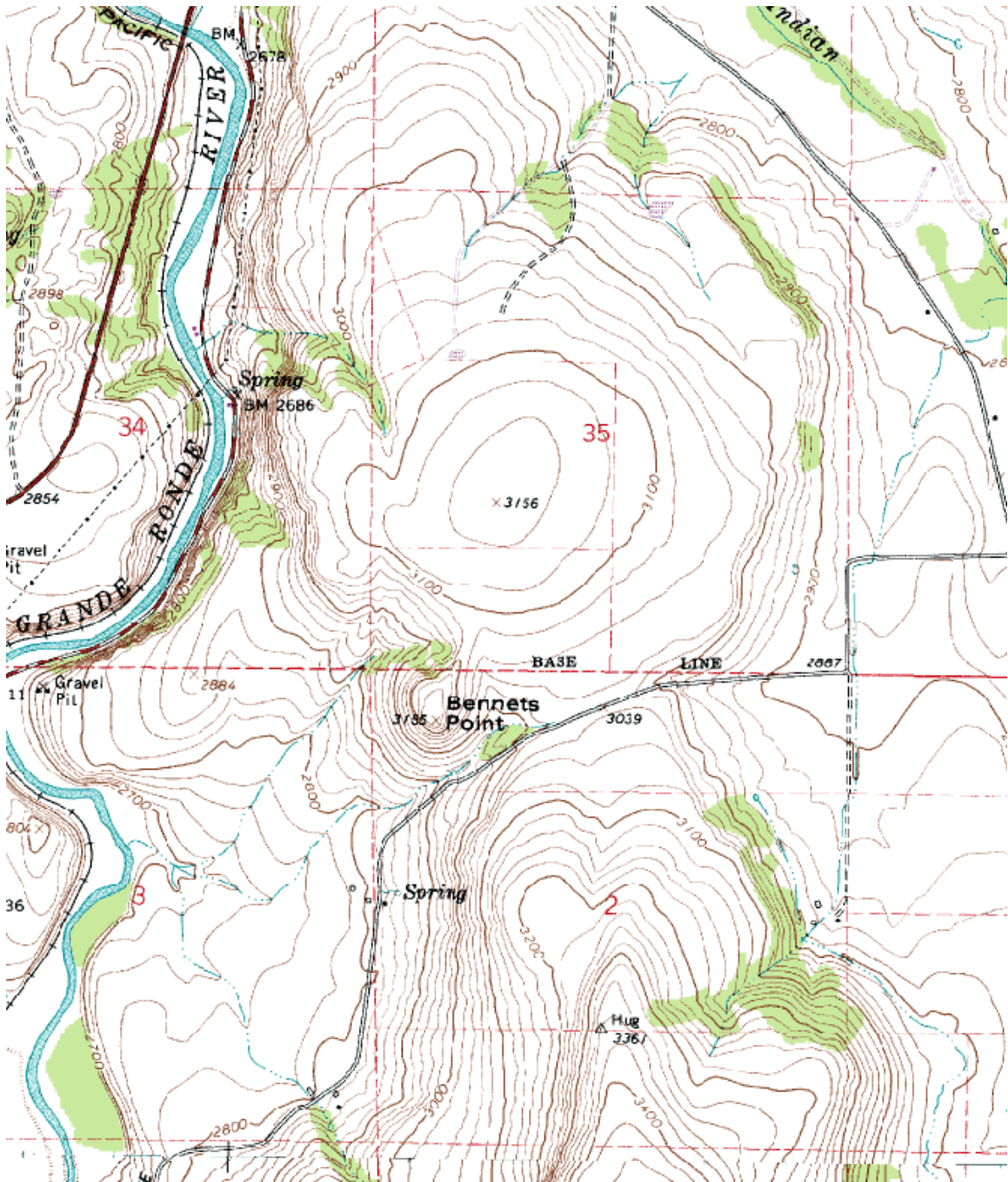
Table 4: Monthly mean and departures for winds at the LaGrande Airport.

LaGrande NWS Latitude: 42.19N Elevation: 2750' Longitude 118.05W			
Month	Normal (mph) 1992-2007	Mean (mph) 2006-2007	Departure (%)
Apr	8.3	8.9	7.9
May	7.2	7.7	7.5
Jun	6.8	6.5	-4.4
Jul	6.4	6.5	1.6
Aug	6.2	6.3	1.6
Sep	5.7	5.3	-6.2
Oct	6.7	6.2	-7.5
Nov	9.7	9.5	-2.1
Dec	11.1	11.5	3.6
Jan	11.4	9.8	-14.0
Feb	9.6	8.3	-13.5
Mar	9.0	8.5	-5.6
ANN	8.2	7.9	-3.0

Summary,

- 1) The annual mean wind speed at this site was found to be 10.6 mph at 50m. When adjusted for climatological variations the long-term mean is expected to be 11.0 mph.
- 2) The measured shear coefficient between the 90 ft. and 165 ft. levels was 0.097
- 3) Winds at the site were observed to be seasonal with light winds in the summer and somewhat stronger winds in the winter. Stronger winds tend to occur from the south.
- 4) Computed capacity factors for two sample wind turbine types were found in a range between 12.9% and 14.1%.

Appendix A: Topographic map of the Stack Wind site.



Appendix B: Miscellaneous analysis Tables.

STATION - Stack Wind 165' (E1)					
WIND SPEED FREQUENCY DISTRIBUTION WITH NORMALIZED AVAILABLE ENERGY					
DATA PERIOD OF RECORD - 4/2006 - 3/2007					
NORMALIZATION PERIOD - ONE YEAR					
AVERAGE WIND SPEED FOR PERIOD: 10.6 MPH					
NORMALIZED AVAILABLE ENERGY: 1732.8 KWH/M**2/YEAR					
TOTAL HOURS OBSERVED: 8656					
SPD	HOURS/				NORMALIZED
MPH	PERIOD	RELFREQ	CUMHRS	CUMRELFREQ	AVAIL. ENERGY
					KWH/M**2/YEAR
0	0	0.00	8656	100.00	0.0
1	141	1.63	8656	100.00	0.0
2	271	3.13	8515	98.37	0.1
3	471	5.44	8244	95.24	0.6
4	607	7.01	7773	89.80	2.0
5	781	9.02	7166	82.79	4.9
6	862	9.96	6385	73.76	9.4
7	770	8.90	5523	63.81	13.3
8	639	7.38	4753	54.91	16.5
9	535	6.18	4114	47.53	19.7
10	438	5.06	3579	41.35	22.1
11	403	4.66	3141	36.29	27.1
12	364	4.21	2738	31.63	31.7
13	277	3.20	2374	27.43	30.7
14	219	2.53	2097	24.23	30.3
15	219	2.53	1878	21.70	37.3
16	178	2.06	1659	19.17	36.8
17	143	1.65	1481	17.11	35.4
18	110	1.27	1338	15.46	32.4
19	110	1.27	1228	14.19	38.1
20	103	1.19	1118	12.92	41.6
21	104	1.20	1015	11.73	48.6
22	96	1.11	911	10.52	51.6
23	88	1.02	815	9.42	54.0
24	92	1.06	727	8.40	64.2
25	61	0.70	635	7.34	48.1
26	67	0.77	574	6.63	59.4
27	64	0.74	507	5.86	63.5
28	49	0.57	443	5.12	54.3
29	41	0.47	394	4.55	50.4
30	47	0.54	353	4.08	64.0
31	42	0.49	306	3.54	63.1
32	41	0.47	264	3.05	67.8
33	37	0.43	223	2.58	67.1
34	33	0.38	186	2.15	65.4
35	21	0.24	153	1.77	45.4
36	21	0.24	132	1.52	49.4
37	17	0.20	111	1.28	43.4
38	14	0.16	94	1.09	38.8
39	21	0.24	80	0.92	62.8
40	14	0.16	59	0.68	45.2
41	11	0.13	45	0.52	38.2
42	6	0.07	34	0.39	22.4
43	5	0.06	28	0.32	20.1
44	6	0.07	23	0.27	25.8
45	9	0.10	17	0.20	41.4
46	1	0.01	8	0.09	4.9
47	2	0.02	7	0.08	10.5
48	1	0.01	5	0.06	5.6
49	0	0.00	4	0.05	0.0
50	1	0.01	4	0.05	6.3
51	1	0.01	3	0.03	6.7
52	1	0.01	2	0.02	7.1
53	1	0.01	1	0.01	7.5

STATION - Stack Wind 165 ft. (E1)
MONTHLY WIND SPEEDS (MPH)
DATA PERIOD OF RECORD - 6/2005 - 3/2007

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	# OBS	AVG
2005	0.0	0.0	0.0	0.0	0.0	7.9	7.7	7.9	8.2	9.0	13.5	0.0	3356	8.27
# OBS	0	0	0	0	0	343	744	744	720	744	61	0.0		
2006	0.0	13.5	10.7	9.8	9.0	7.5	8.1	8.0	7.5	8.9	16.9	14.8	7872	10.33
# OBS	0	528	744	720	744	720	744	744	720	744	720	744		
2007	14.9	11.5	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2056	12.42
# OBS	640	672	744	0	0	0	0	0	0	0	0	0		

STATION - Stack Wind 120 ft. (E2)
MONTHLY WIND SPEEDS (MPH)
DATA PERIOD OF RECORD - 6/2005 - 3/2007

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	# OBS	AVG
2005	0.0	0.0	0.0	0.0	0.0	7.6	7.6	7.8	8.0	8.6	13.1	0.0	3356	8.03
# OBS	0	0	0	0	0	343	744	744	720	744	61	0		
2006	0.0	12.7	10.3	9.3	8.5	7.0	7.7	7.7	7.2	8.4	16.2	14.3	7872	9.86
# OBS	0	528	744	720	744	720	744	744	720	744	720	744		
2007	14.4	11.2	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2056	11.97
# OBS	640	672	744	0	0	0	0	0	0	0	0	0		

STATION - Stack Wind 90 ft. (E3)
MONTHLY WIND SPEEDS (MPH)
DATA PERIOD OF RECORD - 6/2005 - 3/2007

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	# OBS	AVG
2005	0.0	0.0	0.0	0.0	0.0	7.6	7.5	7.7	7.9	8.5	2.7	0.0	3356	7.94
# OBS	0	0	0	0	0	343	744	744	720	744	61	0		
2006	0.0	12.9	10.1	9.2	8.4	7.1	7.7	7.6	7.2	8.5	15.8	13.9	7856	9.78
# OBS	0	512	744	720	744	720	744	744	720	744	720	744		
2007	14.1	10.6	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2056	11.64
# OBS	640	672	744	0	0	0	0	0	0	0	0	0		

**STATION - Stack Wind 165 ft. (E1)
 DIURNAL WIND SPEEDS (MPH)
 DATA PERIOD OF RECORD - 4/2006 - 3/2007**

	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	AVG SPD
MON	14.5	15.0	14.8	15.1	14.4	14.2	13.8	13.9	13.9	14.1	14.8	15.6	15.9	15.7	15.6	16.0	14.8	14.0	14.4	15.8	16.6	16.4	14.6	14.7	14.9
JAN	11.0	10.4	8.5	7.8	8.7	8.5	8.9	10.9	11.4	12.3	13.8	14.5	14.6	14.1	13.7	12.7	12.0	11.9	10.7	12.0	12.4	11.9	11.3	12.5	11.5
FEB	10.5	9.9	9.5	9.5	9.6	9.9	10.6	10.8	10.8	11.9	13.5	13.5	14.5	14.0	13.7	13.3	12.1	10.1	10.0	10.1	9.5	9.2	10.0	9.1	11.1
MAR	8.0	7.2	8.1	9.1	8.0	8.5	8.9	8.8	9.0	10.4	11.9	12.6	12.6	11.7	11.7	11.4	12.5	11.1	10.1	9.4	9.1	8.3	8.0	8.0	9.8
APR	6.8	6.2	6.5	7.5	6.7	6.6	6.3	6.5	8.6	10.3	10.7	11.1	11.9	10.8	11.4	12.6	12.8	12.1	10.8	8.1	7.4	8.2	8.3	7.1	9.0
MAY	7.2	7.4	6.9	6.9	6.8	6.8	5.6	5.6	6.0	6.2	7.2	7.5	7.6	8.4	8.2	8.9	10.2	9.6	9.2	8.5	7.9	7.4	7.8	7.4	7.5
JUN	7.4	7.2	6.3	6.0	5.7	5.4	4.5	5.4	6.9	7.0	7.2	7.8	8.6	9.2	10.2	11.8	13.2	12.6	10.6	8.6	7.9	7.8	8.1	7.7	8.1
JUL	7.1	6.9	6.9	6.1	6.5	6.4	5.3	4.6	5.8	6.9	7.8	8.4	8.8	9.2	9.7	10.9	11.9	12.4	10.3	8.3	8.0	8.2	8.2	7.1	8.0
AUG	6.3	6.6	6.9	6.5	6.9	6.4	5.5	5.0	5.1	6.8	8.5	9.7	9.4	9.0	9.8	9.9	9.2	8.7	7.3	7.4	8.0	8.0	7.2	6.4	7.5
SEP	7.5	7.4	6.9	6.6	6.4	6.9	6.5	6.6	6.7	9.0	11.0	11.6	11.7	11.9	12.3	12.2	11.0	9.7	8.5	9.3	9.3	8.5	8.1	7.9	8.9
OCT	16.0	16.2	15.1	15.1	15.4	15.6	14.7	15.6	17.7	18.1	19.1	18.9	20.0	19.3	18.9	18.1	17.2	17.3	16.7	17.4	16.5	16.0	15.7	15.6	16.9
NOV	14.4	15.7	14.9	15.1	14.0	13.6	14.0	14.0	14.8	15.8	17.0	17.1	17.0	16.8	15.4	15.7	14.9	14.9	14.0	13.1	12.9	13.3	13.4	13.7	14.8
DEC																									
AVG	9.7	9.6	9.2	9.2	9.0	9.0	8.7	8.9	9.7	10.7	11.8	12.3	12.7	12.5	12.5	12.8	12.6	12.0	11.0	10.6	10.4	10.2	10.0	9.7	10.6
SPD																									

**STATION - - Stack Wind 165 ft. (E1)
WIND ROSE FOR ALL DATA - 8656 OBSERVATIONS
DATA PERIOD OF RECORD - 4/2006 - 3/2007**

		SPEED CATEGORIES (MPH)																TOTAL		MEAN
DIR	0	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	%	SPEED	
	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	>=	(MPH)	
	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	55			
N	14.0	2.4	0.7	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	7.8	
NNE	5.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	5.6	
NE	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	4.8	
ENE	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.0	
E	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	5.0	
ESE	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	4.8	
SE	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	6.0	
SSE	1.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	13.9	
S	7.4	2.0	1.8	1.7	1.4	1.5	1.2	1.0	0.8	0.6	0.4	0.2	0.2	0.0	0.0	0.0	0.0	20.3	16.2	
SSW	7.8	2.6	1.5	1.1	1.1	0.9	0.7	0.3	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	16.8	13.3	
SW	2.4	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	8.8	
WSW	1.5	0.8	0.5	0.3	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	11.5	
W	2.2	0.9	0.5	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	9.8	
WNW	2.3	1.1	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	9.8	
NW	3.3	1.1	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	8.8	
NNW	5.6	1.3	0.8	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.3	
CALM																		0.0		
TOTAL	61.1	13.1	7.8	4.5	3.5	3.0	2.2	1.5	1.3	0.8	0.6	0.3	0.2	0.0	0.0	0.0	0.0	100.0	10.6	
%																				

NOTE: MEAN SPEED OF THE TOTAL IN A WIND ROSE MAY DIFFER FROM THE SPEED FREQUENCY DISTRIBUTION FOR A GIVEN PERIOD DUE TO DATA SELECTION. SPEED FREQUENCY DISTRIBUTIONS REQUIRE ONLY A WIND SPEED OBSERVATION BE PRESENT. WIND ROSES, ON THE OTHER HAND, REQUIRE BOTH SPEED AND DIRECTION BE PRESENT FOR EACH OBSERVATION.

**STATION - - Stack Wind 165 ft. (E1)
 ENERGY ROSE (TOTALS ARE NORMALIZED AVAILABLE ENERGY (KWH/M**2)
 DATA PERIOD OF RECORD - 4/2006 - 3/2007**

MON	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	OBS.
JAN	8.0	0.5	0.0	0.0	0.0	0.0	0.1	9.7	235.1	99.5	2.5	10.4	2.1	0.1	0.1	6.9	374.9	640
FEB	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.6	96.1	25.5	1.9	8.8	1.5	0.5	0.3	0.5	136.9	670
MAR	2.0	0.2	0.1	0.1	0.1	0.0	0.1	1.3	73.1	33.7	1.6	3.0	3.9	1.4	2.5	2.1	125.2	741
APR	21.6	1.2	0.2	0.2	0.1	0.1	0.2	7.2	25.6	4.8	1.5	6.8	2.8	3.1	1.8	7.6	84.7	718
MAY	8.7	1.3	0.3	0.2	0.1	0.3	3.0	2.9	14.2	3.9	0.7	4.1	5.4	4.1	2.9	3.2	55.1	741
JUN	4.9	0.8	0.2	0.2	0.1	0.1	0.0	0.0	3.4	2.2	0.6	0.9	2.1	4.1	2.9	2.9	25.3	718
JUL	5.7	0.5	0.4	0.2	0.4	0.0	0.3	0.2	6.6	2.3	0.4	0.7	2.0	6.8	6.6	4.8	38.1	742
AUG	5.2	1.2	0.3	0.3	0.1	0.2	0.1	0.7	3.2	1.7	1.0	0.9	4.1	4.9	6.3	4.6	34.7	744
SEP	4.5	0.7	0.4	0.2	0.4	0.1	0.0	0.0	9.1	4.3	0.9	2.9	2.3	2.4	1.7	2.1	32.0	715
OCT	10.2	1.5	0.2	0.1	0.1	0.0	0.0	0.1	22.1	18.1	1.2	2.5	4.0	2.2	1.9	2.4	66.5	744
NOV	0.8	0.1	0.0	0.0	0.0	0.1	0.0	69.5	244.5	97.2	4.2	2.3	3.9	0.8	0.3	0.5	424.2	719
DEC	3.2	0.2	0.0	0.0	0.1	0.0	0.1	10.8	196.9	140.7	13.0	3.2	0.5	0.2	0.0	0.3	369.1	743
744																		
TOT	75.5	8.3	2.3	1.6	1.6	0.9	3.9	102.9	929.9	433.8	29.4	46.4	34.4	30.5	27.5	37.9	1766.8	8633

NOTE: AVAILABLE ENERGY IN AN ENERGY ROSE MAY DIFFER FROM THE SPEED FREQUENCY DISTRIBUTION FOR A GIVEN PERIOD DUE TO DATA SELECTION. SPEED FREQUENCY DISTRIBUTIONS REQUIRE ONLY A WIND SPEED OBSERVATION BE PRESENT. ENERGY ROSES, ON THE OTHER HAND, REQUIRE BOTH SPEED AND DIRECTION BE PRESENT FOR EACH OBSERVATION.