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|---|---|
| **From:** | Dawn Kolkman |
| **To:** | Linton, Ron |
| **Cc:** | Aaron Linard; Tracy Hanna |
| **Subject:** | [External_Sender] Meteorological Data - Uranerz Nichols Ranch ISR Project (Electronic Submission Only) |
| **Date:** | Monday, November 14, 2016 12:26:44 PM |
| **Attachments:** | Nichols Ranch Year 5 Wind and Atmospheric Stability Analysis Revised 11-….pdf |

Ron,

Attached is an updated report of the meteorological data to include:

1. Wind rose for the past year, and
2. Recovery rates based on individual years.

This is an Electronic Submission Only – no hard copy will follow.

If questions, please let me know.

***Energy Fuels Resources (USA) Inc.***

Dawn Kolkman

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# Wind Rose and Atmospheric Stability Analysis

Annual Update for Nichols Ranch Site

8 November 2016

**Uranerz Energy Corporation**

**(an Energy Fuels Company)**

Casper, Wyoming

Prepared by:

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## Introduction

Baseline hourly meteorological data were collected at the Nichols Ranch site from 6/28/2011 to 7/3/2012. This period was established as the baseline year and results were provided in a previous report. Meteorological monitoring at Nichols Ranch has continued through 6/27/2016, providing an additional 4 years of hourly data. This report summarizes the wind monitoring results from the most recent year of monitoring and compares these to the baseline year and to the years 2 through 4. These results include wind roses, wind speed and direction frequency distributions, atmospheric stability class distributions, and joint distributions of stability class, wind speed and wind direction. Also included is a summary of hourly wind data recovery for each of the five monitoring years and for the entire monitoring period.

## Wind Monitoring Results

July 2015 – June 2016

Figure 1 shows the most recent yearly wind rose (year 5) for Nichols Ranch. Joint wind speed and direction data recovery was 99% for this period. The highest wind speeds occur from the north-northwest and southwest directions. The dominant wind direction overall is from the east. A previous report demonstrated that this pattern is due mostly to night-time drainage, or downslope convection winds from nearby North Pumpkin Butte.

Project-to-Date Results

Figures 2 through 5 show the yearly wind roses for the baseline monitoring year (year 1) and for subsequent monitoring years (year 2 through 4). For ease of comparison, wind roses for all five monitoring years appear in Figure 6, which demonstrates similar wind patterns at Nichols Ranch from year to year. Table 1 presents the yearly and project-to-date data recovery statistics, which easily exceed the 90% minimum joint data recovery requirement in NRC's Regulatory Guide 3.63. Table 2 presents project-to-date monitoring results for all recorded meteorological parameters. Joint wind speed and wind direction data recovery was 99.1% over the entire monitoring period. East winds accounted for nearly 16% of the total hours.

**Figure 1. Nichols Ranch Year 5 Wind Rose**

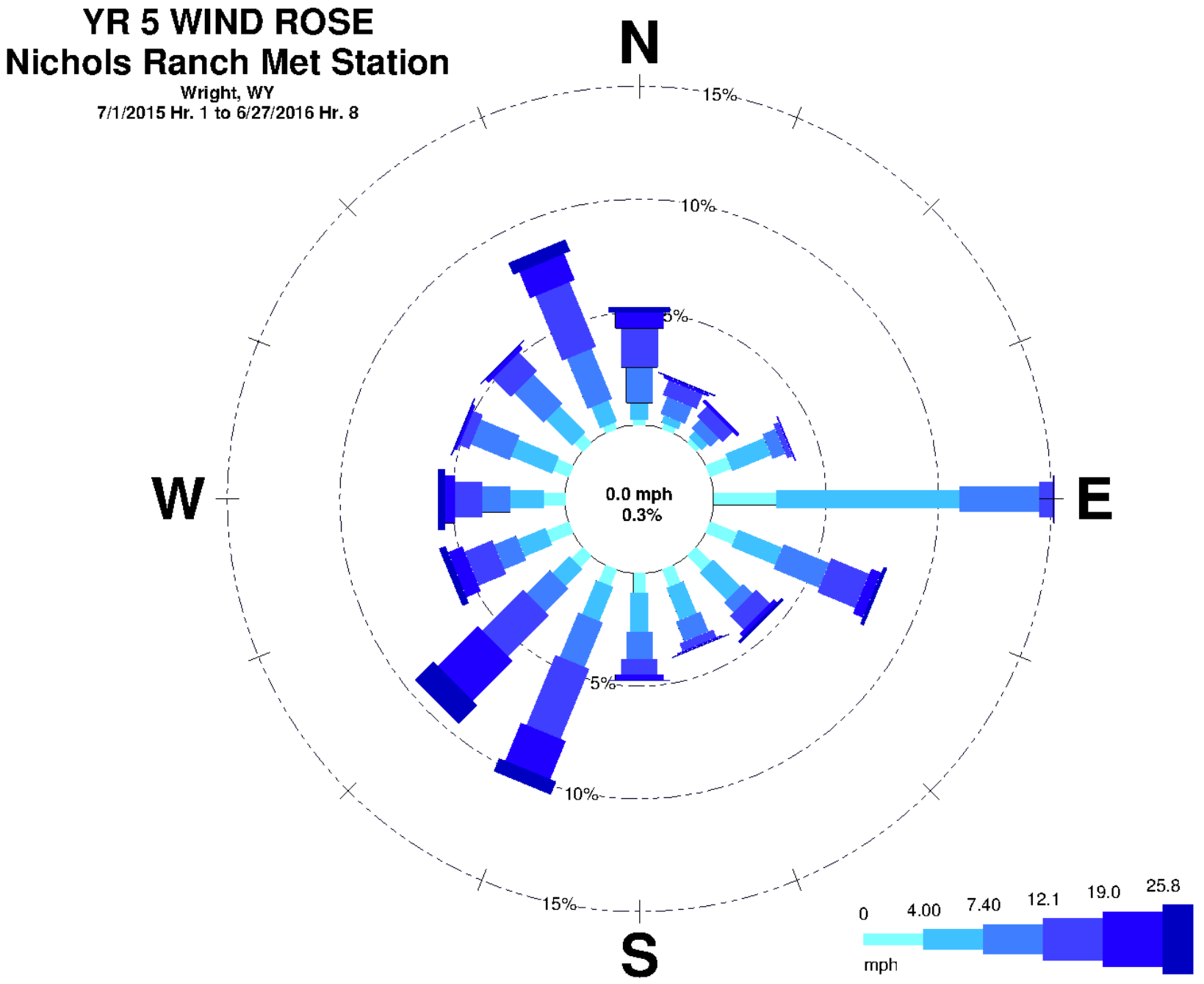


**Figure 2. Nichols Ranch Baseline Year Wind Rose**

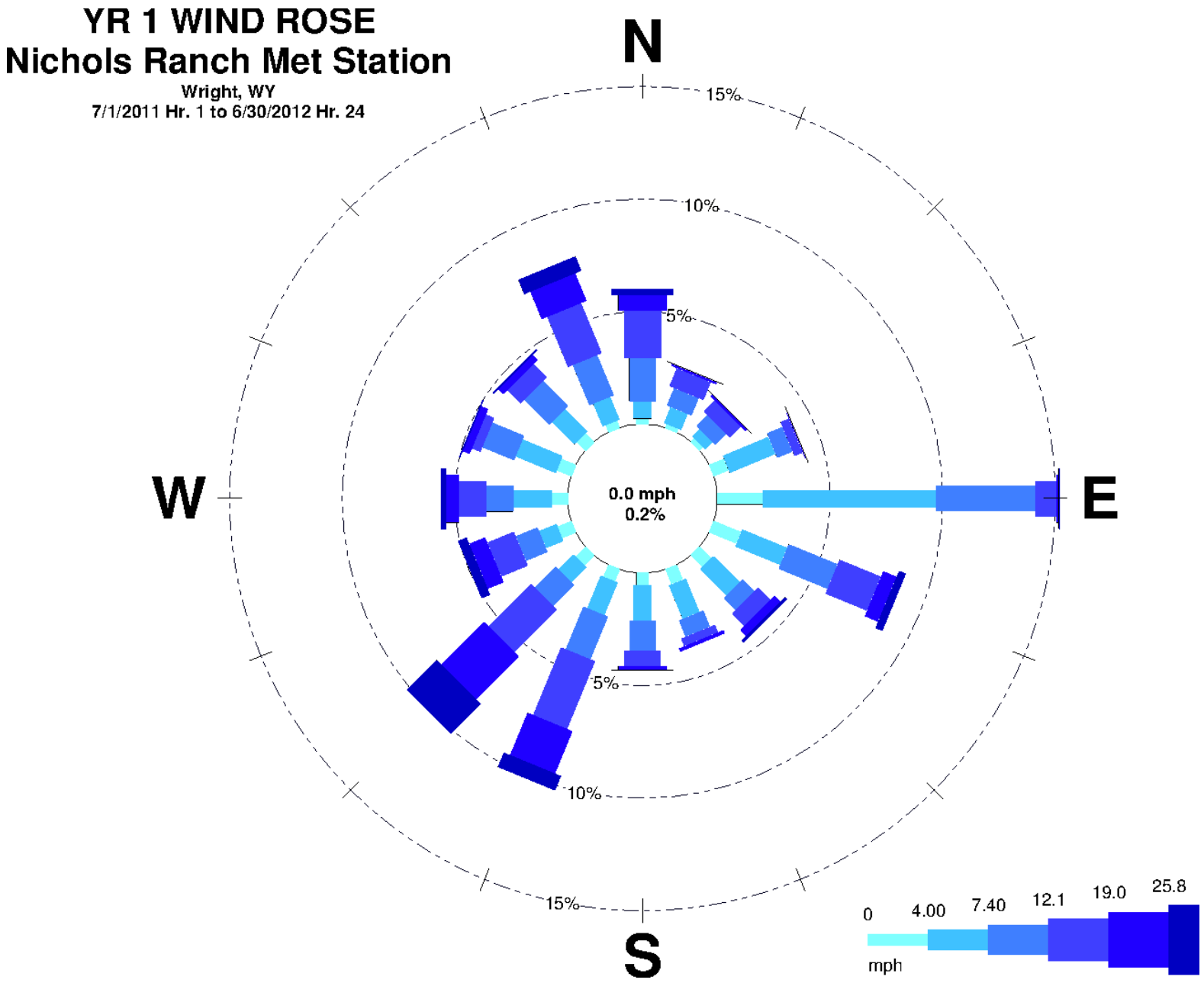


**Figure 3. Nichols Ranch Year 2 Wind Rose**

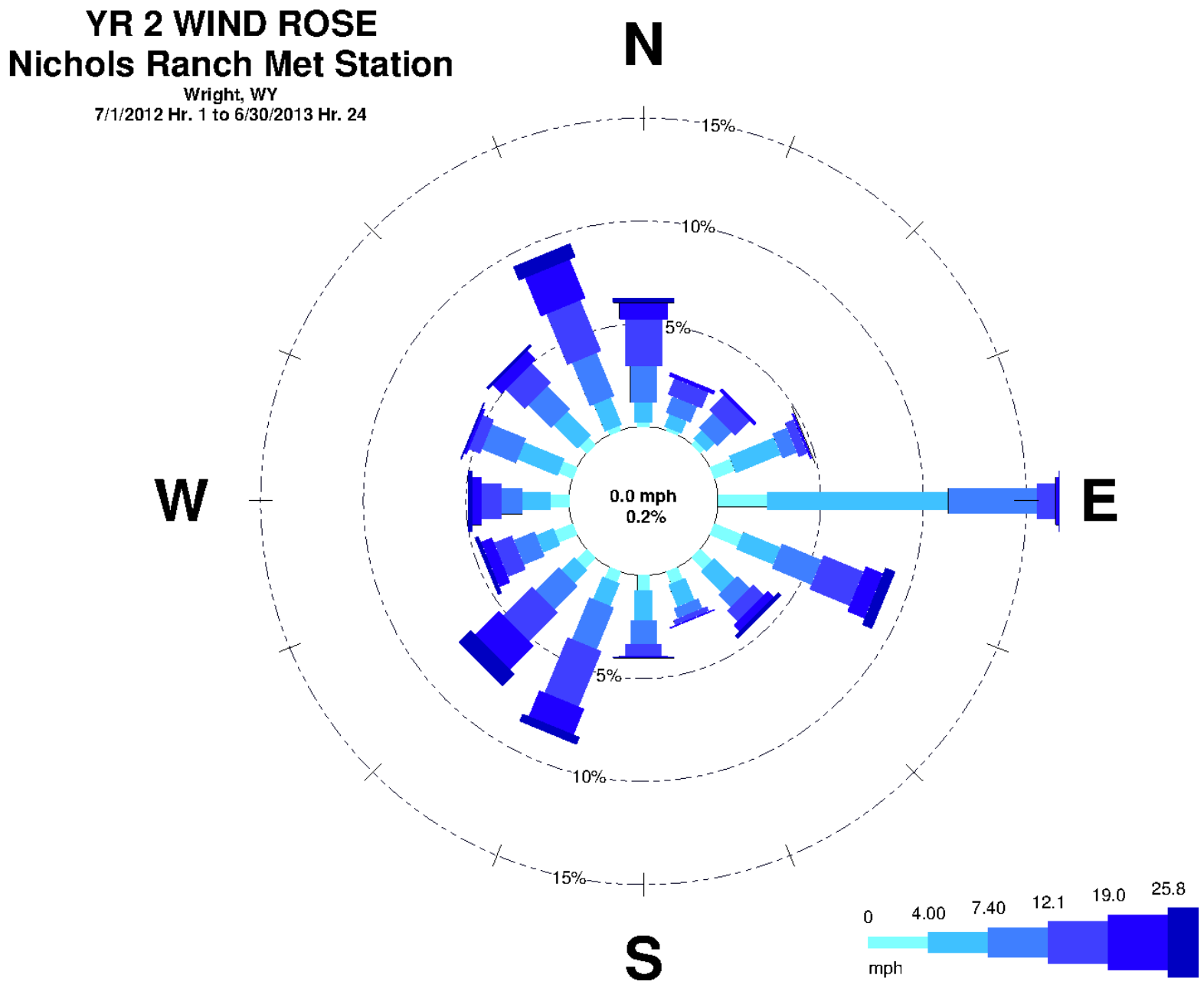


**Figure 4. Nichols Ranch Year 3 Wind Rose**

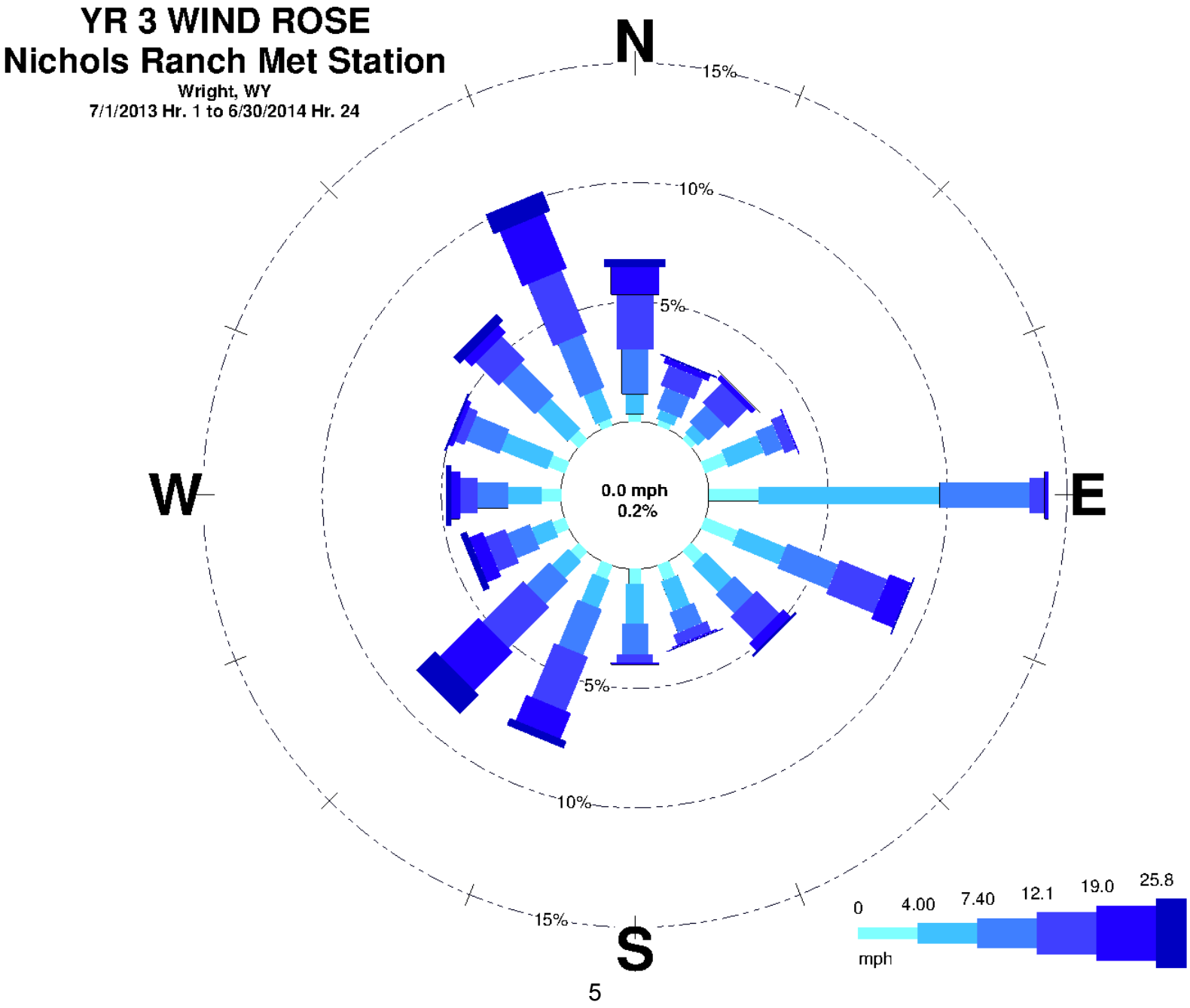


**Figure 5. Nichols Ranch Year 4 Wind Rose**

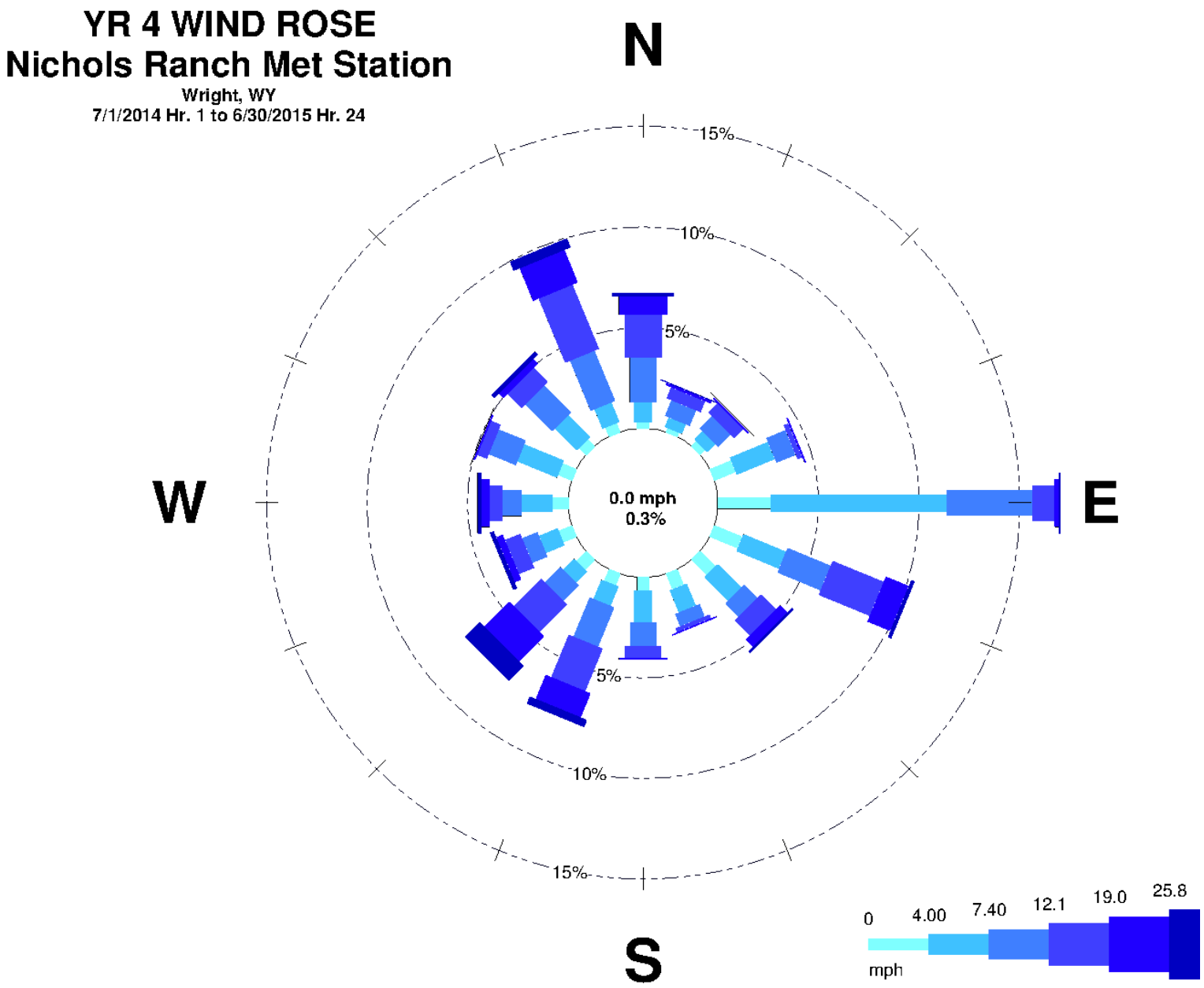
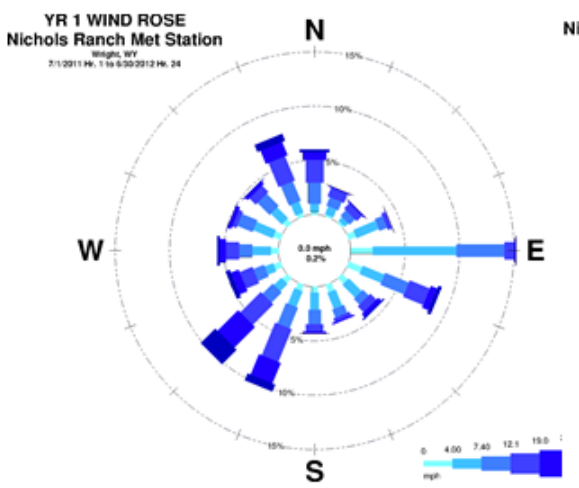
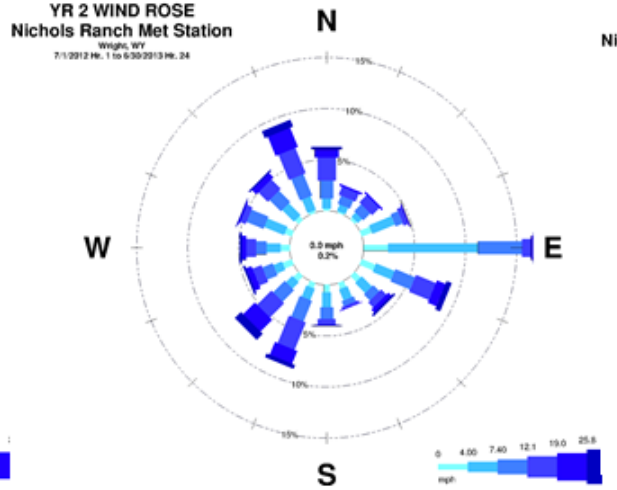


**Figure 6. Nichols Ranch Year-to-Year Wind Roses**

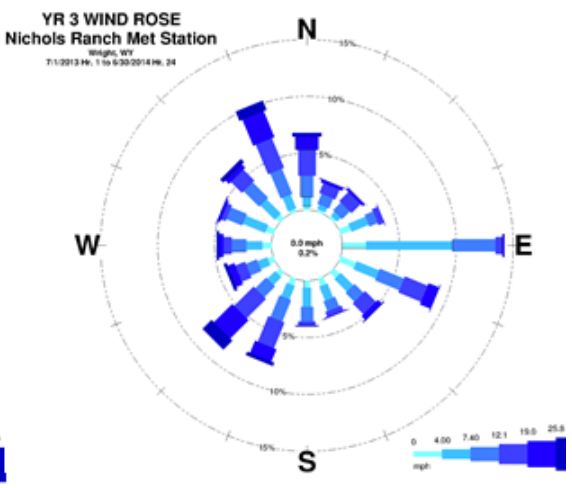
7/1/11 – 6/30/12



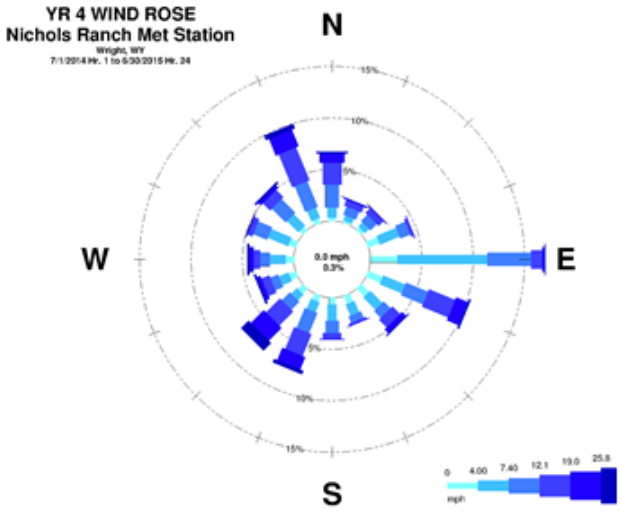

7/1/12 – 6/30/13




7/1/13 – 6/30/14




7/1/14 – 6/30/15




7/1/15 – 6/30/16

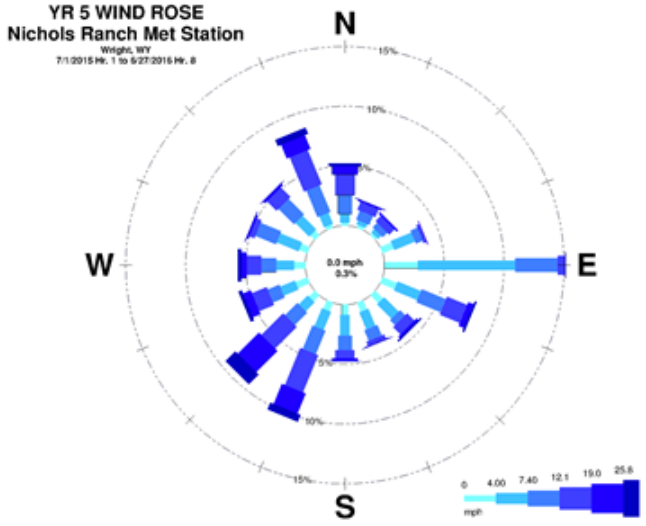


**Table 1. Nichols Ranch Yearly Wind Data Recovery**

| Year | Dates | Wind Speed | Wind Direction | Sigma Theta | Temperature |
|---|---|---|---|---|---|
| Baseline | 7/1/11 – 6/30/12 | 100.00 % | 100.00 % | 100.00% | 98.43% |
| 2 | 7/1/12 – 6/30/13 | 99.98% | 99.98% | 99.98% | 99.98% |
| 3 | 7/1/13 – 6/30/14 | 99.99% | 99.99% | 99.99% | 99.99% |
| 4 | 7/1/14 – 6/30/15 | 96.00% | 96.00% | 96.00% | 96.14% |
| 5 | 7/1/15 – 6/30/16 | 98.99% | 98.99% | 98.99% | 98.98% |
| PTD | 7/1/11 – 6/30/16 | 99.12% | 99.12% | 99.12% | 98.70% |

**Table 2. Nichols Ranch PTD Meteorological Summary**

# Nichols Ranch

## Meteorological Data Summary

6/28/2011 - 6/27/2016

### Hourly Data

| | Average/Total | Max | Min |
|---|---|---|---|
| Wind Speed (mph) | 10.7 | 51.3 | 0.3 |
| Sigma-Theta (°) | 15.9 | 82.7 | 1.3 |
| Temperature (C) | 8.7 | 38.2 | -32.5 |

Predominant wind direction was from the E sector, accounting for 15.6% of the possible winds

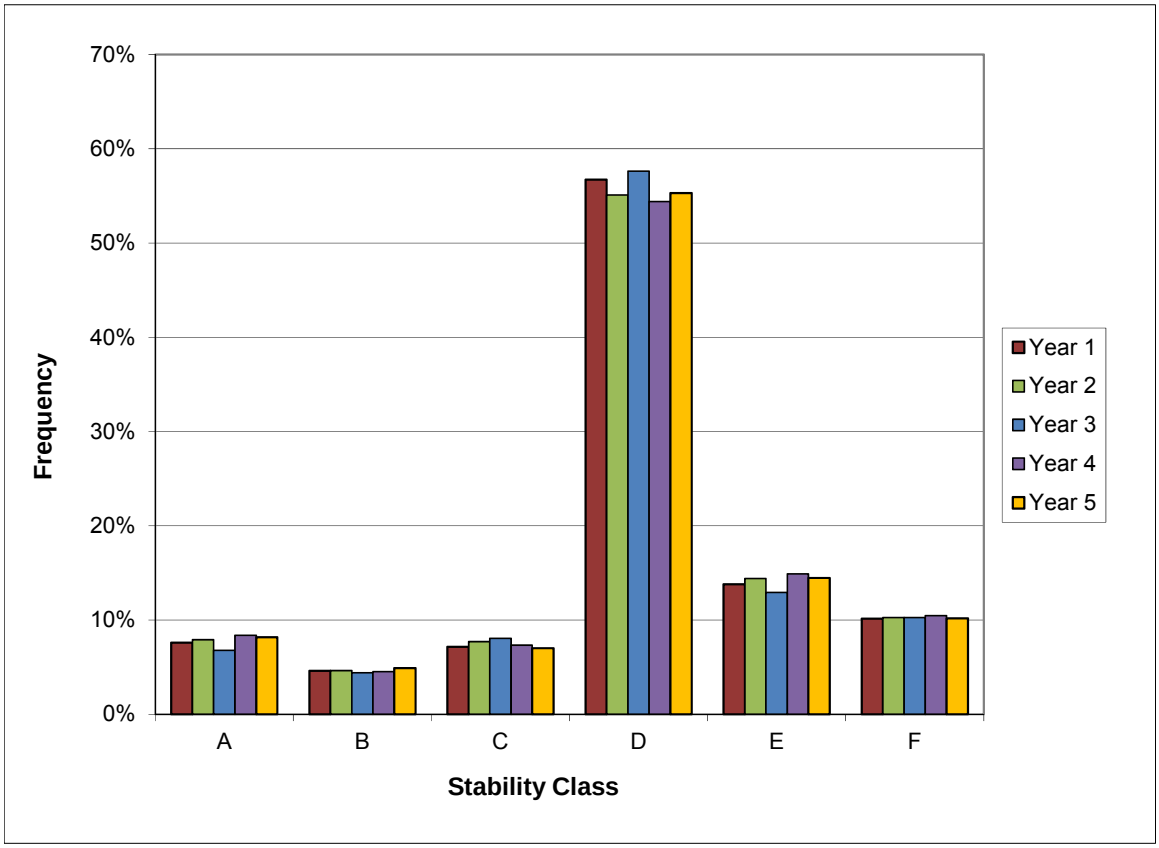
### Data Recovery

| Parameter | Possible (hours) | Reported (hours) | Recovery |
|---|---|---|---|
| Wind Speed | 43848 | 43463 | 99.12% |
| Wind Direction | 43848 | 43463 | 99.12% |
| Sigma-Theta | 43848 | 43463 | 99.12% |
| Temperature | 43848 | 43279 | 98.70% |

## Atmospheric Stability Results

Figure 7 compares the atmospheric stability class distributions for the five monitoring years at Nichols Ranch, demonstrating pronounced similarities from year to year. Between 55% and 58% of the winds at the project site consistently fall into stability class D, which represents near neutral to slightly unstable conditions. The light-to-calm winds which accompany stable environments, corresponding to stability class F, are also quite consistent for the five periods.

**Figure 7. Nichols Ranch Atmospheric Stability Class Distribution by Year**




The $\sigma_\theta$ method was used to determine the Pasquill-Gifford stability class, where $\sigma_\theta$ refers to the standard deviation of the horizontal wind azimuth angle in degrees. This method is also referred to as the $\sigma_A$ method in EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications (February 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 $\sigma_\theta$ is defined using

15-minute $\sigma_\theta$ 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 $\sigma_\theta$. 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.

Tables 3 and 4 present the most recent 12-month joint frequency distribution (JFD) at Nichols Ranch. Stability classes A, B, and C appear in Table 3, while stability classes D, E, and F appear in Table 4. Tables 5 and 6 present the project-to-date JFD. Stability classes A, B, and C appear in Table 5, while stability classes D, E, and F appear in Table 6. The JFD partitions hourly wind speed and direction by stability class, wind direction sector, and wind speed category. It is the basis for meteorological input to the MILDOS dispersion model.

**Table 3. Nichols Ranch Year 5 JFD, Classes A-C**

| Stability Class | Wind Direction | Wind Speed (mph) - Monitoring Year 5 | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 3 | 4 - 7 | 8 - 12 | 13 - 18 | 19 - 24 | > 24 |
| A | N | 0.000823 | 0.002185 | | | | |
| | NNE | 0.000941 | 0.000345 | | | | |
| | NE | 0.000353 | 0.000690 | | | | |
| | ENE | 0.001294 | 0.000690 | | | | |
| | E | 0.003176 | 0.001150 | | | | |
| | ESE | 0.003411 | 0.003565 | | | | |
| | SE | 0.002470 | 0.003680 | | | | |
| | SSE | 0.002235 | 0.003565 | | | | |
| | S | 0.002941 | 0.004255 | | | | |
| | SSW | 0.002823 | 0.004715 | | | | |
| | SW | 0.002941 | 0.003910 | | | | |
| | WSW | 0.003529 | 0.004140 | | | | |
| | W | 0.002235 | 0.004600 | | | | |
| | WNW | 0.002941 | 0.003680 | | | | |
| | NW | 0.001176 | 0.003105 | | | | |
| | NNW | 0.001765 | 0.002300 | | | | |
| B | N | 0.000118 | 0.002530 | 0.000115 | | | |
| | NNE | | 0.000690 | | | | |
| | NE | | 0.000345 | 0.000115 | | | |
| | ENE | 0.000471 | 0.000805 | | | | |
| | E | 0.000471 | 0.000920 | 0.000115 | | | |
| | ESE | 0.000588 | 0.001265 | 0.000115 | | | |
| | SE | 0.000118 | 0.002530 | 0.000115 | | | |
| | SSE | 0.000471 | 0.002760 | 0.000230 | | | |
| | S | 0.000471 | 0.003220 | | | | |
| | SSW | 0.000235 | 0.003105 | 0.000115 | | | |
| | SW | 0.000235 | 0.003910 | 0.000230 | | | |
| | WSW | 0.000588 | 0.004025 | 0.000460 | | | |
| | W | 0.000471 | 0.002530 | 0.000345 | | | |
| | WNW | 0.000353 | 0.006325 | 0.000460 | | | |
| | NW | 0.000353 | 0.003105 | | | | |
| | NNW | 0.000118 | 0.002760 | 0.000575 | | | |
| C | N | | 0.000115 | 0.002415 | | | |
| | NNE | | 0.000575 | 0.001380 | | | |
| | NE | 0.000235 | 0.000230 | 0.000920 | | | |
| | ENE | 0.000235 | 0.000575 | 0.000345 | | | |
| | E | 0.002117 | 0.001265 | 0.000690 | | | |
| | ESE | 0.000471 | 0.000690 | 0.001840 | | | |
| | SE | 0.000118 | 0.001150 | 0.000920 | | | |
| | SSE | 0.000118 | 0.000690 | 0.002530 | | | |
| | S | | 0.001035 | 0.003335 | | | |
| | SSW | 0.000118 | 0.001035 | 0.005290 | | | |
| | SW | 0.000471 | 0.001380 | 0.005405 | | | |
| | WSW | 0.000471 | 0.001955 | 0.004025 | | | |
| | W | 0.000706 | 0.002070 | 0.006325 | | | |
| | WNW | 0.000353 | 0.001610 | 0.003680 | | | |
| | NW | 0.000118 | 0.002070 | 0.003680 | | | |
| | NNW | 0.000118 | 0.000690 | 0.004600 | | | |

**Table 4. Nichols Ranch Year 5 JFD, Classes D-F**

| Stability Class | Wind Direction | Wind Speed (mph) - Monitoring Year 5 | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 3 | 4 - 7 | 8 - 12 | 13 - 18 | 19 - 24 | > 24 |
| D | N | 0.000118 | 0.004025 | 0.015526 | 0.013801 | 0.004600 | 0.001380 |
| | NNE | 0.000118 | 0.001380 | 0.006095 | 0.004600 | 0.000920 | 0.000230 |
| | NE | 0.000118 | 0.001495 | 0.004485 | 0.004255 | 0.000460 | |
| | ENE | 0.002588 | 0.008281 | 0.004025 | 0.001610 | 0.000230 | |
| | E | 0.008234 | 0.043473 | 0.010006 | 0.002760 | 0.000230 | |
| | ESE | 0.000471 | 0.008051 | 0.017596 | 0.012766 | 0.003105 | 0.000920 |
| | SE | 0.000235 | 0.002645 | 0.005750 | 0.006440 | 0.001150 | 0.000575 |
| | SSE | 0.000235 | 0.003795 | 0.004485 | 0.001610 | 0.000575 | 0.000230 |
| | S | 0.000118 | 0.004715 | 0.007246 | 0.004370 | 0.001610 | |
| | SSW | 0.000235 | 0.007131 | 0.022197 | 0.028522 | 0.013456 | 0.003450 |
| | SW | | 0.002875 | 0.012076 | 0.029097 | 0.017366 | 0.008396 |
| | WSW | 0.000588 | 0.002990 | 0.006210 | 0.011961 | 0.004830 | 0.002070 |
| | W | 0.001412 | 0.005750 | 0.005865 | 0.009201 | 0.004255 | 0.001840 |
| | WNW | 0.000471 | 0.009661 | 0.006901 | 0.002760 | 0.001035 | 0.000345 |
| | NW | 0.000941 | 0.008396 | 0.011616 | 0.007706 | 0.000690 | 0.000230 |
| | NNW | | 0.006440 | 0.021967 | 0.026107 | 0.009316 | 0.003105 |
| E | N | 0.000118 | 0.001725 | 0.000805 | | | |
| | NNE | | 0.001725 | 0.001610 | | | |
| | NE | | 0.001495 | 0.001380 | | | |
| | ENE | 0.002000 | 0.009201 | 0.000575 | | | |
| | E | 0.005999 | 0.050259 | 0.008856 | | | |
| | ESE | 0.001647 | 0.006325 | 0.005520 | | | |
| | SE | 0.000471 | 0.002645 | 0.000805 | | | |
| | SSE | 0.000823 | 0.003335 | 0.000345 | | | |
| | S | 0.000235 | 0.004255 | 0.000345 | | | |
| | SSW | 0.000588 | 0.002530 | 0.000690 | | | |
| | SW | 0.000706 | 0.001150 | 0.000115 | | | |
| | WSW | 0.001529 | 0.002760 | 0.000460 | | | |
| | W | 0.000941 | 0.002530 | 0.000690 | | | |
| | WNW | 0.000588 | 0.004945 | 0.001265 | | | |
| | NW | 0.000823 | 0.003565 | 0.001725 | | | |
| | NNW | 0.000118 | 0.002760 | 0.001610 | | | |
| F | N | 0.001529 | 0.000460 | | | | |
| | NNE | 0.001412 | 0.000690 | | | | |
| | NE | 0.001765 | 0.000920 | | | | |
| | ENE | 0.003882 | 0.001495 | | | | |
| | E | 0.009058 | 0.003220 | | | | |
| | ESE | 0.006587 | 0.005520 | | | | |
| | SE | 0.006117 | 0.005980 | | | | |
| | SSE | 0.004588 | 0.005405 | | | | |
| | S | 0.005176 | 0.004830 | | | | |
| | SSW | 0.003764 | 0.003220 | | | | |
| | SW | 0.002588 | 0.001610 | | | | |
| | WSW | 0.004117 | 0.001150 | | | | |
| | W | 0.004235 | 0.001150 | | | | |
| | WNW | 0.002706 | 0.002070 | | | | |
| | NW | 0.002117 | 0.002070 | | | | |
| | NNW | 0.001294 | 0.000805 | | | | |

**Table 5. Nichols Ranch PTD JFD, Classes A-C**

| Stability Class | Wind Direction | Wind Speed (mph) - Project-to-Date | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 3 | 4 - 7 | 8 - 12 | 13 - 18 | 19 - 24 | > 24 |
| A | N | 0.000704 | 0.002373 | | | | |
| | NNE | 0.000798 | 0.001590 | | | | |
| | NE | 0.000822 | 0.001405 | | | | |
| | ENE | 0.001503 | 0.001267 | | | | |
| | E | 0.002278 | 0.001659 | | | | |
| | ESE | 0.003076 | 0.002488 | | | | |
| | SE | 0.002254 | 0.003041 | | | | |
| | SSE | 0.002372 | 0.003064 | | | | |
| | S | 0.002442 | 0.004193 | | | | |
| | SSW | 0.002231 | 0.003548 | | | | |
| | SW | 0.002818 | 0.003271 | | | | |
| | WSW | 0.002512 | 0.003294 | | | | |
| | W | 0.002137 | 0.004700 | | | | |
| | WNW | 0.002019 | 0.004792 | | | | |
| | NW | 0.001385 | 0.003594 | | | | |
| | NNW | 0.001221 | 0.002672 | | | | |
| B | N | 0.000047 | 0.002534 | 0.000276 | | | |
| | NNE | | 0.001198 | 0.000161 | | | |
| | NE | 0.000070 | 0.000530 | 0.000092 | | | |
| | ENE | 0.000258 | 0.001014 | 0.000046 | | | |
| | E | 0.000822 | 0.001083 | 0.000069 | | | |
| | ESE | 0.000751 | 0.002073 | 0.000092 | | | |
| | SE | 0.000258 | 0.002742 | 0.000138 | | | |
| | SSE | 0.000164 | 0.002649 | 0.000253 | | | |
| | S | 0.000164 | 0.003064 | 0.000184 | | | |
| | SSW | 0.000235 | 0.002972 | 0.000184 | | | |
| | SW | 0.000188 | 0.002672 | 0.000299 | | | |
| | WSW | 0.000399 | 0.003064 | 0.000253 | | | |
| | W | 0.000423 | 0.002926 | 0.000207 | | | |
| | WNW | 0.000399 | 0.004239 | 0.000299 | | | |
| | NW | 0.000164 | 0.002926 | 0.000299 | | | |
| | NNW | 0.000094 | 0.002695 | 0.000392 | | | |
| C | N | 0.000023 | 0.000622 | 0.005115 | | | |
| | NNE | | 0.000346 | 0.002004 | | | |
| | NE | 0.000047 | 0.000369 | 0.001682 | | | |
| | ENE | 0.000235 | 0.000461 | 0.000806 | | | |
| | E | 0.001315 | 0.001544 | 0.000875 | | | |
| | ESE | 0.000423 | 0.001497 | 0.002511 | | | |
| | SE | 0.000070 | 0.001083 | 0.002626 | | | |
| | SSE | 0.000047 | 0.000852 | 0.002327 | | | |
| | S | 0.000047 | 0.001060 | 0.002949 | | | |
| | SSW | 0.000070 | 0.001083 | 0.005368 | | | |
| | SW | 0.000188 | 0.001198 | 0.004631 | | | |
| | WSW | 0.000258 | 0.001313 | 0.003893 | | | |
| | W | 0.000376 | 0.001705 | 0.004884 | | | |
| | WNW | 0.000141 | 0.002396 | 0.003824 | | | |
| | NW | 0.000070 | 0.001590 | 0.004147 | | | |
| | NNW | 0.000047 | 0.001083 | 0.005322 | | | |

**Table 6. Nichols Ranch PTD JFD, Classes D-F**

| Stability Class | Wind Direction | Wind Speed (mph) - Project-to-Date | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 3 | 4 - 7 | 8 - 12 | 13 - 18 | 19 - 24 | > 24 |
| D | N | 0.000282 | 0.004562 | 0.016611 | 0.016887 | 0.005138 | 0.001428 |
| | NNE | 0.000094 | 0.002096 | 0.006497 | 0.005299 | 0.000806 | 0.000184 |
| | NE | 0.000094 | 0.002189 | 0.006382 | 0.005621 | 0.000553 | 0.000023 |
| | ENE | 0.002066 | 0.009584 | 0.004608 | 0.002419 | 0.000253 | |
| | E | 0.006762 | 0.043197 | 0.011865 | 0.004585 | 0.000760 | 0.000069 |
| | ESE | 0.000798 | 0.009123 | 0.017532 | 0.017048 | 0.005322 | 0.001428 |
| | SE | 0.000188 | 0.003156 | 0.005921 | 0.007902 | 0.002580 | 0.000622 |
| | SSE | 0.000117 | 0.002649 | 0.003709 | 0.001705 | 0.000461 | 0.000092 |
| | S | 0.000047 | 0.004285 | 0.007165 | 0.003571 | 0.000714 | 0.000046 |
| | SSW | 0.000141 | 0.006474 | 0.019652 | 0.025135 | 0.010275 | 0.003087 |
| | SW | 0.000164 | 0.002903 | 0.012325 | 0.024029 | 0.017256 | 0.007994 |
| | WSW | 0.000446 | 0.002511 | 0.005875 | 0.009930 | 0.003940 | 0.001935 |
| | W | 0.000939 | 0.005045 | 0.005667 | 0.007994 | 0.003456 | 0.001567 |
| | WNW | 0.000704 | 0.009100 | 0.006819 | 0.003202 | 0.001221 | 0.000207 |
| | NW | 0.000470 | 0.007856 | 0.011289 | 0.007695 | 0.002488 | 0.001221 |
| | NNW | 0.000164 | 0.007050 | 0.020251 | 0.026148 | 0.012924 | 0.003893 |
| E | N | 0.000235 | 0.001912 | 0.000829 | | | |
| | NNE | 0.000141 | 0.001152 | 0.001313 | | | |
| | NE | 0.000141 | 0.001359 | 0.001613 | | | |
| | ENE | 0.002254 | 0.008801 | 0.001083 | | | |
| | E | 0.004696 | 0.050454 | 0.010966 | | | |
| | ESE | 0.001550 | 0.006704 | 0.005207 | | | |
| | SE | 0.000610 | 0.002719 | 0.000461 | | | |
| | SSE | 0.000517 | 0.002788 | 0.000184 | | | |
| | S | 0.000423 | 0.003548 | 0.000276 | | | |
| | SSW | 0.000423 | 0.002189 | 0.000530 | | | |
| | SW | 0.000446 | 0.001175 | 0.000253 | | | |
| | WSW | 0.001080 | 0.001497 | 0.000507 | | | |
| | W | 0.000986 | 0.002212 | 0.000622 | | | |
| | WNW | 0.001033 | 0.004331 | 0.001244 | | | |
| | NW | 0.000775 | 0.003479 | 0.001428 | | | |
| | NNW | 0.000423 | 0.002603 | 0.001682 | | | |
| F | N | 0.001620 | 0.000968 | | | | |
| | NNE | 0.001198 | 0.001037 | | | | |
| | NE | 0.001714 | 0.000875 | | | | |
| | ENE | 0.003804 | 0.002073 | | | | |
| | E | 0.008923 | 0.004907 | | | | |
| | ESE | 0.007819 | 0.005022 | | | | |
| | SE | 0.005354 | 0.005667 | | | | |
| | SSE | 0.004344 | 0.004769 | | | | |
| | S | 0.003968 | 0.004631 | | | | |
| | SSW | 0.003264 | 0.002580 | | | | |
| | SW | 0.002724 | 0.001636 | | | | |
| | WSW | 0.003546 | 0.001336 | | | | |
| | W | 0.003780 | 0.001981 | | | | |
| | WNW | 0.003381 | 0.001958 | | | | |
| | NW | 0.002465 | 0.002027 | | | | |
| | NNW | 0.001691 | 0.001428 | | | | |

## Representativeness of On-Site Baseline Year Monitoring

The accumulation of five years of on-site, hourly wind data enables a comparison between the baseline monitoring year and the subsequent four-year period. The purpose of this comparison is to demonstrate that the baseline wind data used for air quality monitoring and dispersion modeling are typical of the longer term. While five years do not constitute a formal long-term demonstration (which Regulatory Guide 3.63 recommends be made at an off-site location), the following discussion suggests a trend of only slight variations from year to year.

Figure 8 compares wind speed frequency distributions between the baseline year and the subsequent four years of monitoring. The hourly data for each distribution fall into one of 7 wind speed categories ranging from calm to greater than 24 mph (see Tables 3 through 6). Figure 9 illustrates the linear association between the baseline and 4-year wind speed frequencies graphed in Figure 8. In keeping with convention, the less certain variable (short-term frequency) is assigned to the vertical (dependent) axis and the better-supported, longer-term frequency is assigned to the horizontal (independent) axis. The graph illustrates the degree to which the baseline-year frequencies match the 4-year frequencies. The $R^2$ value of 0.99 confirms a very strong linear relationship, and the slope of 0.99 indicates substantial equivalence between short and long-term wind speed frequencies at Nichols Ranch. A p-value of zero establishes a near-100% confidence level that this relationship is statistically significant.

Figure 10 compares wind direction frequency distributions between the baseline year and the subsequent four years of monitoring. The hourly data for each distribution fall into one of 17 wind direction categories, including calm winds and 16 cardinal wind direction sectors (see Tables 3 through 6). Figure 11 illustrates the linear association between the baseline and longer-term wind direction frequencies as graphed in Figure 10, with the same choice of dependent and independent variables as for the wind speed frequency comparison. The graph illustrates the degree to which the baseline-year frequencies match the 4-year frequencies. The $R^2$ value of 0.94 confirms a strong linear relationship, and the slope of 0.99 indicates substantial equivalence between short and longer-term frequencies at Nichols Ranch. A p-value of zero leaves little doubt that this relationship is statistically significant.

The MILDOS model accepts meteorological inputs in the form of joint wind speed, wind direction and stability class frequency distributions, also known as STAR distributions. An important subset of the STAR distribution is the two-way wind classification, which categorizes hourly wind data by both speed and direction. Joint wind speed and direction distributions are amenable to linear regression or correlation. Analyzing these two-way distributions can strengthen the case for longer-term representativeness of baseline wind data. The joint analysis offers a more rigorous comparison than individual speed and direction analyses. This comparison also offers the best quantitative measure of the similarity between the associated wind roses (see Figure 6).

Figure 12 shows the linear relationship between baseline-year and subsequent 4-year joint frequencies at Nichols Ranch. The hourly data for each distribution fall into one of 97 categories. The graph illustrates the degree to which the baseline-year joint frequencies match the 4-year frequencies. The $R^2$ value of 0.95 confirms a strong linear relationship, and the slope of 0.98 indicates substantial equivalence between short and long-term frequencies. A p-value of zero leaves little doubt that this relationship is statistically significant.

Linear regression also isolates the sources of variation among category frequencies. When multiplied by 100, $R^2$ signifies the percent of the variation from a mean frequency that is common to both the baseline-year and the 4-year distributions. In Figure 12, for example, 95% of the baseline-year variation can be predicted based on measured 4-year frequencies, while only 5% is attributed to random, year-to-year fluctuations and/or measurement error.

In conclusion, the comparative wind roses, frequency distribution graphs, and regression analyses offer no evidence that monitored wind data from the baseline year do not represent longer-term wind patterns at Nichols Ranch.

**Figure 8. Nichols Ranch Wind Speed Comparison**

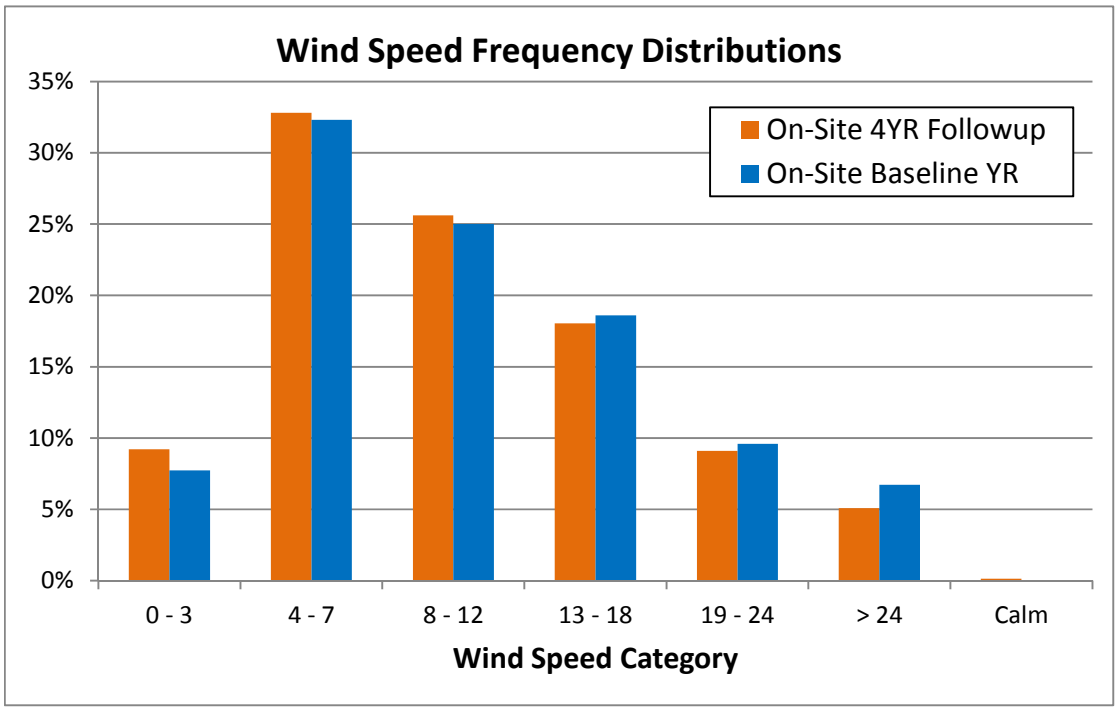



**Figure 9. Nichols Ranch Wind Speed Correlation**

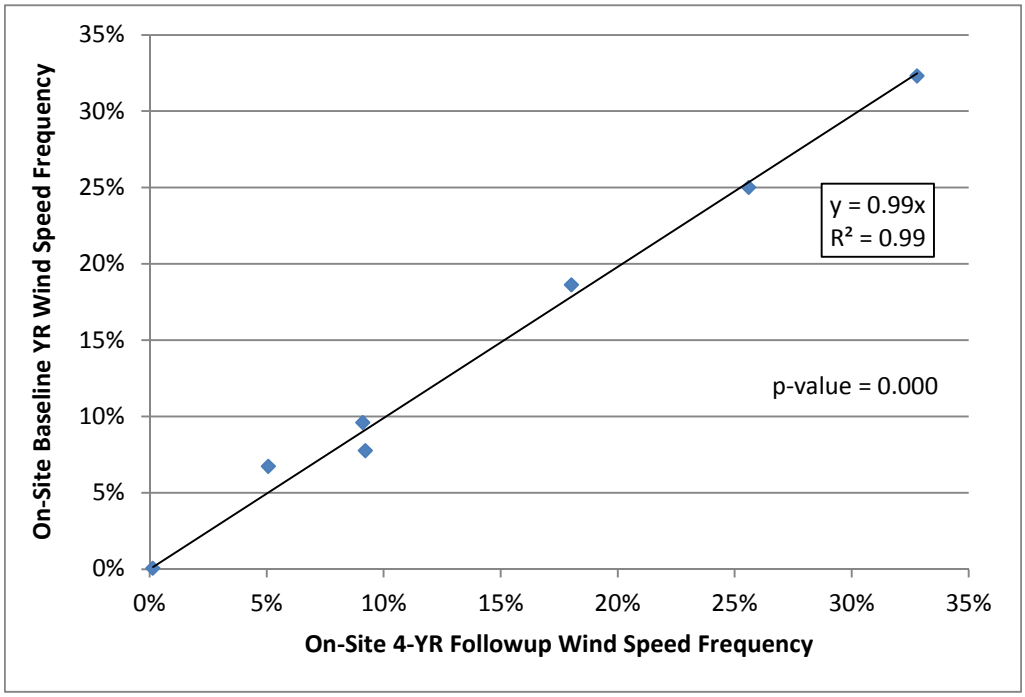


**Figure 10. Nichols Ranch Wind Direction Comparison**

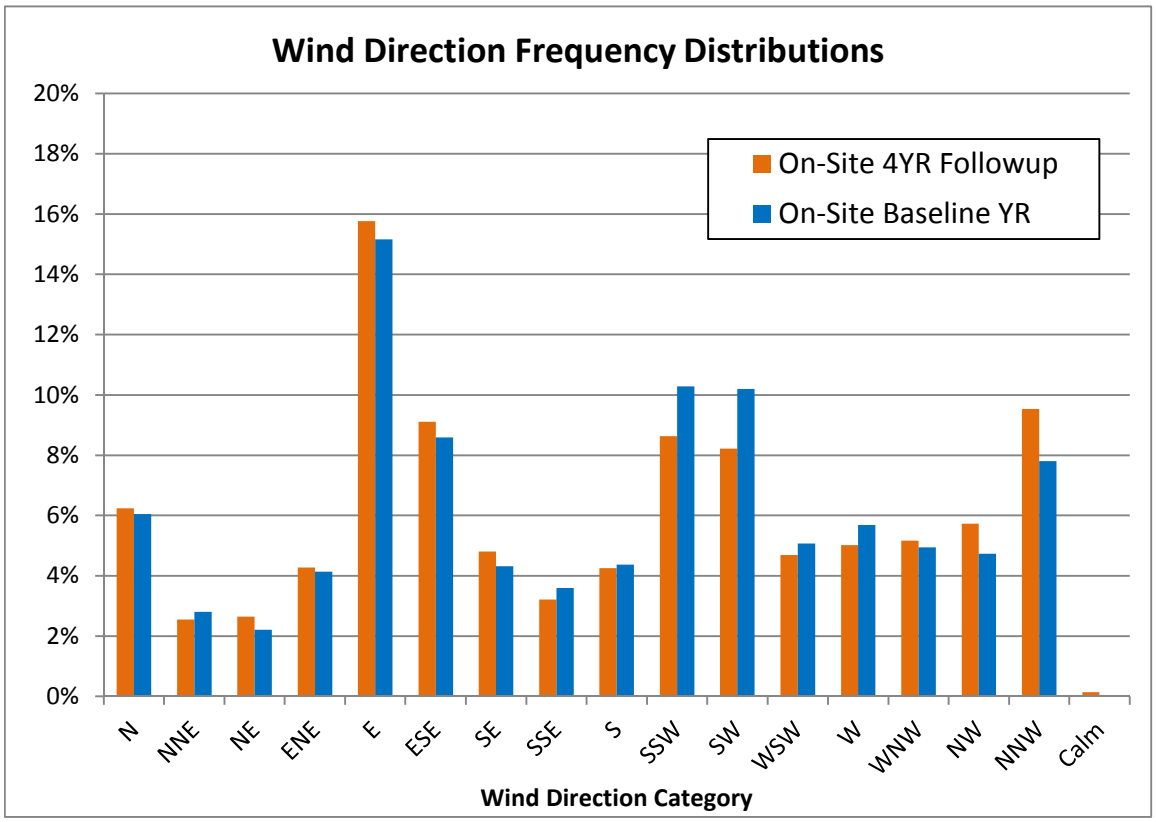



**Figure 11. Nichols Ranch Wind Direction Correlation**

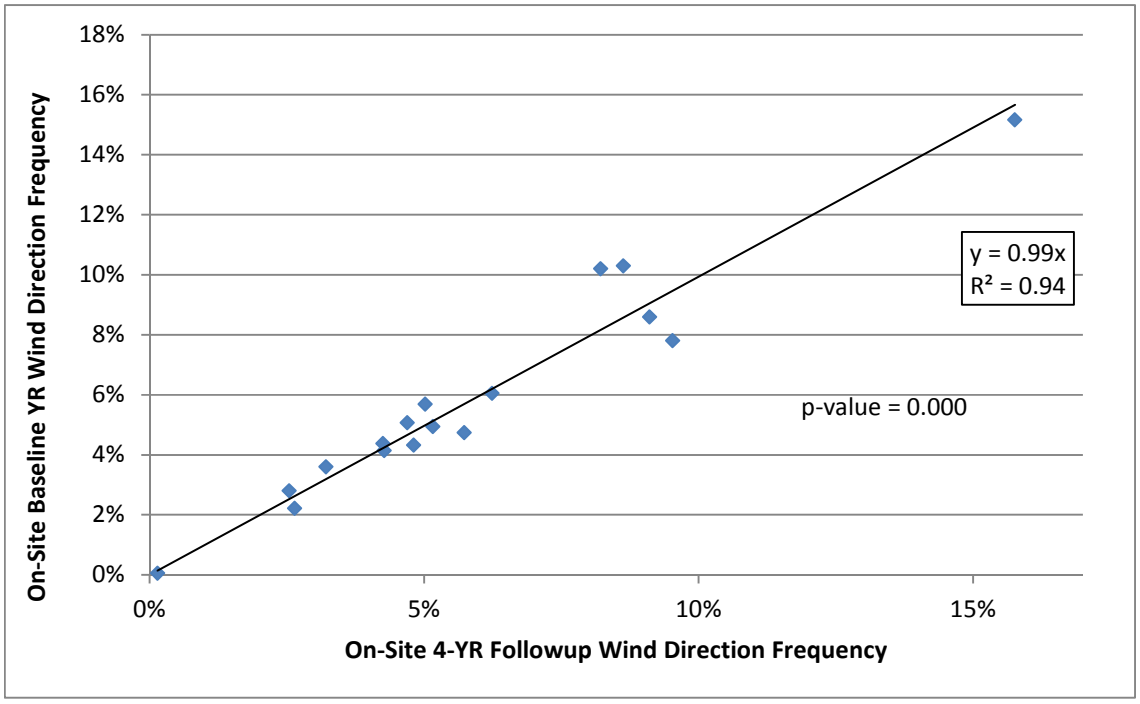


**Figure 12. Nichols Ranch Joint Wind Speed and Direction Correlation**