# Acoustical Analysis of the Horse Creek Wind Project

TO: Horse Creek Project Team

FROM: Mark Bastasch/CH2M HILL

DATE: January 27, 2011

## Summary

This memorandum presents the predicted sound levels from the proposed Horse Creek Wind Power Facility (the Facility). Atlantic Wind, LLC proposes to construct an approximately 100 megawatts (MW) wind-generation facility near Clayton, New York utilizing the Gamesa G90 wind turbines. The facilities steady state noise levels are predicted to comply with the Town of Clayton's Wind Energy Facilities Ordinance limit of 50 dBA at all residences, both participating and non-participating. While this analysis is based on the Gamesa G90 wind turbine, the Applicant may consider additional turbine models. In the event a different turbine model is selected, the Applicant intends to ensure it does not exceed the sound levels presented herein and will conduct additional modeling prior to construction.

## Fundamentals of Acoustics

It is useful to understand how noise is defined and measured. Noise is defined as unwanted sound. Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. There are several ways to measure noise, depending on the source of the noise, the receiver, and the reason for the noise measurement. Table 1 summarizes the technical noise terms used in this memorandum.

TABLE 1
Definitions of Acoustical Terms

| Term | Definitions |
|---|---|
| Ambient noise level | The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location. |
| Decibel (dB) | A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the measured pressure to the reference pressure, which is 20 micropascals. |
| A-weighted sound pressure level (dBA) | The sound pressure level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighted filter provides measurements in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise by de-emphasizing the very low and very high frequency components of the sound. All sound levels in this report are A-weighted. |

TABLE 1
Definitions of Acoustical Terms

| Term | Definitions |
|---|---|
| Equivalent Sound Level ($L_{eq}$) | The $L_{eq}$ integrates fluctuating sound levels over a period of time to express them as a steady-state sound level. As an example, if two sounds are measured and one sound has twice the energy but lasts half as long, the two sounds would be characterized as having the same equivalent sound level. Equivalent Sound Level is considered to be related directly to the effects of sound on people since it expresses the equivalent magnitude of the sound as a function of frequency of occurrence and time. |
| Day–Night Level ($L_{dn}$ or DNL) | The Day-Night level ($L_{dn}$ or DNL) is a 24-hour average $L_{eq}$ where 10 dBA is added to nighttime levels between 10 p.m. and 7 a.m. For a continuous source that emits the same noise level over a 24-hour period, the $L_{dn}$ will be 6.4 dB greater than the $L_{eq}$. |
| Statistical noise level ($L_n$) | The noise level exceeded during n percent of the measurement period, where n is a number between 0 and 100 (for example, $L_{50}$ is the level exceeded 50 percent of the time) |

Sound levels typically are measured or presented as equivalent sound pressure level ($L_{eq}$), which is defined as the average noise level, on an equal energy basis for a stated period of time, and is commonly used to measure steady-state sound or sound that is usually dominant. Statistical methods are used to capture the dynamics of a changing acoustical environment. Statistical measurements are typically denoted by $L_{xx}$, where xx represents the percentile of time the sound level is exceeded. The $L_{90}$ is a measurement that represents the noise level that is exceeded during 90 percent of the measurement period. Similarly, the $L_{10}$ represents the noise level exceeded for 10 percent of the measurement period.

It is critical to understand the difference between a sound pressure level (or noise level) and a sound power level. A sound power level (commonly abbreviated as PWL or Lw) is analogous to the wattage of a light bulb; it is a measure of the acoustical energy emitted by the source and is, therefore, independent of distance. A sound pressure level (commonly abbreviated as SPL or Lp) is analogous to the brightness or intensity of light experienced at a specific distance from a source. Sound pressure levels are similar to intensity of light in that they are attenuated by distance. Sound pressure levels are measured directly with a sound-level meter. Sound pressure levels always should be specified with a location or distance from the noise source.

Sound power level data are used in acoustic models to predict sound pressure levels. This is because sound power levels take into account the size of the acoustical source and account for the total acoustical energy emitted by the source. For example, the sound pressure level 15 feet from a small radio and a large orchestra may be the same, but the sound power level of the orchestra will be much larger because it emits sound over a much larger area. Similarly, a two horsepower (hp) and 2,000-hp pumps can both achieve 85 dBA at three feet (a common specification), but the 2,000-hp pump will have a significantly larger sound power level, so the noise from the 2,000-hp pump will travel farther. A sound power level can be determined from a sound pressure level if the distance from and dimensions of the source are known. Sound power levels will *always* be greater than sound pressure levels, and *sound power levels should never be compared to sound pressure levels*. The maximum sound power level of a wind turbine typically will vary between 104 and 110 dBA. This will result in a sound pressure level of about 65 dBA at 130 feet (similar in level to a normal conversation at 3 feet).

## Existing Environment

All Facility components will be located on private land on which the Applicants have negotiated long-term wind energy leases with the landowners. The majority of the area consists of fields and pastures, with forested areas generally confined to small woodlots and slopes that descend into adjacent valleys. In the area where the Facility will be located, scattered residences exist. Appendix A presents the ambient sound level measurements collected at six representative locations over an approximately two week period when leaves on trees were minimal. Measurement equipment consisted of Larson Davis 824 and 820 Type 1 (precision) sound level meters. All equipment had been factory calibrated within the previous 12 months and field calibrated both before and after the measurement period. Measurements were collected in 10-minute intervals to correspond to meteorological data collection efforts. As expected, locations near more traveled roads were found to have higher levels than those on less traveled roadways. The ambient sound levels also generally increase with increasing wind speed and nighttime levels were generally less than daytime levels.

## Facility Sound Levels

Standard acoustical engineering methods were used in this noise analysis. The sound propagation factors used in this analysis have been adopted from ISO 9613-2, *Acoustics – Sound Attenuation During Propagation Outdoors, Part 2: General Method of Calculation* (ISO, 1993) and VDI 2714, *Outdoor Sound Propagation* (VDI, 1988). Atmospheric absorption for conditions of 10°C and 70 percent relative humidity (conditions that favor propagation) was computed in accordance with ISO 9613-1, *Acoustics – Sound Attenuation During Propagation Outdoors, Part 1: Calculation of the Absorption of Sound by the Atmosphere (ISO, 1993)*.
Each Gamesa G90 wind turbine was considered to have an overall sound power level of 108 dBA. This overall sound power level represents the maximum turbine noise level determined in accordance with IEC61400-11, *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* (IEC, 2006) and includes a +2 dBA adjustment to account for typical vendor warranty or declared sound power levels. The majority of turbines are anticipated to operate at their expected value while a more limited number may operate above or below this expected value. Although it is statistically unlikely that all of the turbines would simultaneously operate above the expected sound power range of 106 dBA, the +2 dBA adjustment (108 dBA) was included in the modeling as a conservative measure for comparing to the Town of Clayton's requirements.

Inherent in the ISO 9613 and IEC61400-11 standards are downwind conditions. That is, the turbine sound power levels and modeling methods are representative of when the wind is blowing from the turbine to the receptor. In fact, the ISO 9613 modeling method unrealistically assumes that the downwind conditions exist in all directions, between each turbine and each receptor simultaneously. While this is physically impossible, it is a typical assumption. Therefore, lower levels are expected in the upwind direction.

The maximum sound power levels used in this analysis are generally realized at wind speeds of 6 m/s (13.4 mph) or greater. The 6 m/s wind speed is referenced to 10-meter (32.8

feet) height which is equivalent to a hub height wind speed of 8.7 m/s (19.5 mph) in accordance with the IEC 61400-11 standard. Lower sound levels would exist under lower wind speeds.

Transformers are expected to have a National Electrical Manufacturers Association (NEMA) sound rating of less than 87 dBA. The transmission line is 115-kilovolt (kV) and audible corona noise is anticipated to be negligible (corona noise is generally a design concern when voltages exceed 345 kV).

The combination of the modeling parameters used and the inclusion of the +2 dBA term are expected to result in a reasonable and conservative assessment of the maximum project levels. When winds are slower than those that correspond to maximum noise emissions, the noise levels will be less.

Figure 1 present the predicted project levels under full power conditions inclusive of the +2 dBA adjustment. No residences are predicted to exceed the Town of Clayton's limit of 50 dBA. It should be noted that lower levels would be anticipated when turbines are operating in a reduced power mode.

## New York State Department of Environmental Conservation Guidance

The New York State Department of Environmental Conservation (NY DEC) published guidance "Assessing and Mitigating Noise Impacts" (NY DEC, 2001) does not provide quantitative noise limits but its key recommendations are briefly summarized below:

- New noise sources should not increase noise level above 65 dBA in non-industrial areas.
- The U.S. Environmental Protection Agency (EPA) found that 55 $L_{dn}$ was sufficient to protect public health and welfare, and in most cases did not create an annoyance. (55 $L_{dn}$ is equal to a continuous level of 49 dBA)
- Sound level increases of more than 6 dB may require a closer analysis of impact potential depending on existing sound levels and the character of surrounding land use and receptors.
- In determining the potential for an adverse noise impact, consider not only ambient noise levels, but also the existing land use, and whether or not an increased noise level or the introduction of a discernable sound that is out of character with existing sounds will be considered annoying or obtrusive.
- Any unavoidable adverse effects must be weighed along with other social and economic considerations in deciding whether to approve or deny a permit.

The NY DEC guidance states that the $L_{eq}$ "provides an indication of the effects of sound on people (and is) useful in establishing the ambient sound levels" and the $L_{90}$ is "often used to designate the background noise level". The guidance also indicates "quiet seemingly serene setting such as rural farm land" will be 45 dBA while wilderness areas will be 35 dBA. As indicated in Appendix A, the winter time ambient levels for the Project area were found to fluctuate from less than 25 to over 50 dBA and nighttime levels were generally less than daytime levels. The fluctuation in existing ambient noise level is a function of many factors including but not limited to weather, wind conditions, presence of other noise sources (such as, road, rail and air traffic, wildlife (birds, insects and domestic dogs).

This report acknowledges that NYS DEC's guideline for additional analysis (a 6 dBA increase over ambient) will be exceeded in some conditions. It is also acknowledged that ambient levels were found to vary over a wide range. As noted above, the NYSDEC guidance suggests that sound levels for wilderness areas will typically be 35 dBA while rural farm land will be 45 dBA. The project area is clearly more rural farmland than wilderness, and consistent with the DEC guidance, we have determined an approximate baseline of 37 dBA as the ambient condition in this assessment. This level falls between NYS DEC's suggested ambient levels for wilderness areas and rural farm land; and also corresponds to the average median $L_{eq}$ for the wind speed corresponding to 8.7 m/s, the wind speed at which the turbine emit their full sound level. Therefore, the area of potential increases exceeding the 6 dBA guideline may at times be approximated by the 45 dBA contour depicted in Figure 1. It is important to note that this is representative of an expected project level of 43 dBA as the contours include a +2 dBA adjustment to the turbine sound power level (this was to clearly document that Project related sound levels are expected to satisfy the town's 50 dBA requirement).

As to the additional analysis suggested in the DEC guidance for areas exceeding the 6dBA threshold, it is noted that the NY DEC's guidance states that "This guidance does not supersede any local noise ordinances or regulations." Accordingly, the project must be operated in a manner which will comply with the noise ordinance limit of 50 dBA at sensitive receptors. The noise ordinance requirement is less than NYS DEC maximum guideline of 65 dBA for non-industrial settings. Moreover, Table E of the NYS DEC guidelines note that sound levels of 30 to 50 dBA at sensitive receptors are considered "very quiet" to "quiet", respectively. It is acknowledged that such qualitative descriptions will vary among individuals and may be influenced by both acoustic and non-acoustic factors.

## Construction Noise Impact Assessment

The U.S. Environmental Protection Agency (EPA) Office of Noise Abatement and Control studied noise from individual pieces of construction equipment, as well as from construction sites for power plants and other types of facilities (see Table 2). Because specific information, about types, quantities, and operating schedules of construction equipment, is not known at this stage, data from the EPA document for industrial projects of similar size have been used. These data are conservative, because the evolution of construction equipment generally has gravitated toward quieter design. Use of these data is reasonable for estimating noise levels, given that they still are used widely by acoustical professionals.

TABLE 2
Average Noise Levels from Common Construction at a Reference Distance of 50 feet (dBA)

| Construction Equipment | Typical Average Noise Level at 50 ft, dBA |
|---|---|
| Air compressor | 81 |
| Backhoe | 85 |
| Concrete mixer | 85 |

TABLE 2
Average Noise Levels from Common Construction at a Reference Distance of 50 feet (dBA)

| Construction Equipment | Typical Average Noise Level at 50 ft, dBA |
|---|---|
| Concrete pump | 82 |
| Crane, mobile | 83 |
| Dozer | 80 |
| Generator | 78 |
| Grader | 85 |
| Loader | 79 |
| Paver | 89 |
| Pile driver | 101 |
| Pneumatic tool | 85 |
| Pump | 76 |
| Rock drill | 98 |
| Saw | 78 |
| Scraper | 88 |
| Shovel | 82 |
| Truck | 91 |

Source: U.S. EPA, 1971.

Table 3 shows the total composite noise level at a reference distance of 50 feet, based on the pieces of equipment operating for each construction phase and the typical usage factor for each piece. The noise level at 1,500 feet also is shown. The calculated level at 1,500 feet is probably conservative, because the only attenuating mechanism considered was geometric spreading, which results in an attenuation rate of 6 dBA per doubling of distance; attenuation related to the presence of structures, trees or vegetation, ground effects, and terrain was not considered.

TABLE 3
Composite Construction Site Noise Levels

| Construction Phase | Composite Equipment Noise Level at 50 feet, dBA | Composite Equipment Noise Level at 1,500 feet, dBA |
|---|---|---|
| Clearing | 88 | 58 |
| Excavation | 90 | 60 |
| Foundation | 89 | 59 |
| Erection | 84 | 54 |
| Finishing | 89 | 59 |

Construction activities are anticipated to occur over 8 to 12- month duration. The following Best Management Practices will be followed to reduce the potential for annoyance from construction-related activities:

- Establish a project telephone number that the public can use to report complaints.

- Ensure equipment is maintained adequately and equipped with manufacturers recommended muffler.
- When feasible, limit construction to between the hours of 7 a.m. to 7 p.m., Monday through Friday.
- Conduct noisiest activities during weekdays between the hours of 8 a.m. and 5 p.m. For unusually loud activities, such as blasting or pile driving, notify residence by mail or phone at least 1 week in advance.
- Locate stationary construction equipment (air compressors/generators) as far away from residences uses as feasible. When feasible, utilize equipment in acoustically designed enclosures and/or erect temporary barriers.

With the above mitigation measures, project construction activities will be minimized to the greatest extent reasonable.

## References

Beranek, L.L. 1988. *Acoustical Measurements*. American Institute of Physics. Woodbury, New York.

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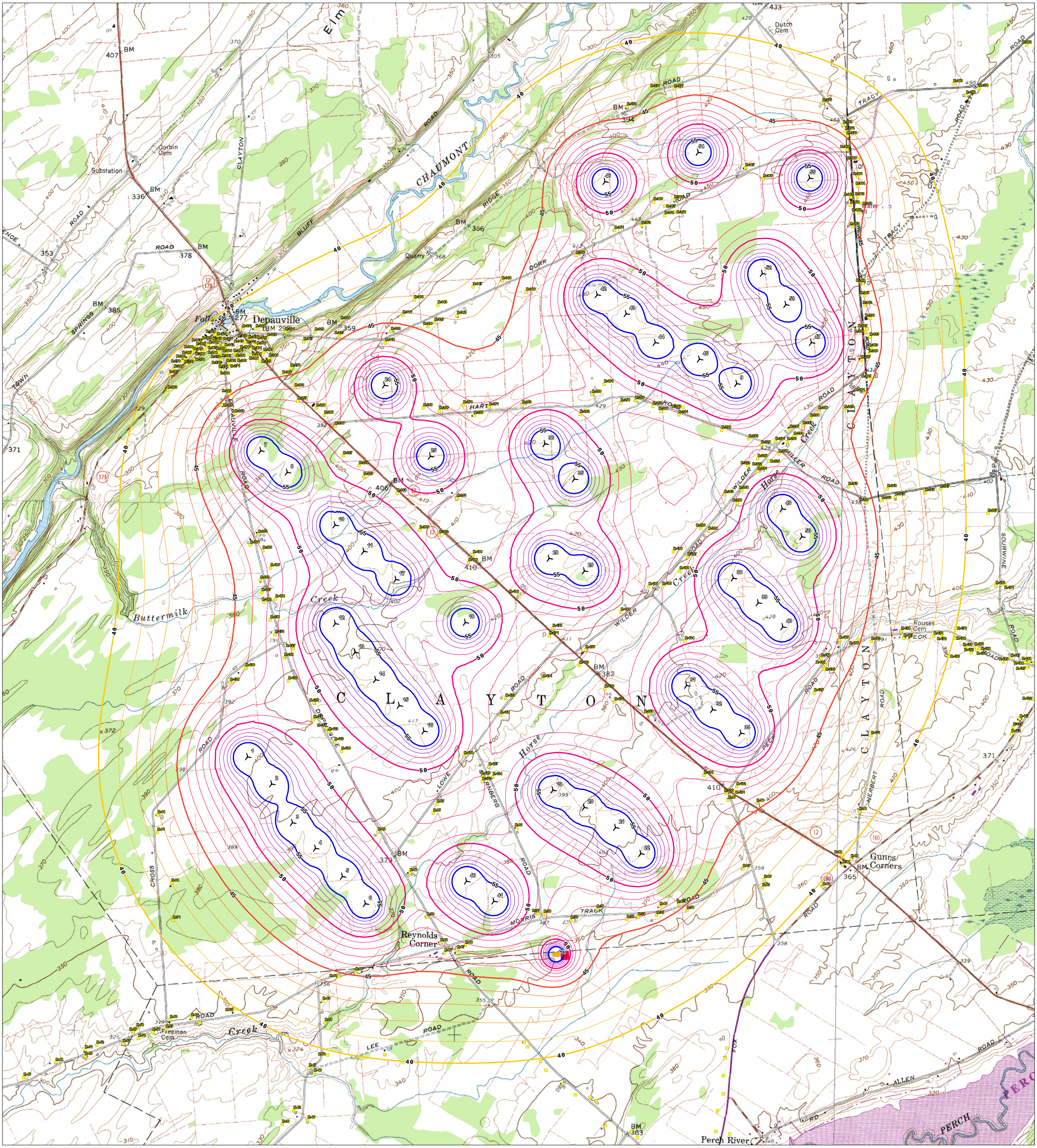
International Electrotechnical Commission (IEC) 61400-11. 2006. *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques – Amendment 1*. Geneva, Switzerland.

International Organization for Standardization (ISO). 1993. *Acoustics – Sound Attenuation During Propagation Outdoors*. Part 1: Calculation of the Absorption of Sound by the Atmosphere, 1993. Part 2: General Method of Calculation. ISO 9613. Switzerland.

U.S. Environmental Protection Agency (EPA). 1971. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*.

VDI. 1988. *Outdoor Sound Propagation*. VDI (Verein Deutscher Ingenieure) 2714, Verlag GmbH, Dussledorf, Beuth Verlag, Berlin, Koln, Germany.




**Legend**

- Proposed Turbine
- Residences
- Proposed Interconnect Station
- Proposed Substation

**Predicted Project Sound Levels (dBA)**

40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55

Turbine: G90
Hub Height: 100 (m)
Tip Height: 145 (m)

Notes:
* Expected Guaranteed (with +/- 2 dBA) = 108.4
* Residences were captured using a combination of Aerial/Planimetric Mapping & Field Verification.

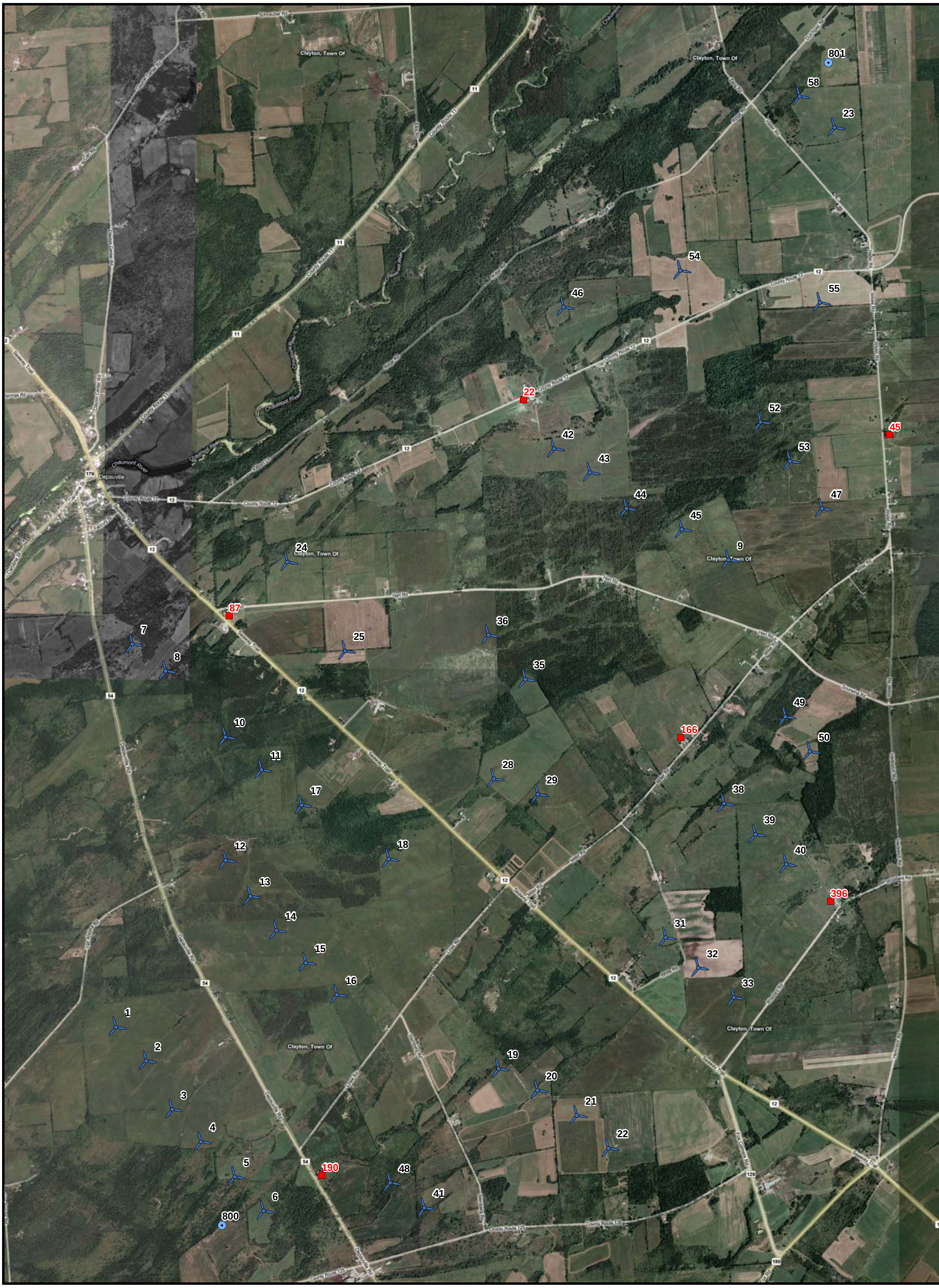
N

0 1,000 2,000 3,000 4,000
Feet

# Figure 1
## Predicted Project Sound Levels (dBA)
## Horse Creek Wind Project

IBERDROLA RENEWABLES

# Appendix A




# Sound Monitoring Locations

## Horse Creek Wind Project

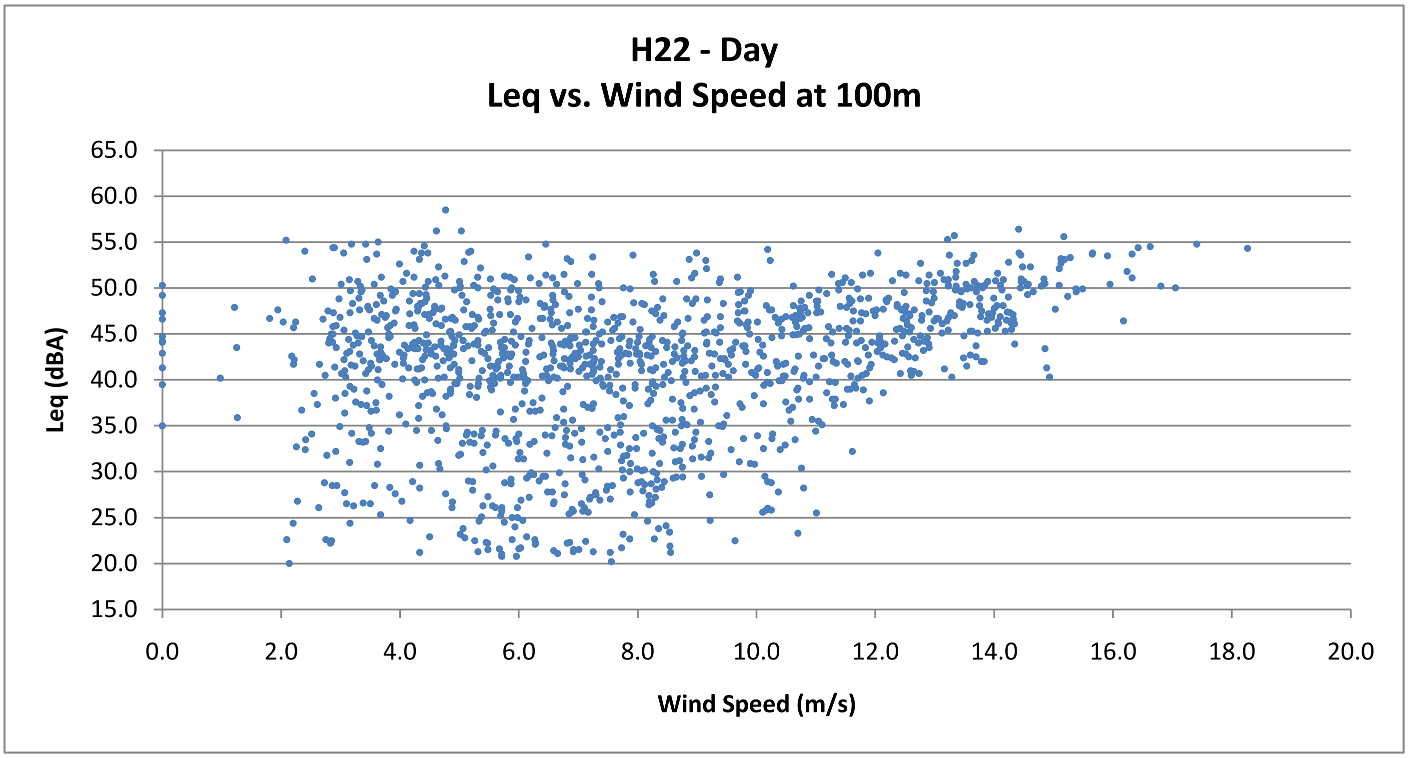
**Legend**

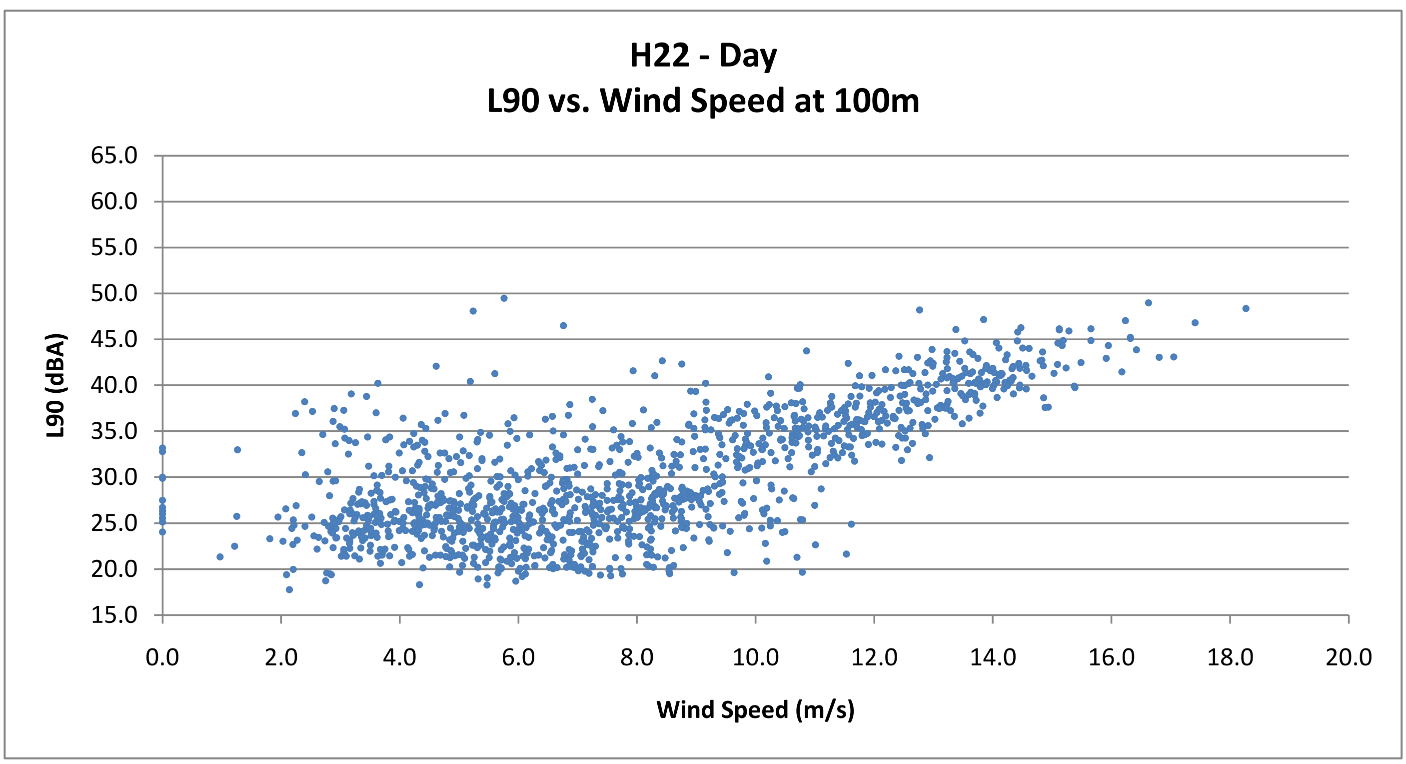
- Sound Monitoring Locations
- Proposed Turbine
- Proposed Permanent Met Tower

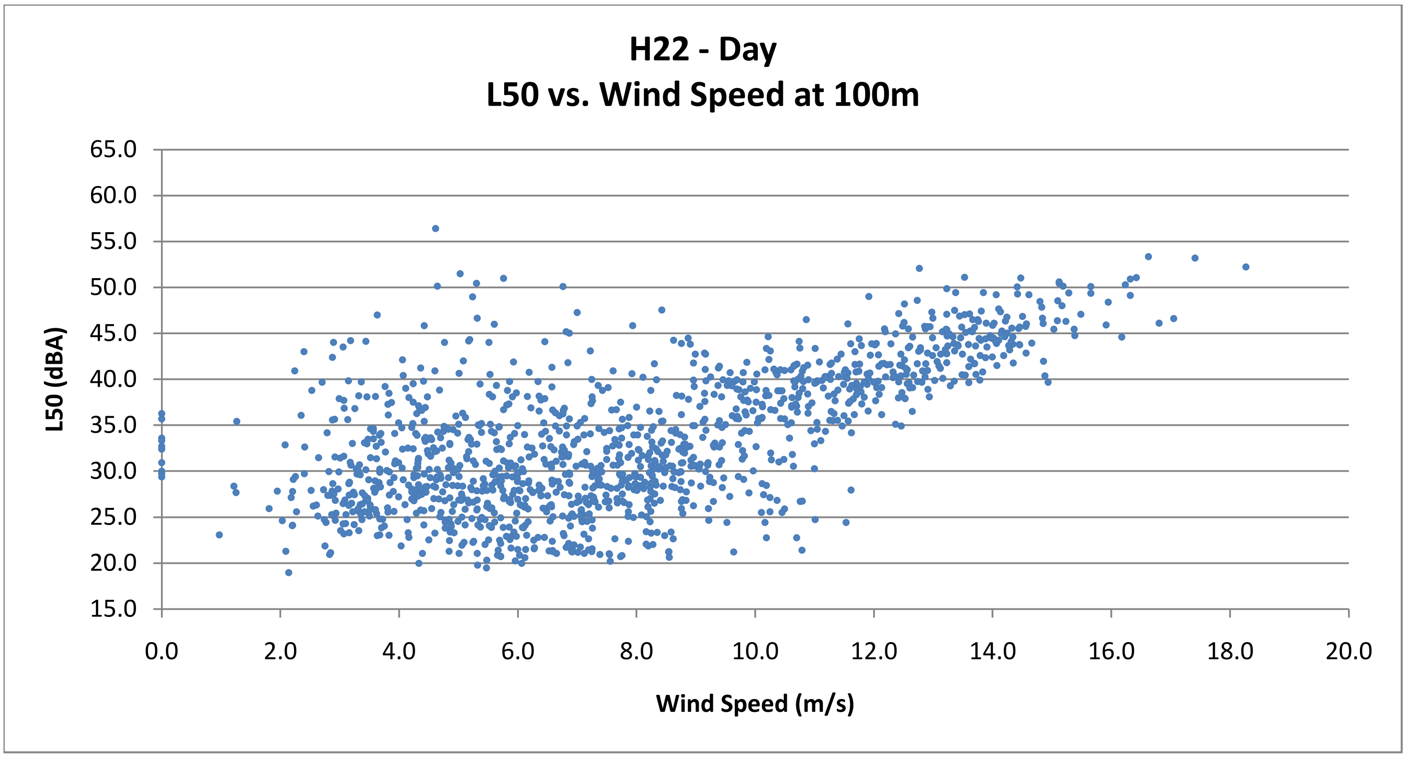
N

0 300 600 900 1,200

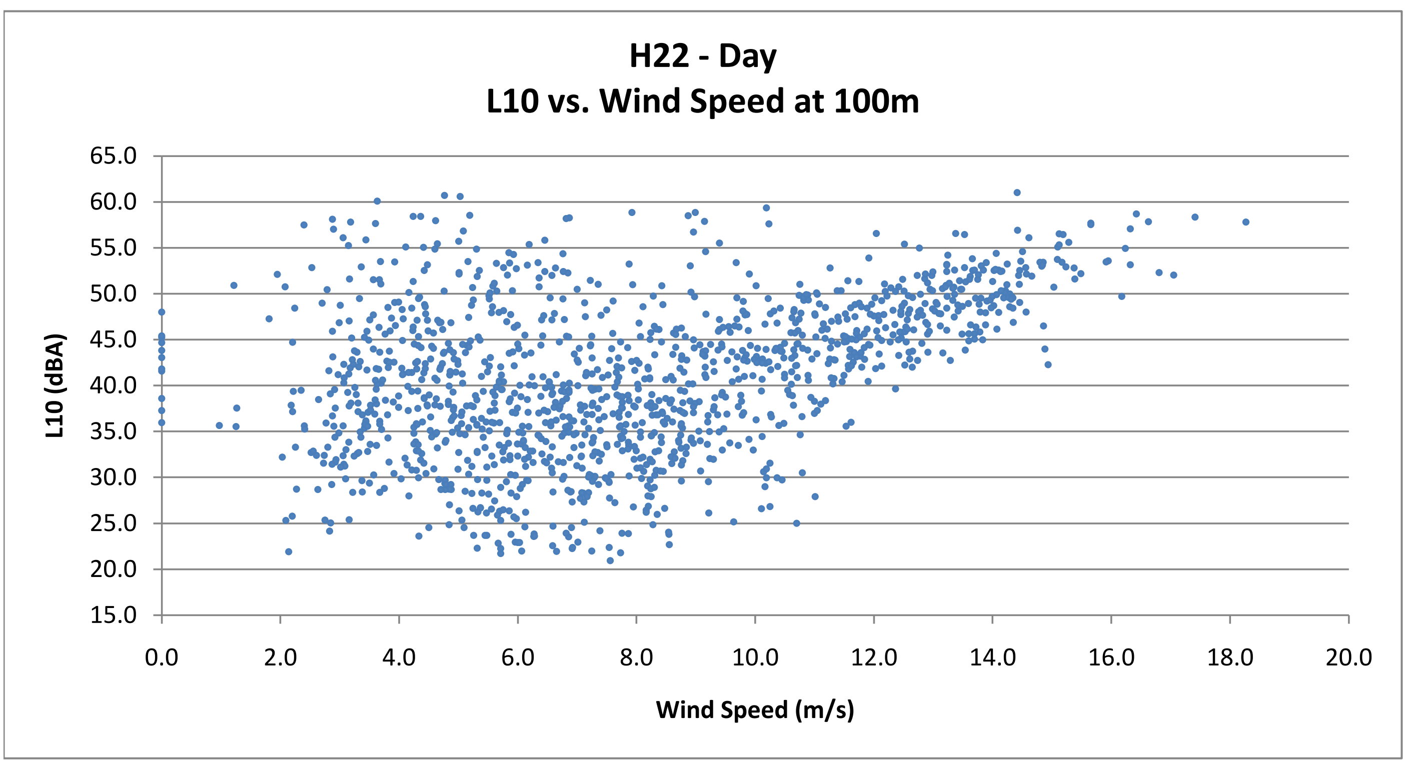
Meters


H22 - Day
Leq vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
Leq (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

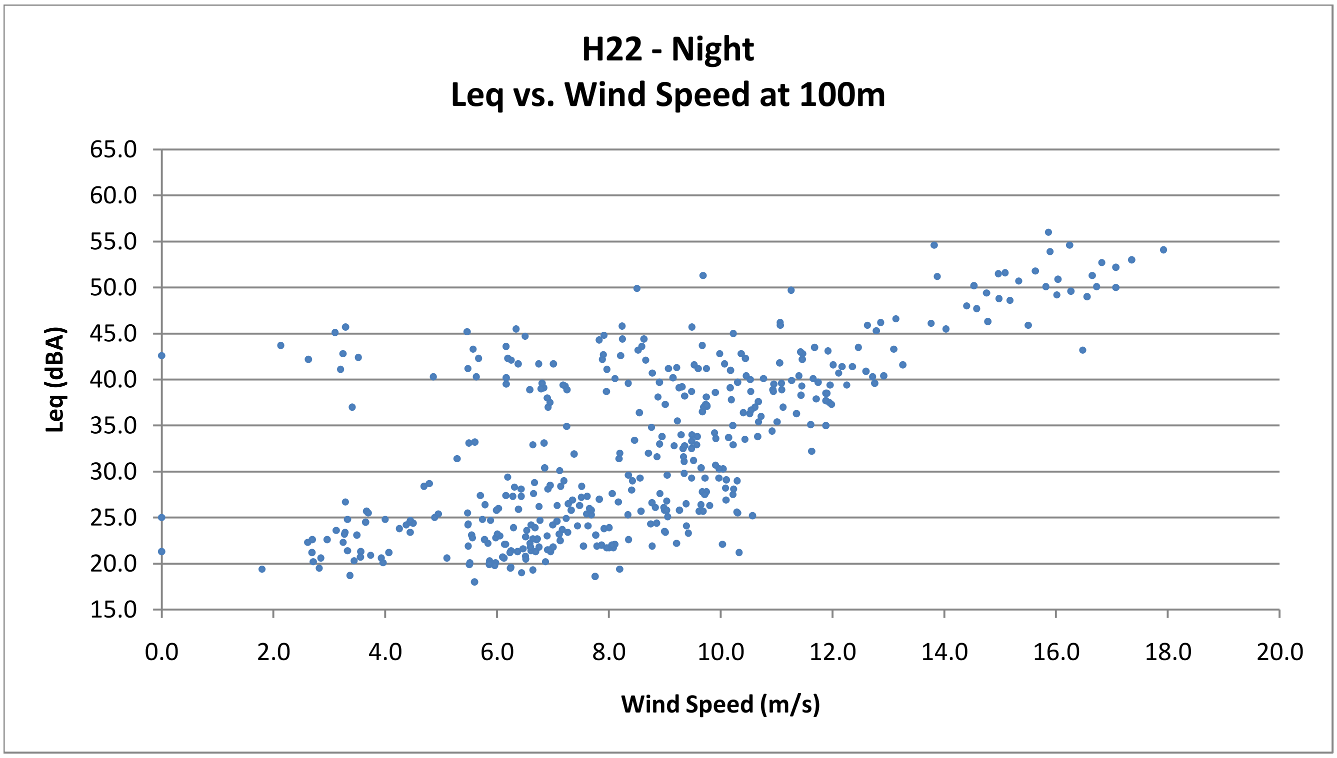

H22 - Day
L90 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L90 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

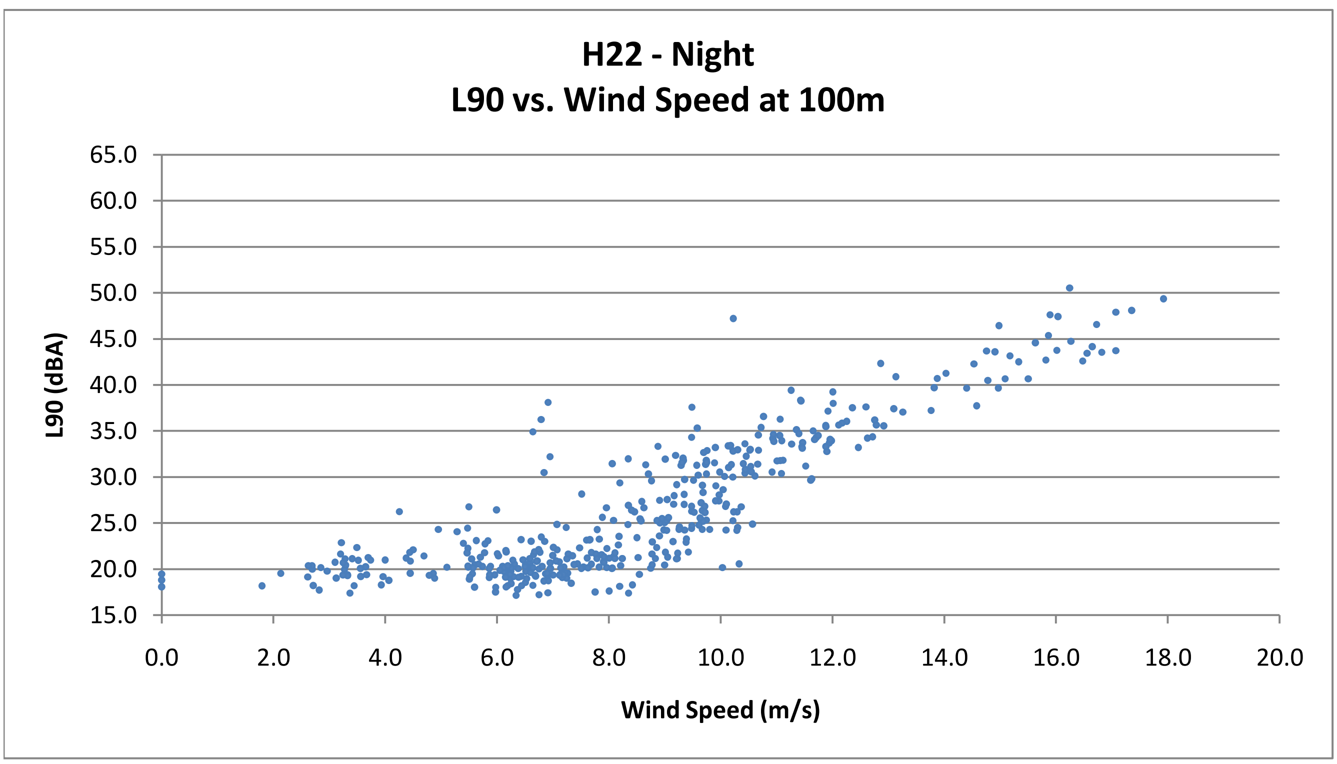


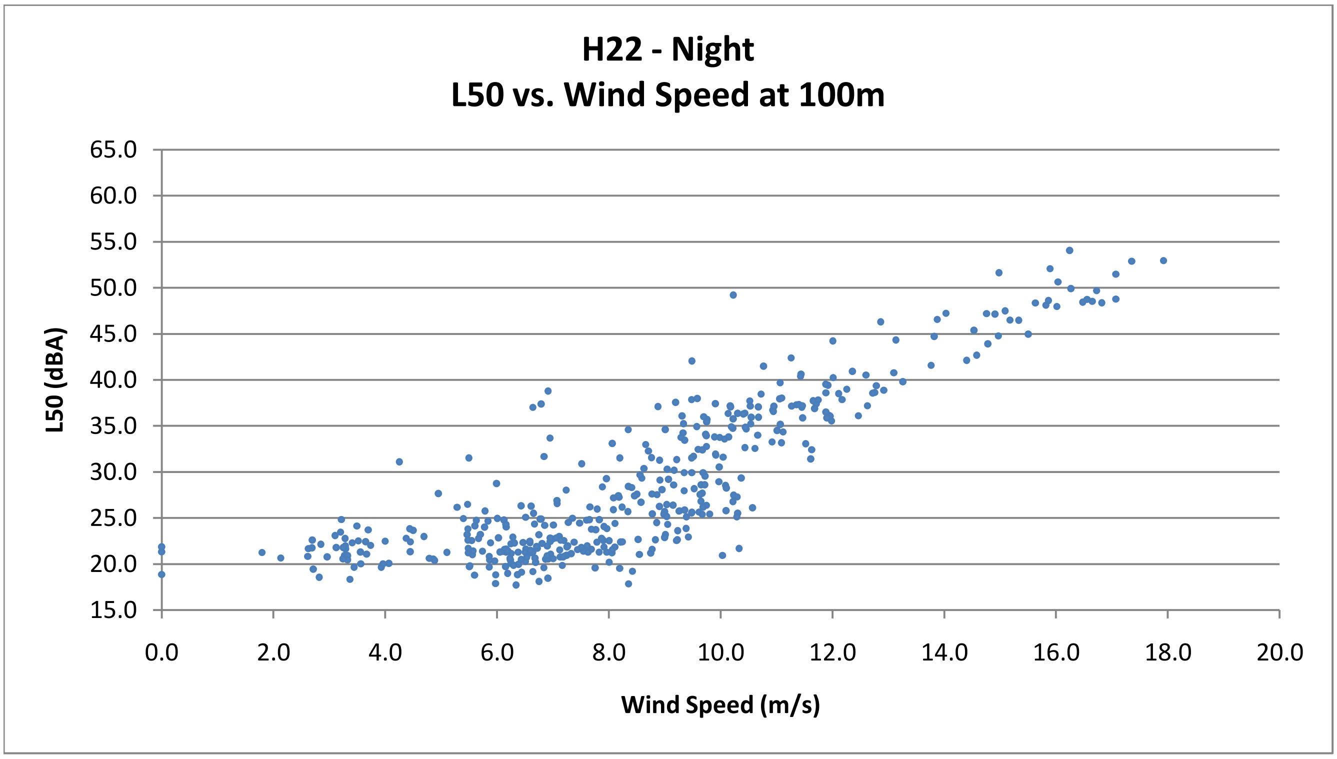
H22 - Day
L50 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L50 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

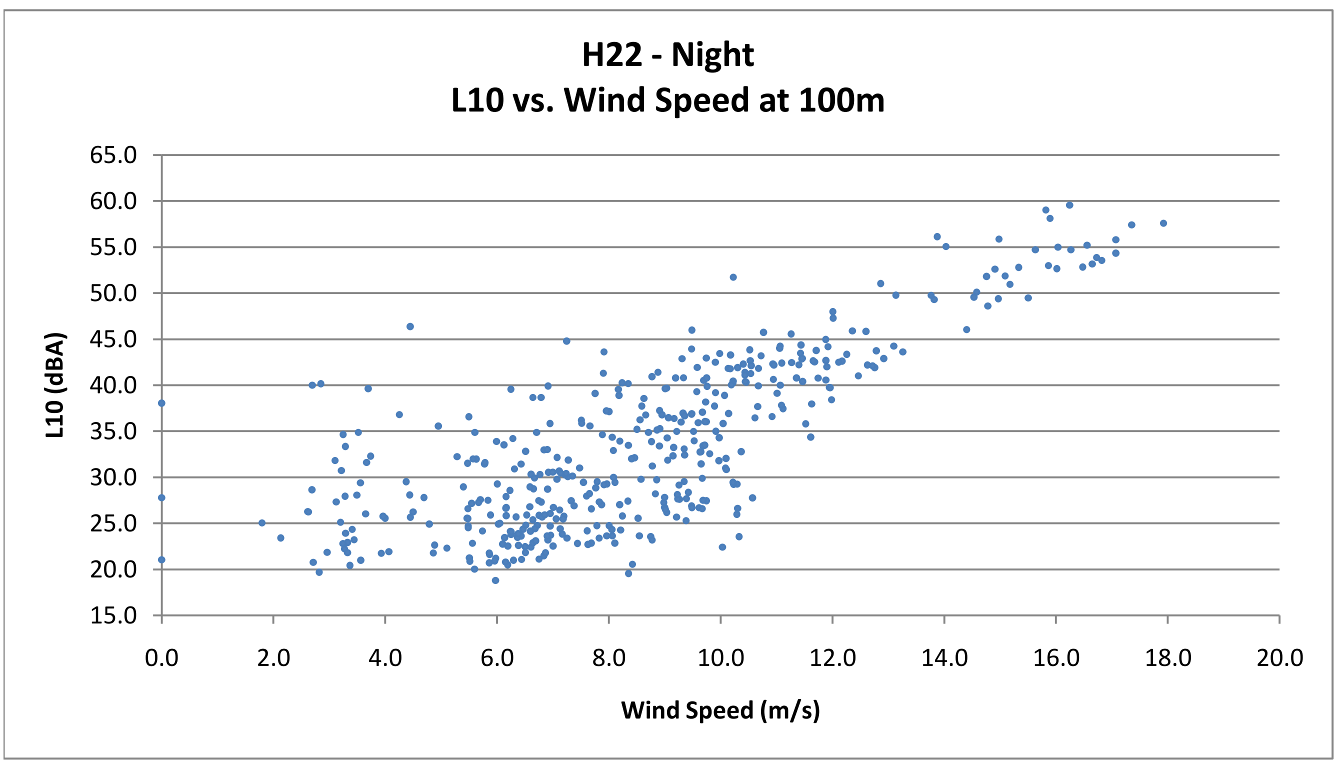



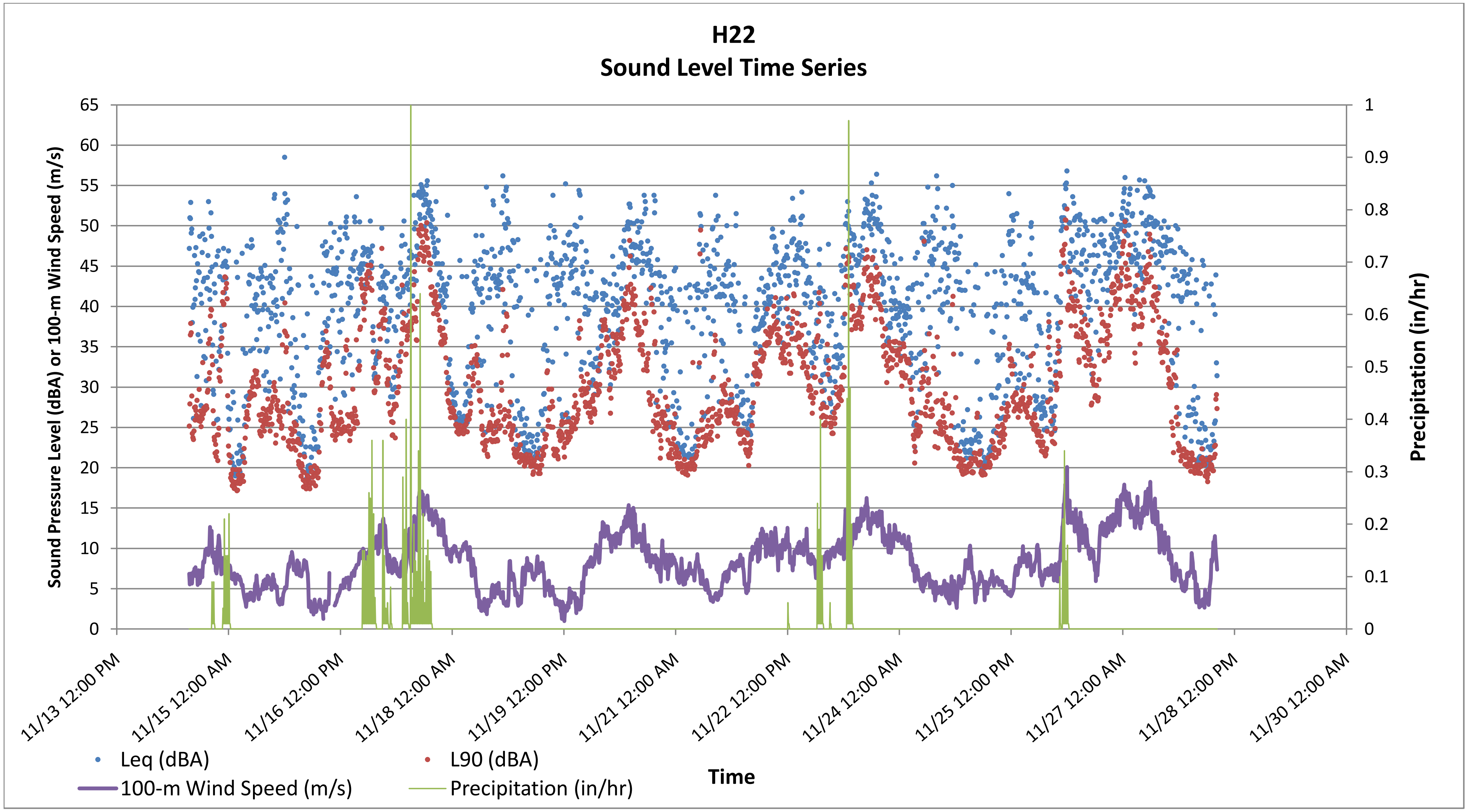
H22 - Day
L10 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L10 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

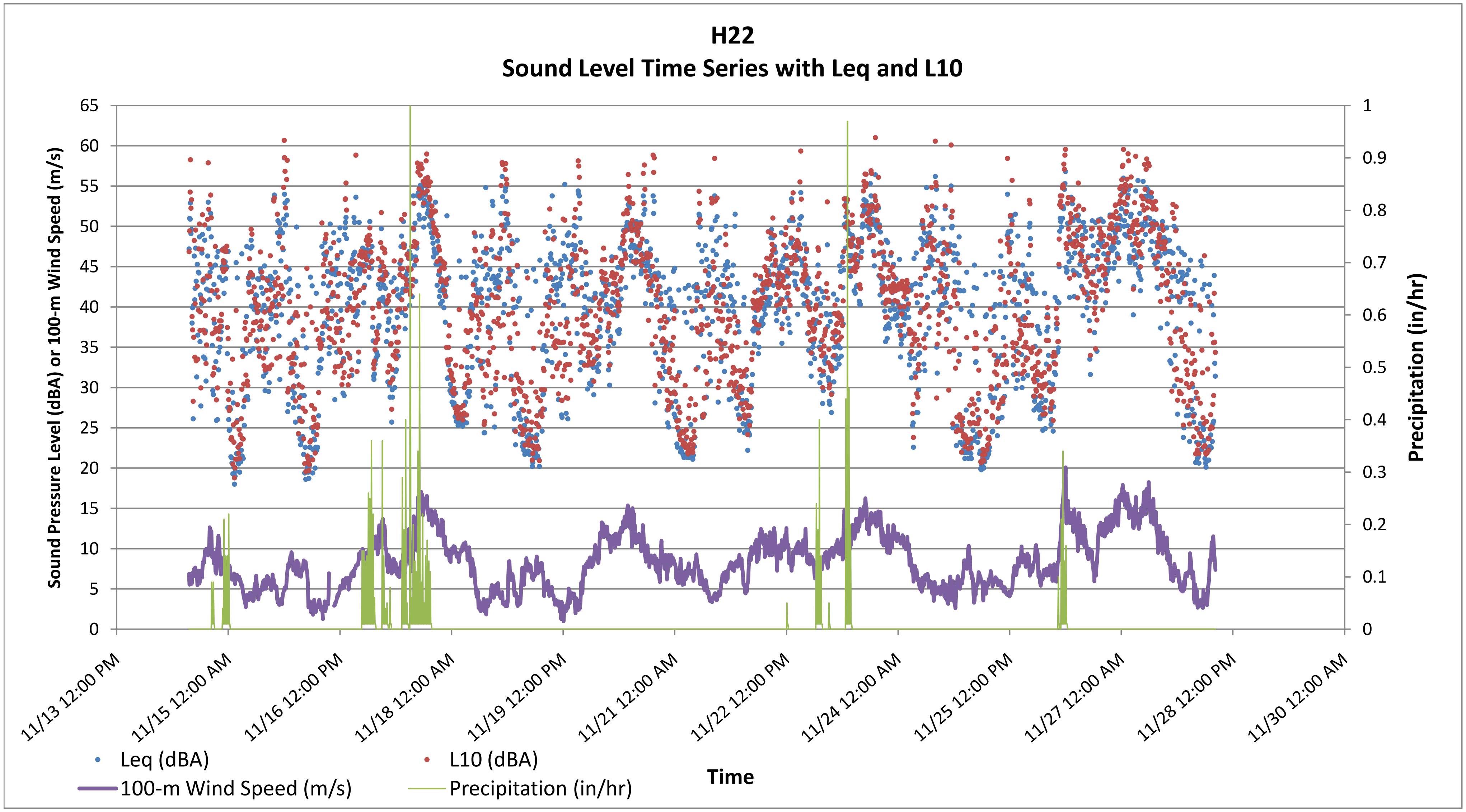

H22 - Night
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H22 - Night
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

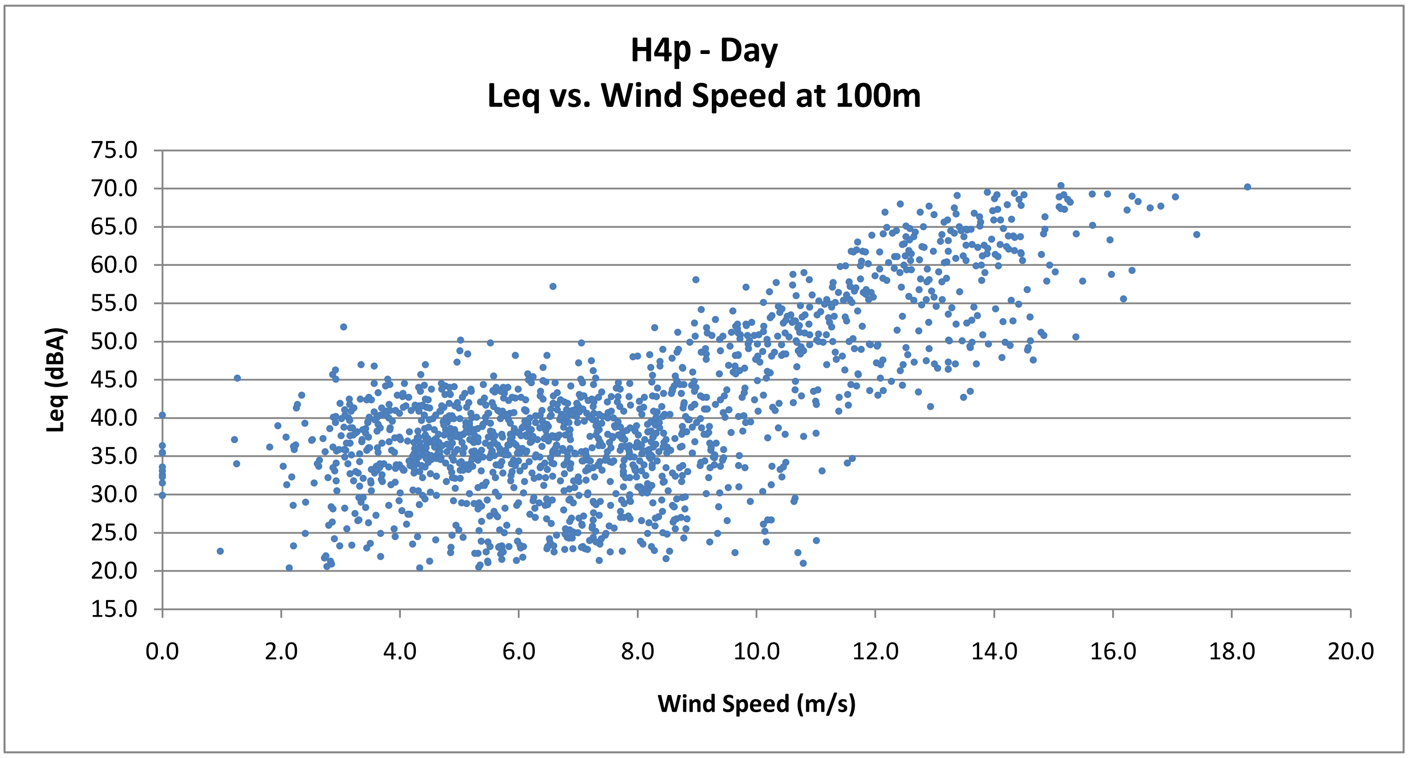

H22 - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

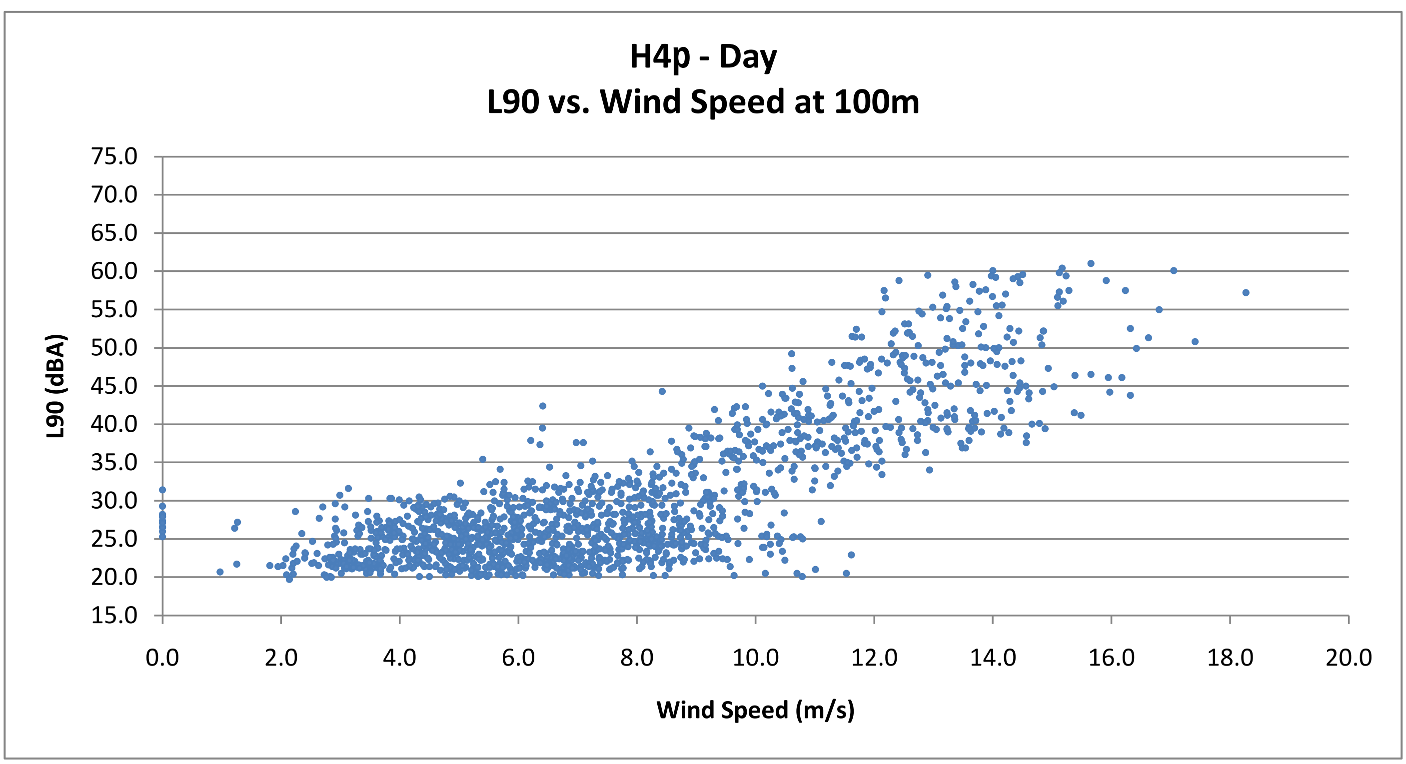

H22 - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

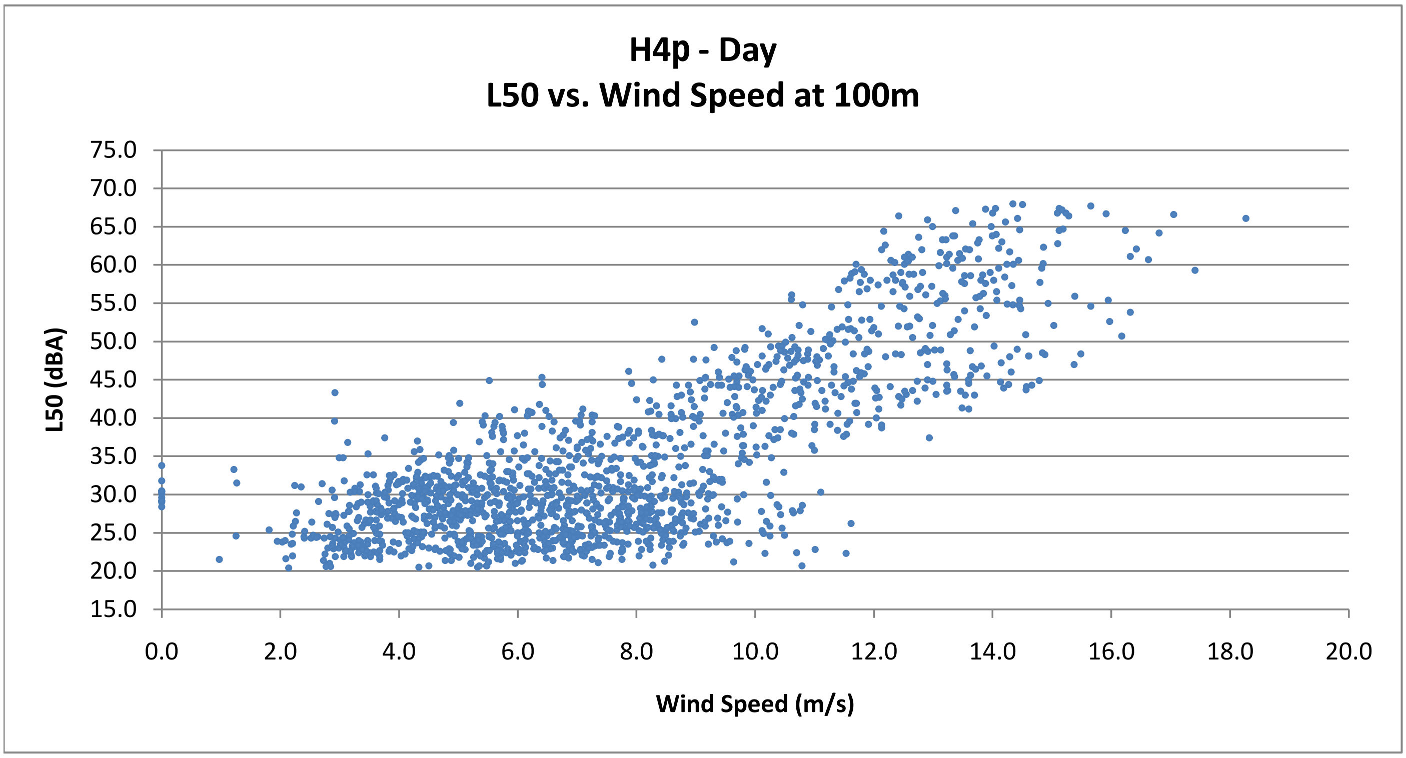

H22
Sound Level Time Series
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
Time
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

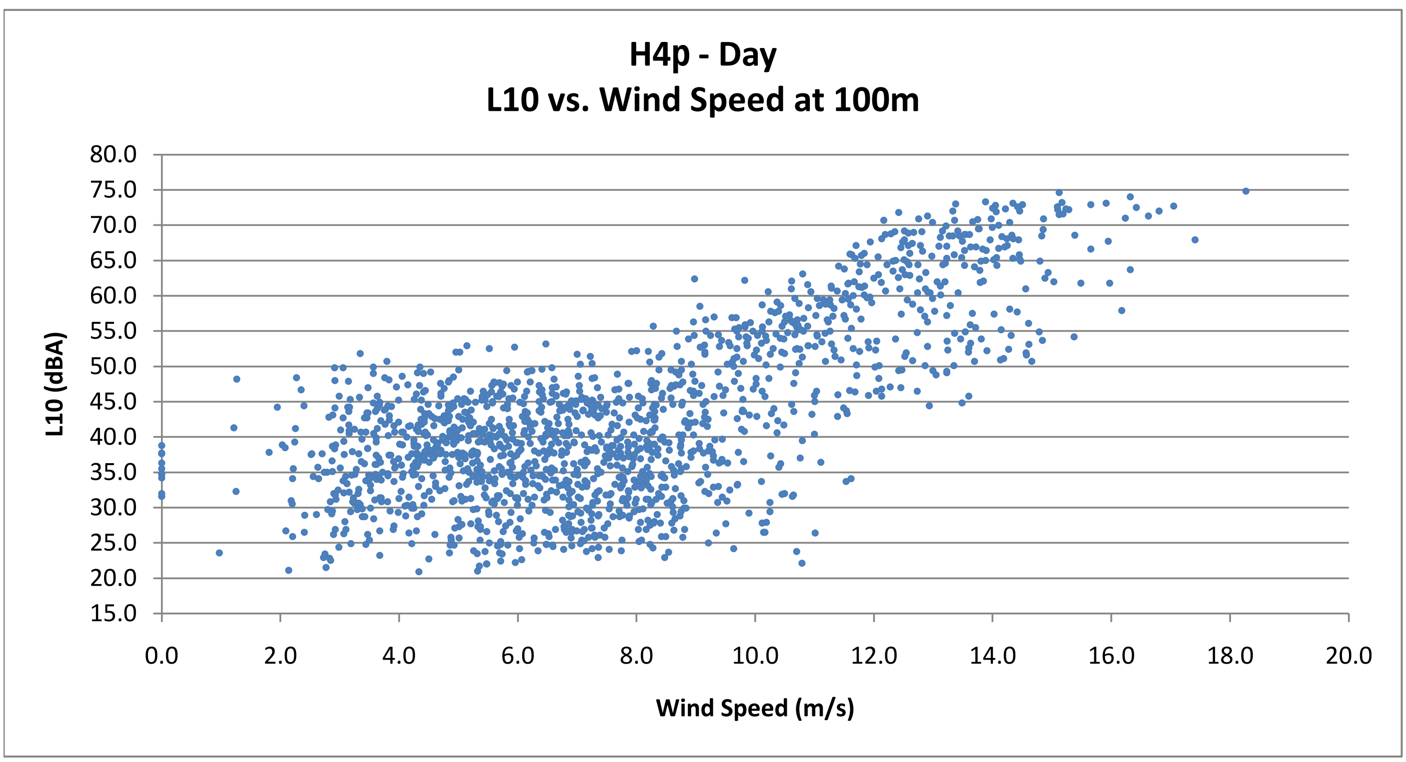


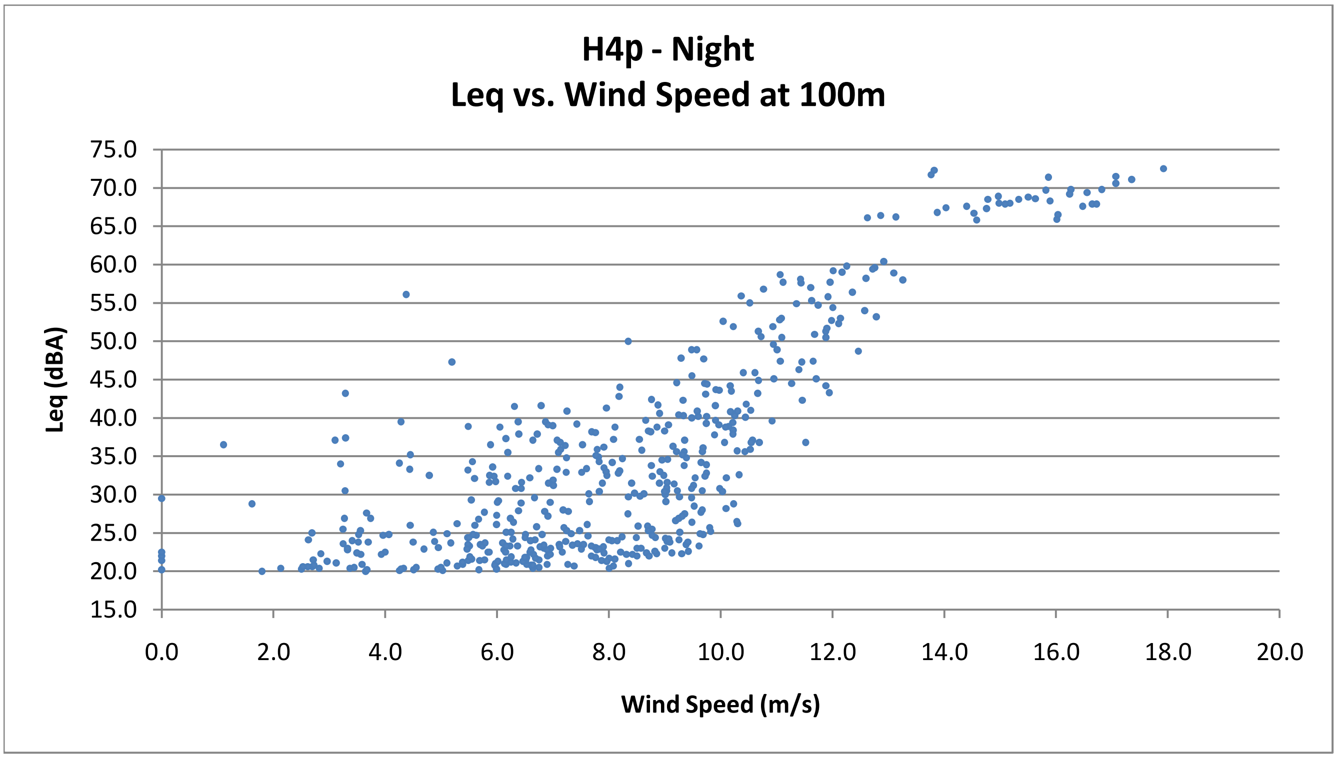
H22
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

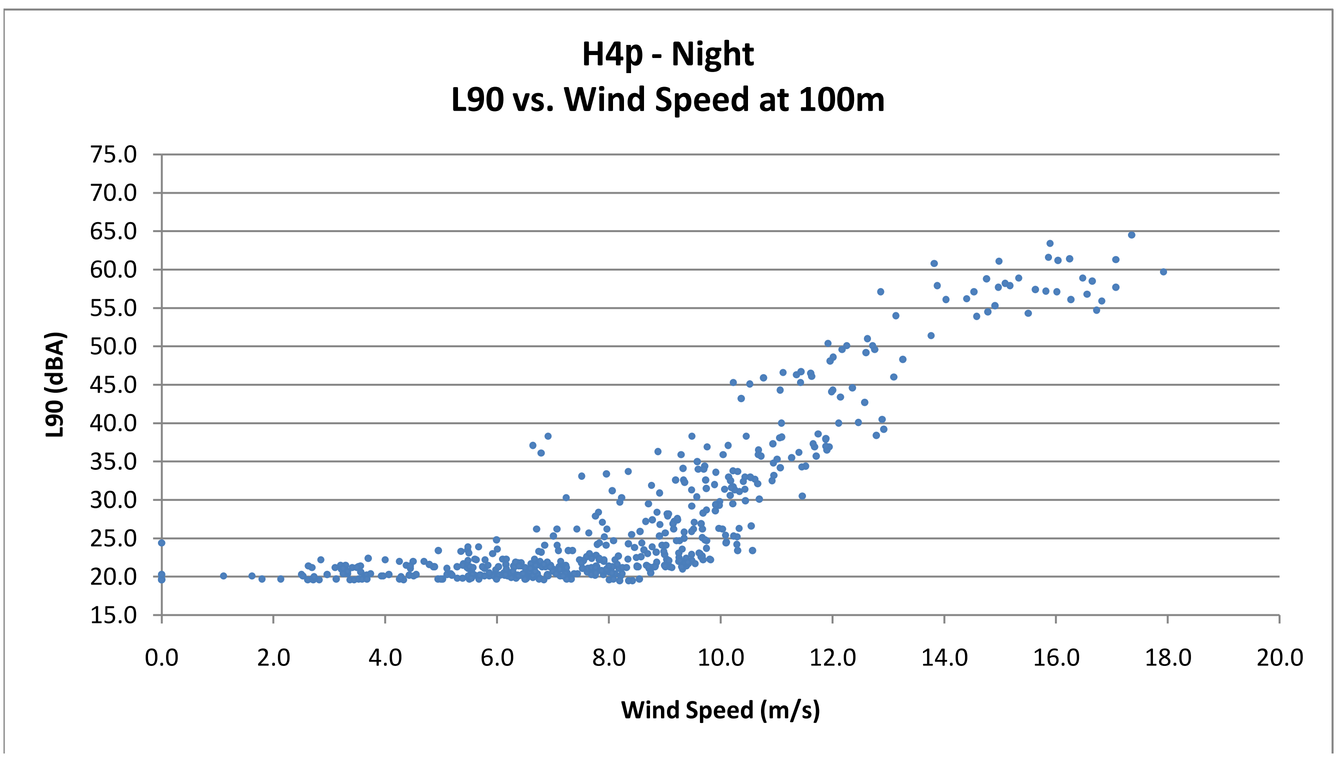

H4p - Day
Leq vs. Wind Speed at 100m
Leq (dBA)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

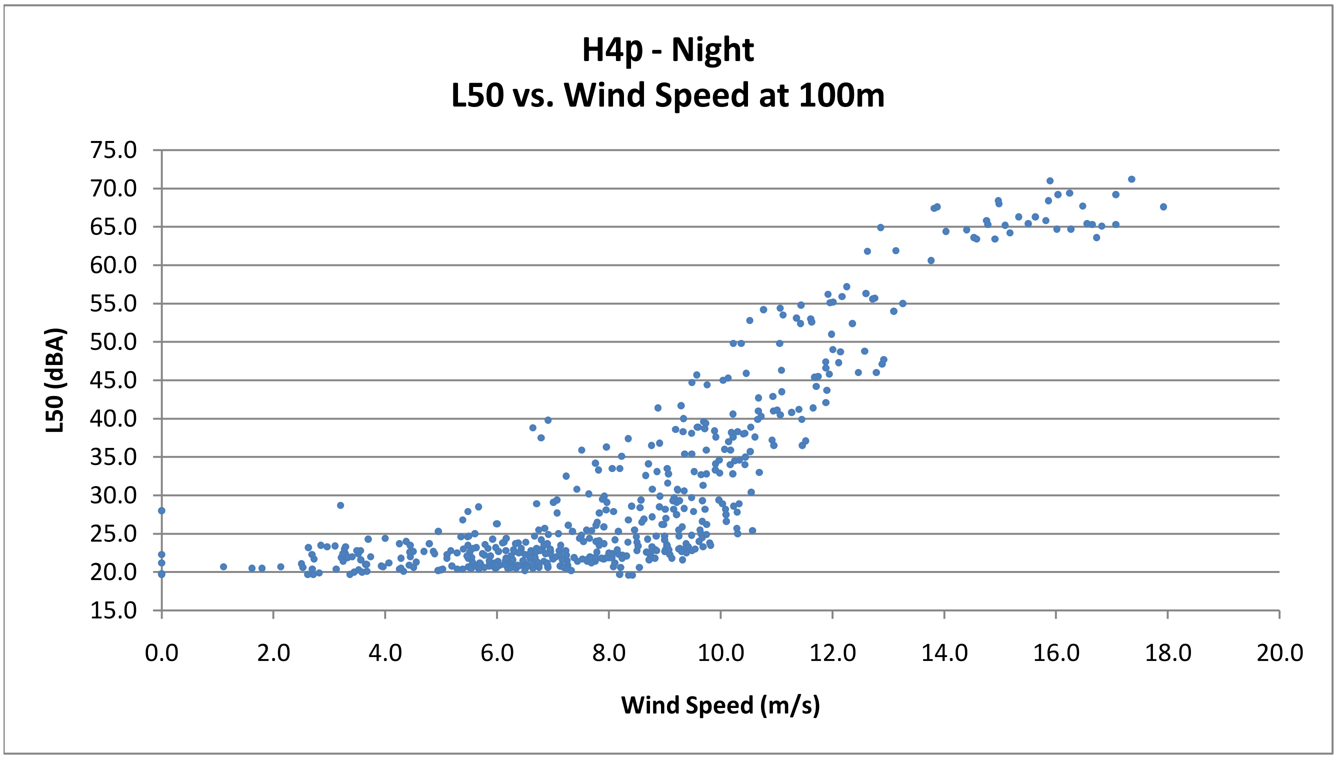

H4p - Day
L90 vs. Wind Speed at 100m
L90 (dBA)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

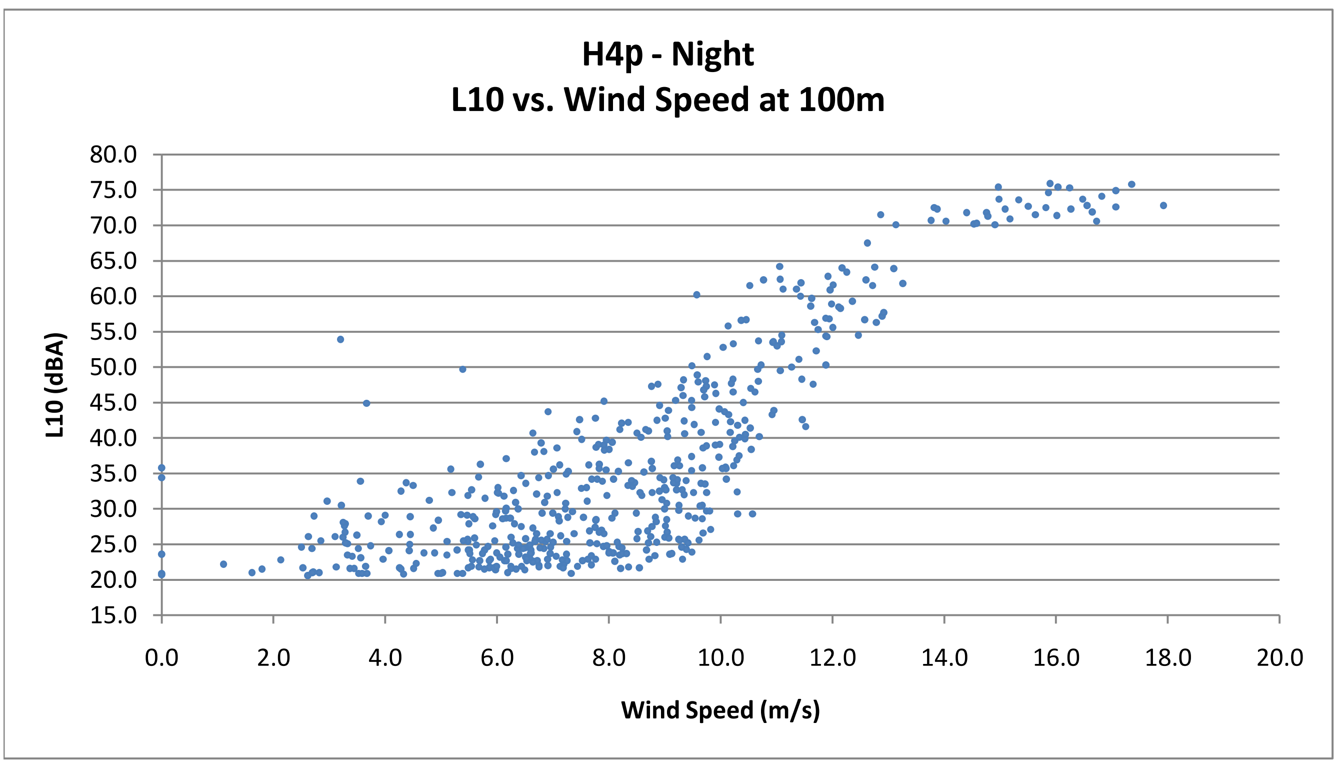

H4p - Day
L50 vs. Wind Speed at 100m
L50 (dBA)
Wind Speed (m/s)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0

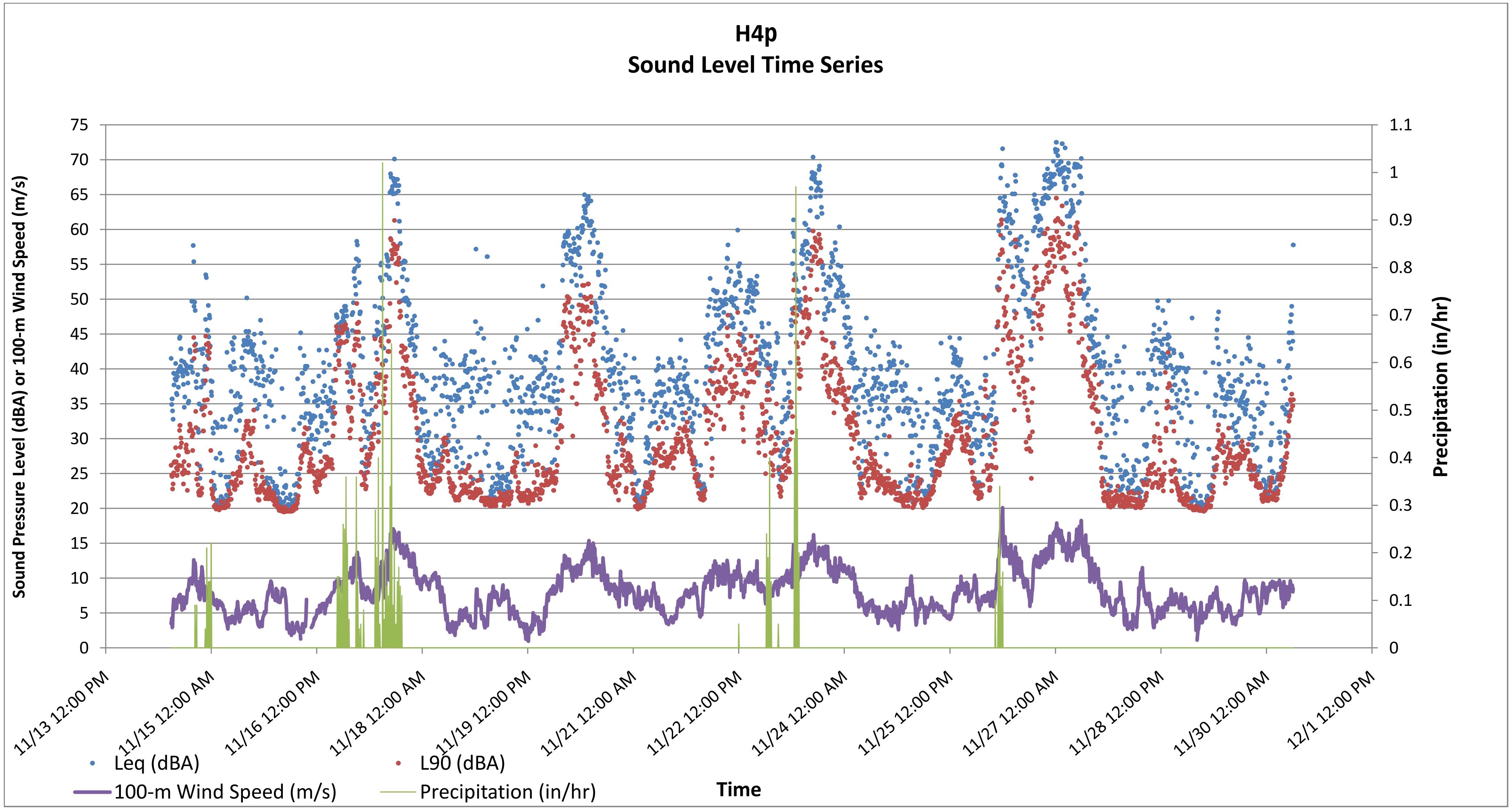

H4p - Day
L10 vs. Wind Speed at 100m
L10 (dBA)
Wind Speed (m/s)
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0


H4p - Night
Leq vs. Wind Speed at 100m
Leq (dBA)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

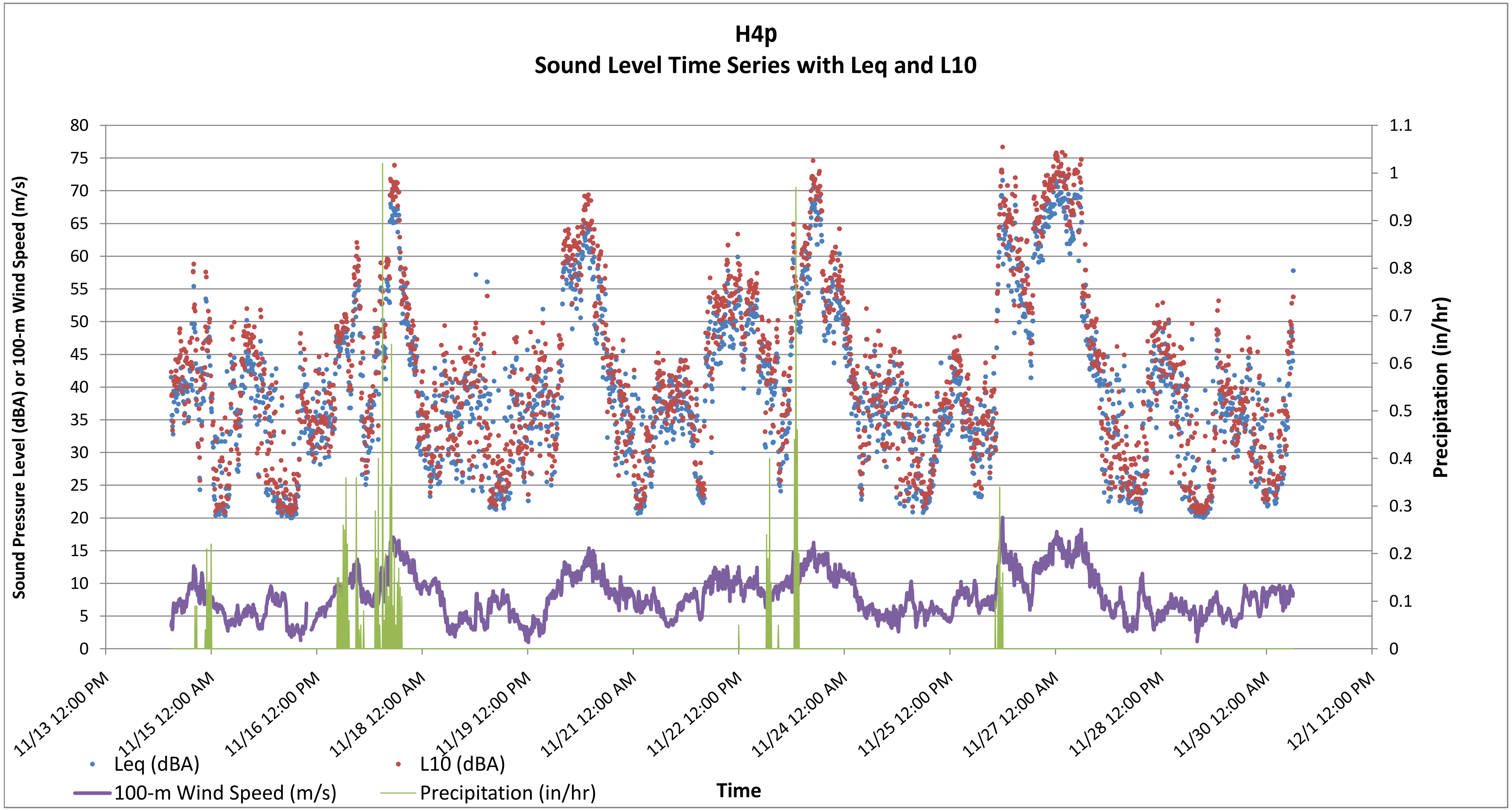

H4p - Night
L90 vs. Wind Speed at 100m
L90 (dBA)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

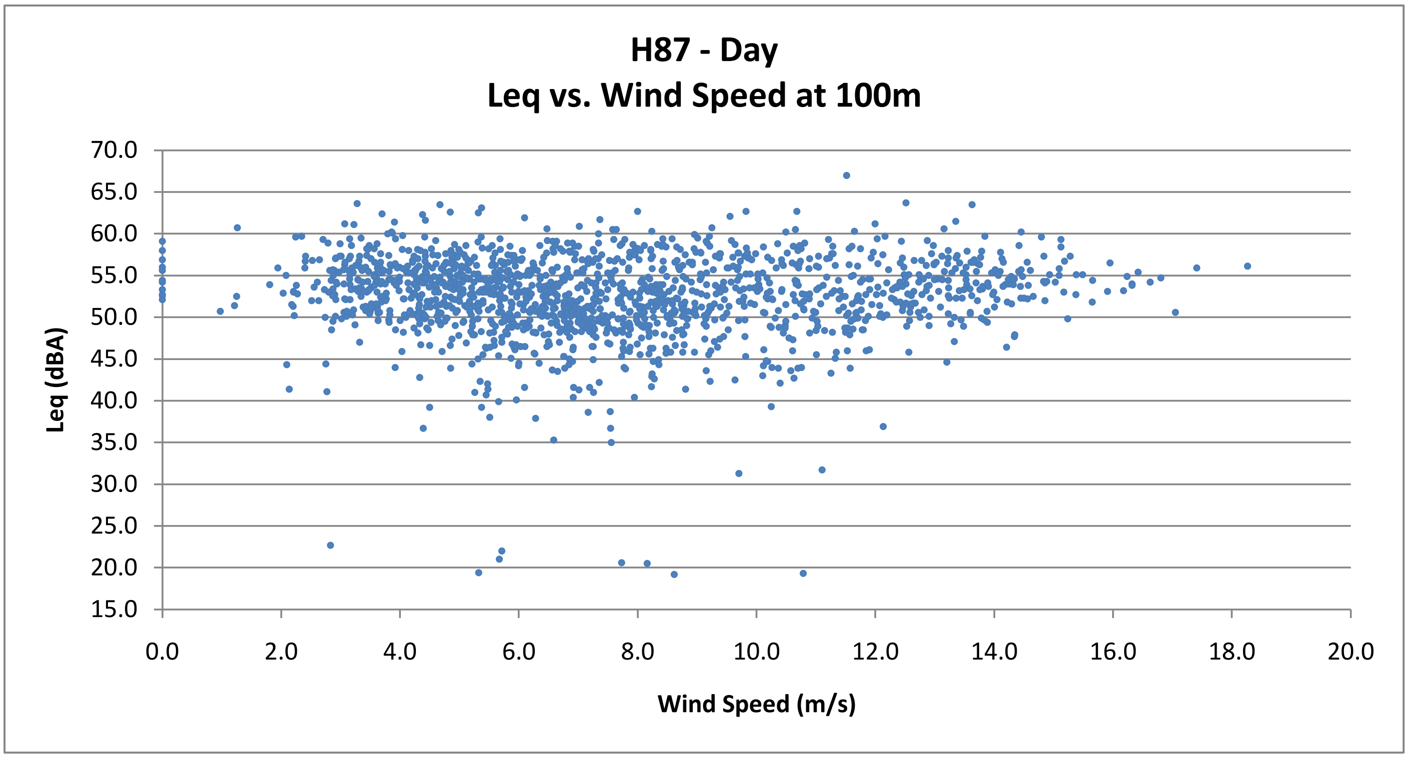

H4p - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

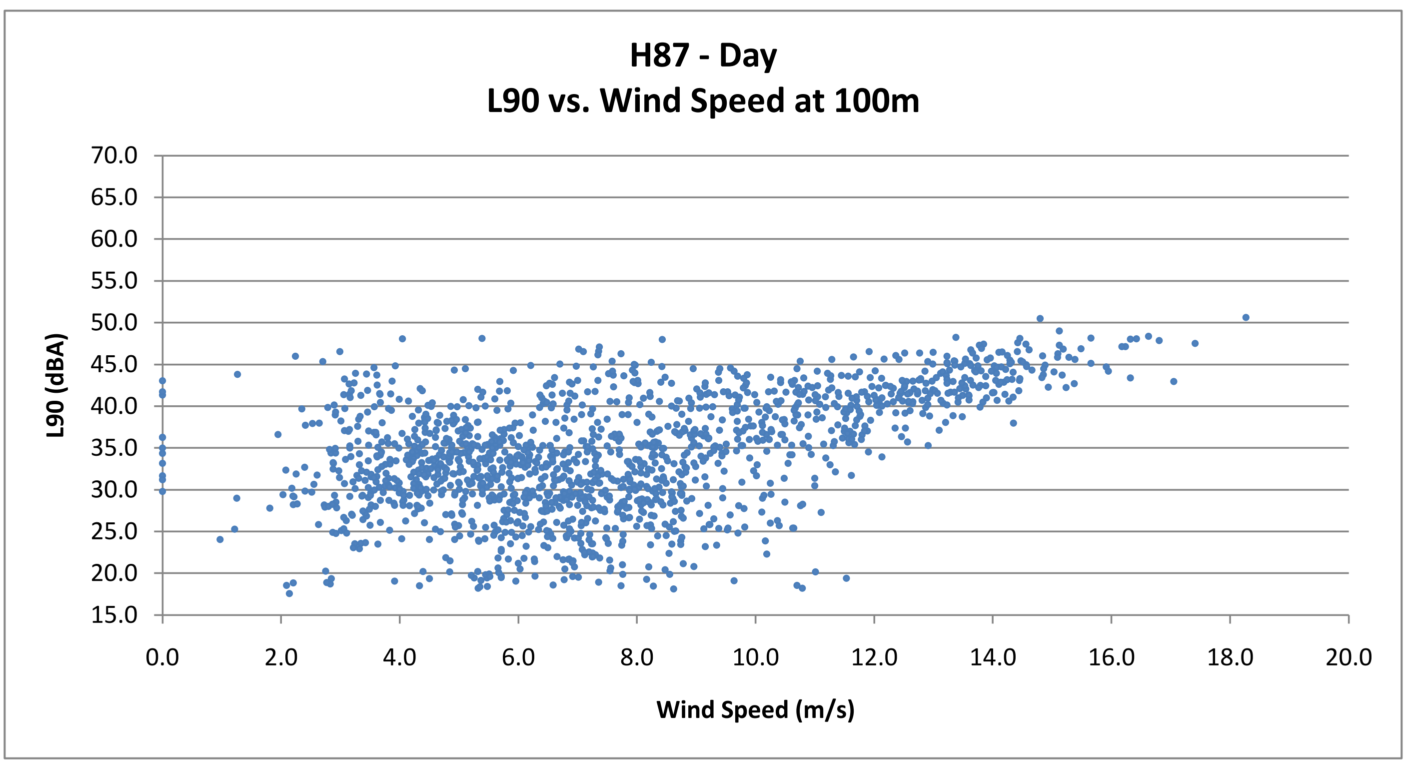

H4p - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

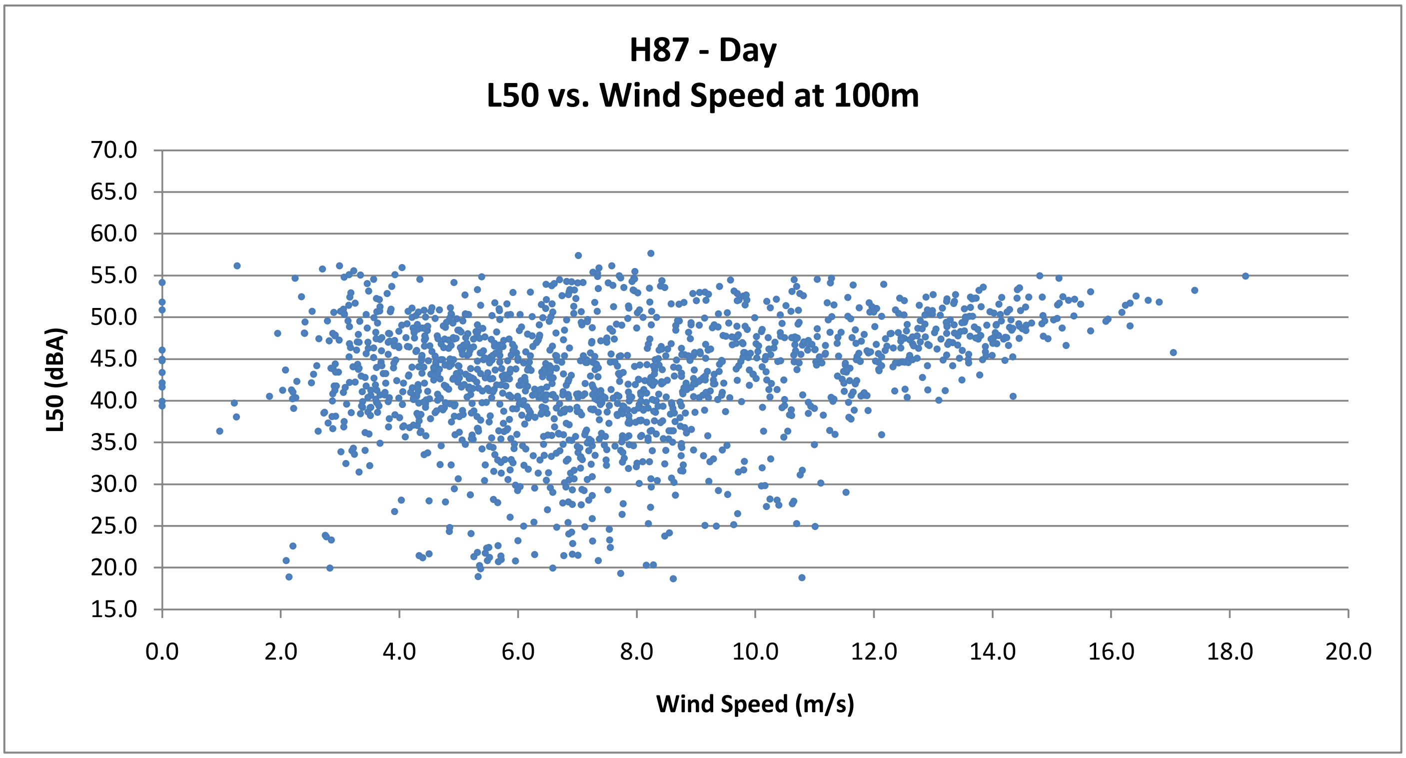


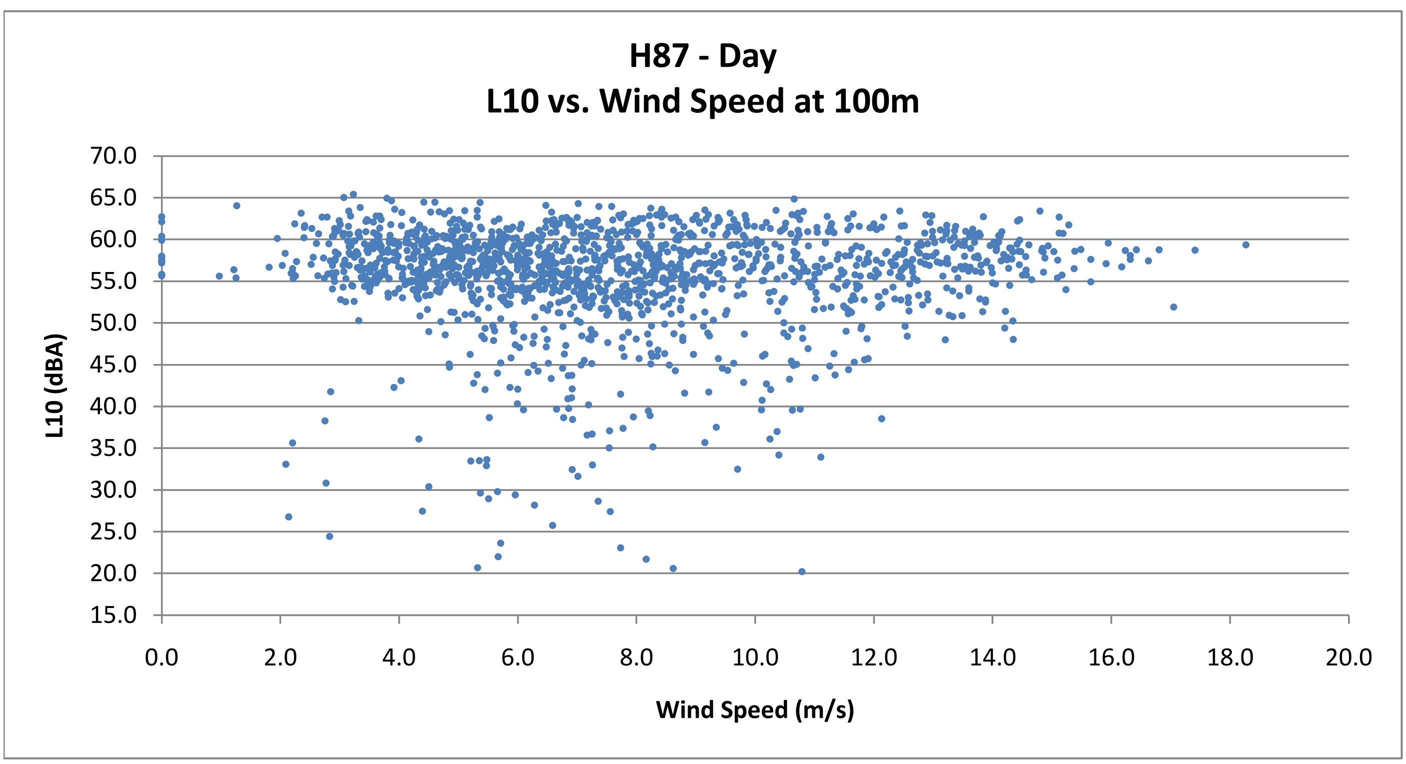
H4p
Sound Level Time Series
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)
Time

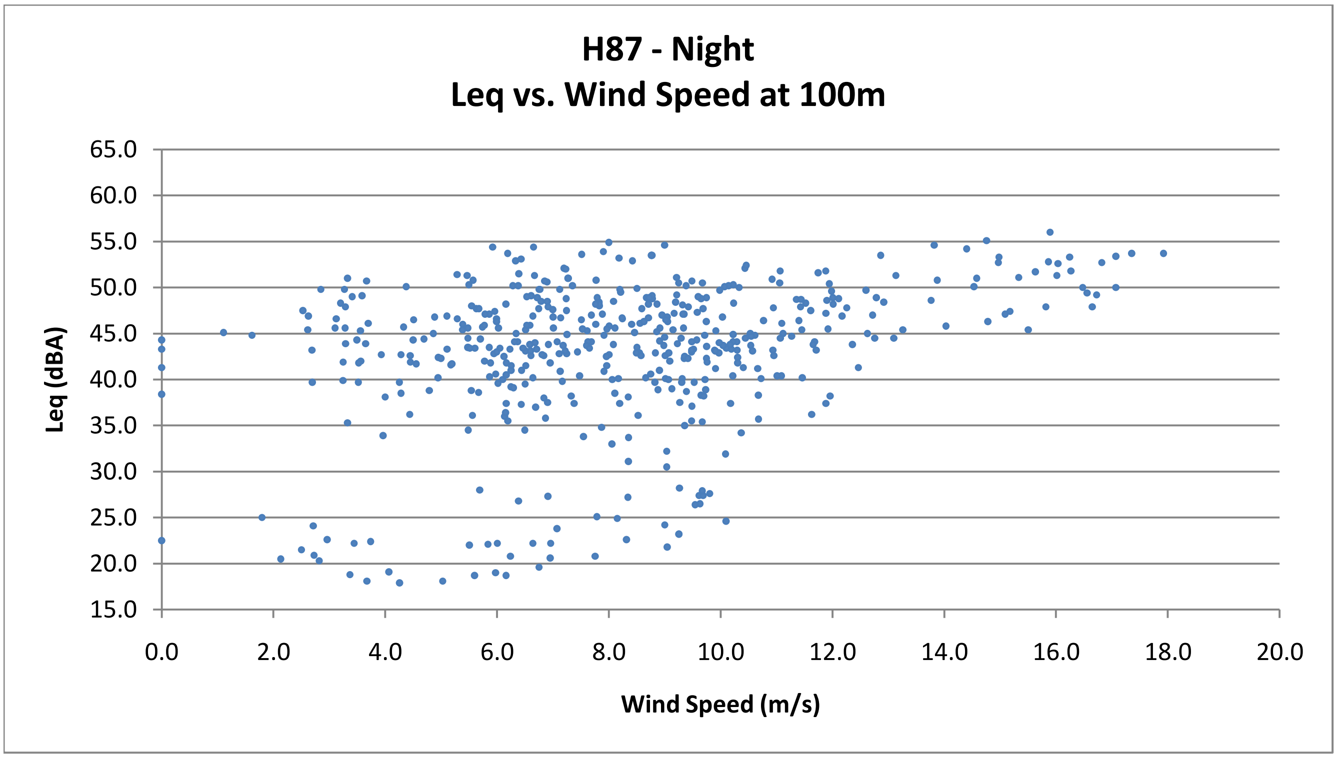

H4p
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

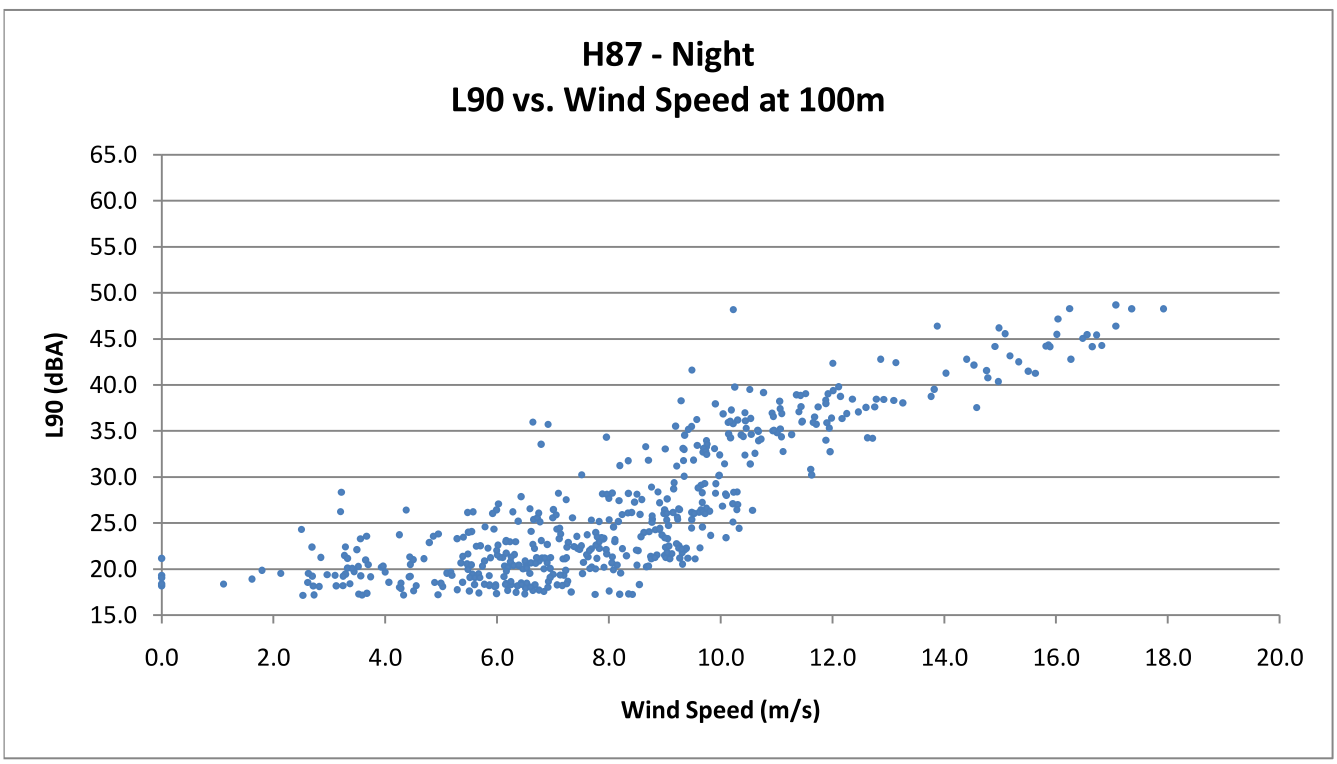

H87 - Day
Leq vs. Wind Speed at 100m
Leq (dBA)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

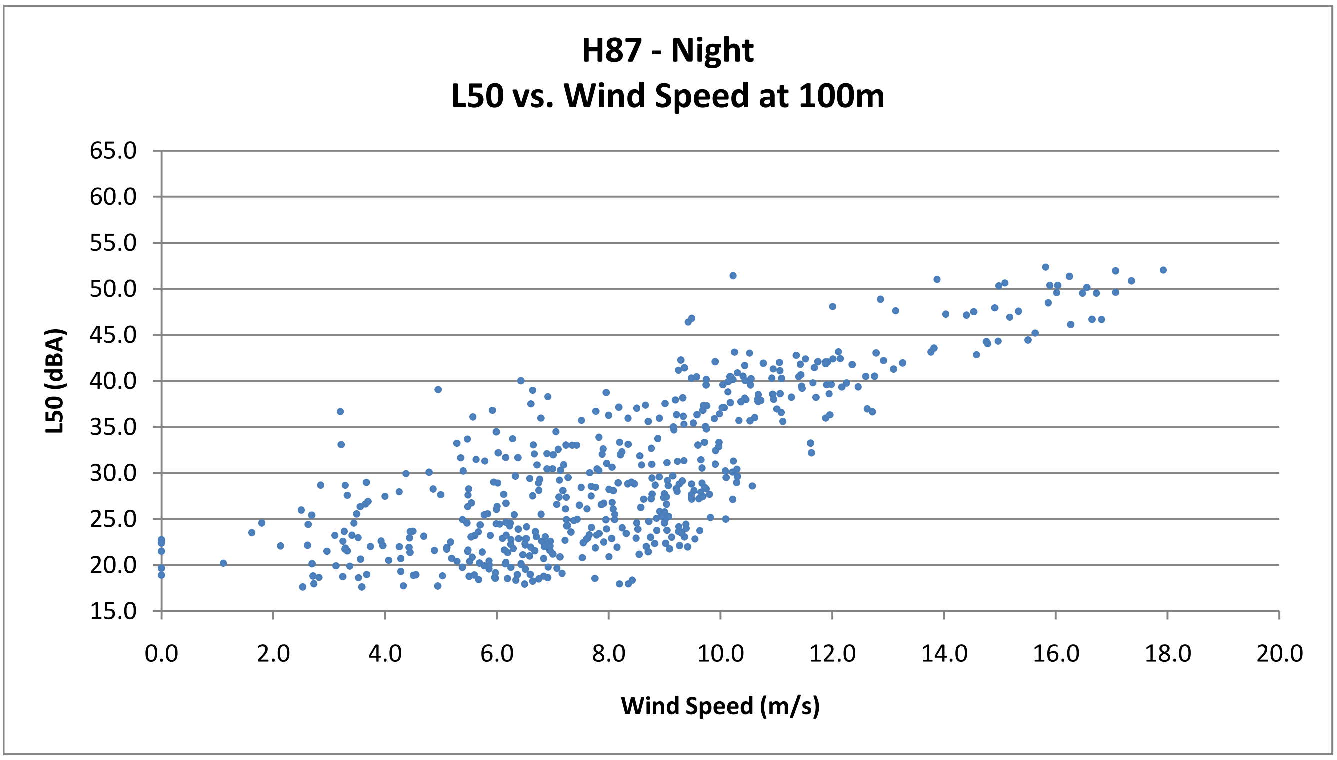

H87 - Day
L90 vs. Wind Speed at 100m
L90 (dBA)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H87 - Day
L50 vs. Wind Speed at 100m
L50 (dBA)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

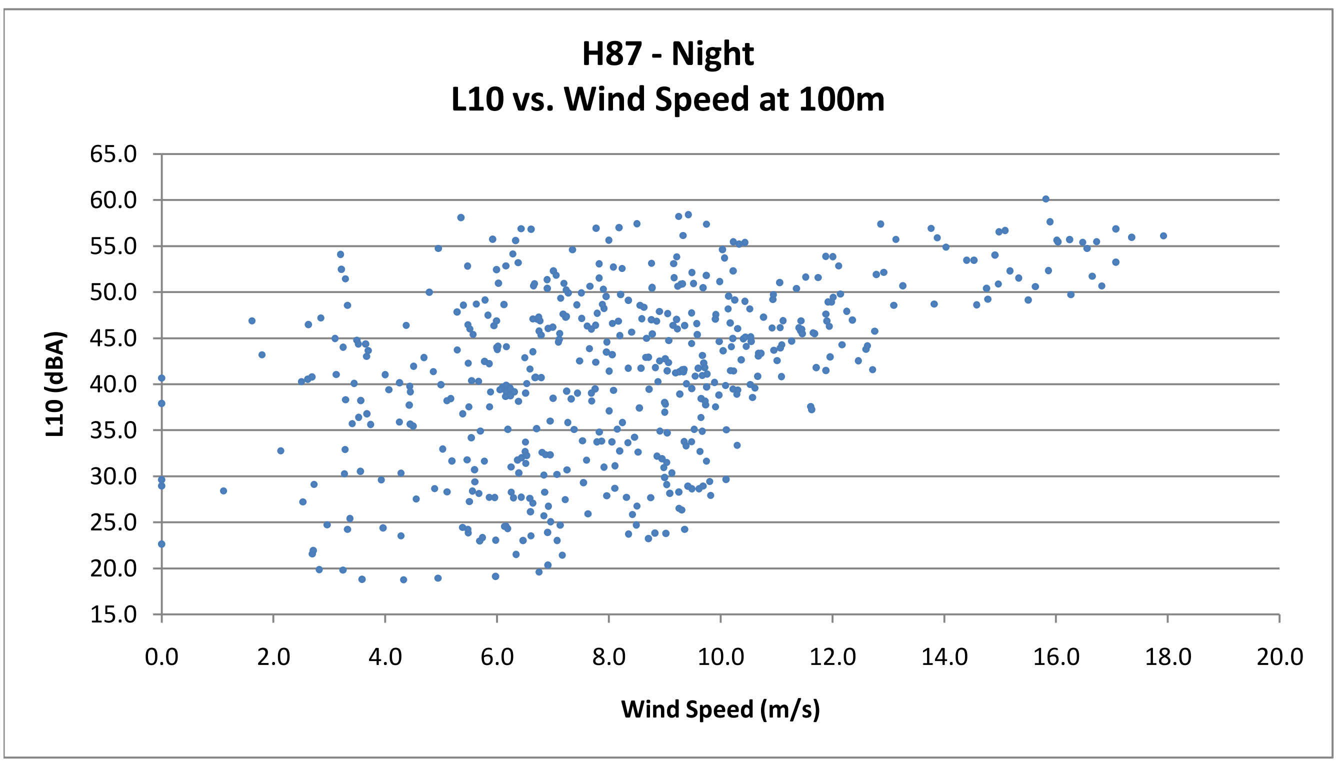

H87 - Day
L10 vs. Wind Speed at 100m
L10 (dBA)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H87 - Night
Leq vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
Leq (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

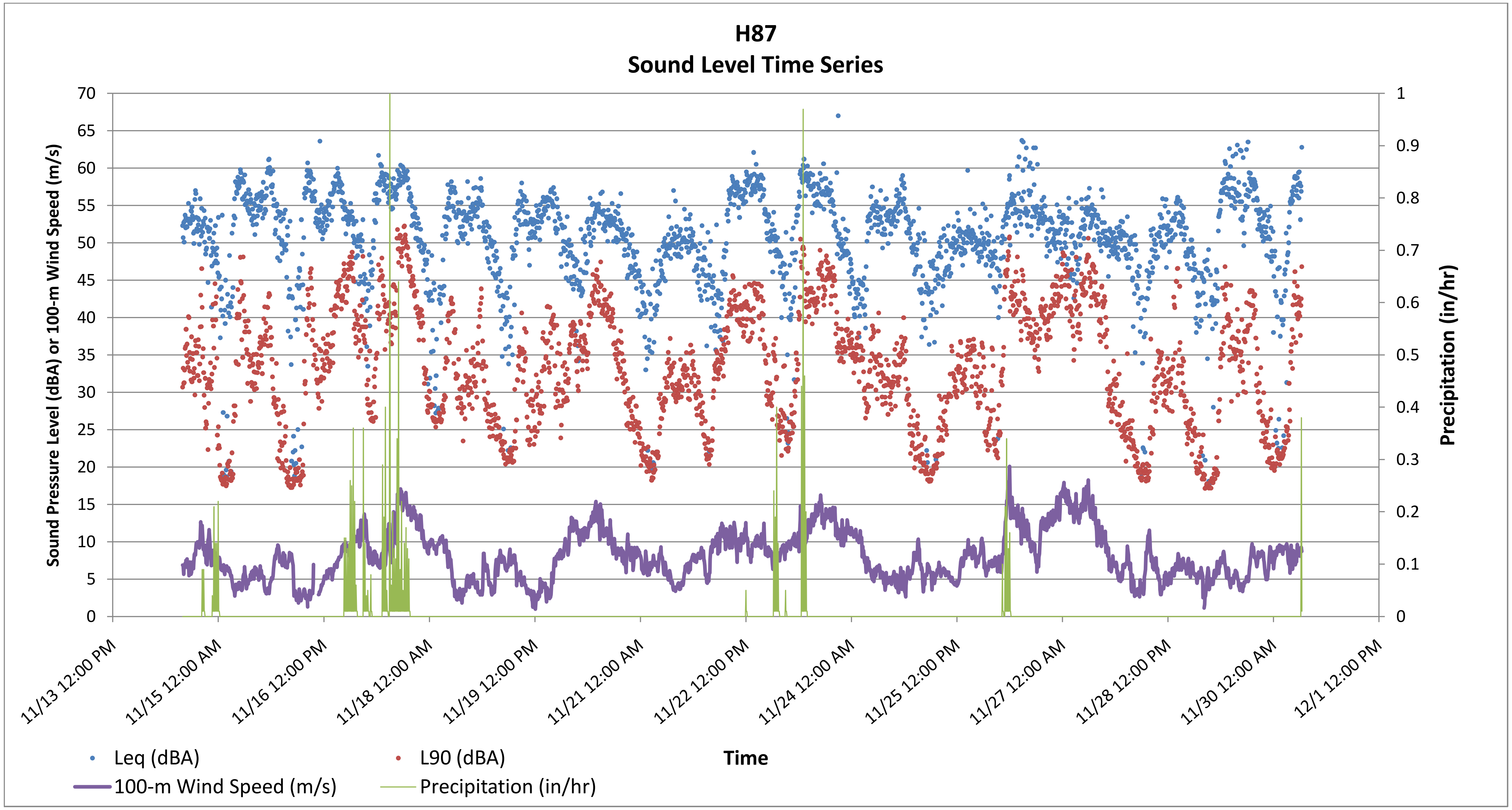

H87 - Night
L90 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L90 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)



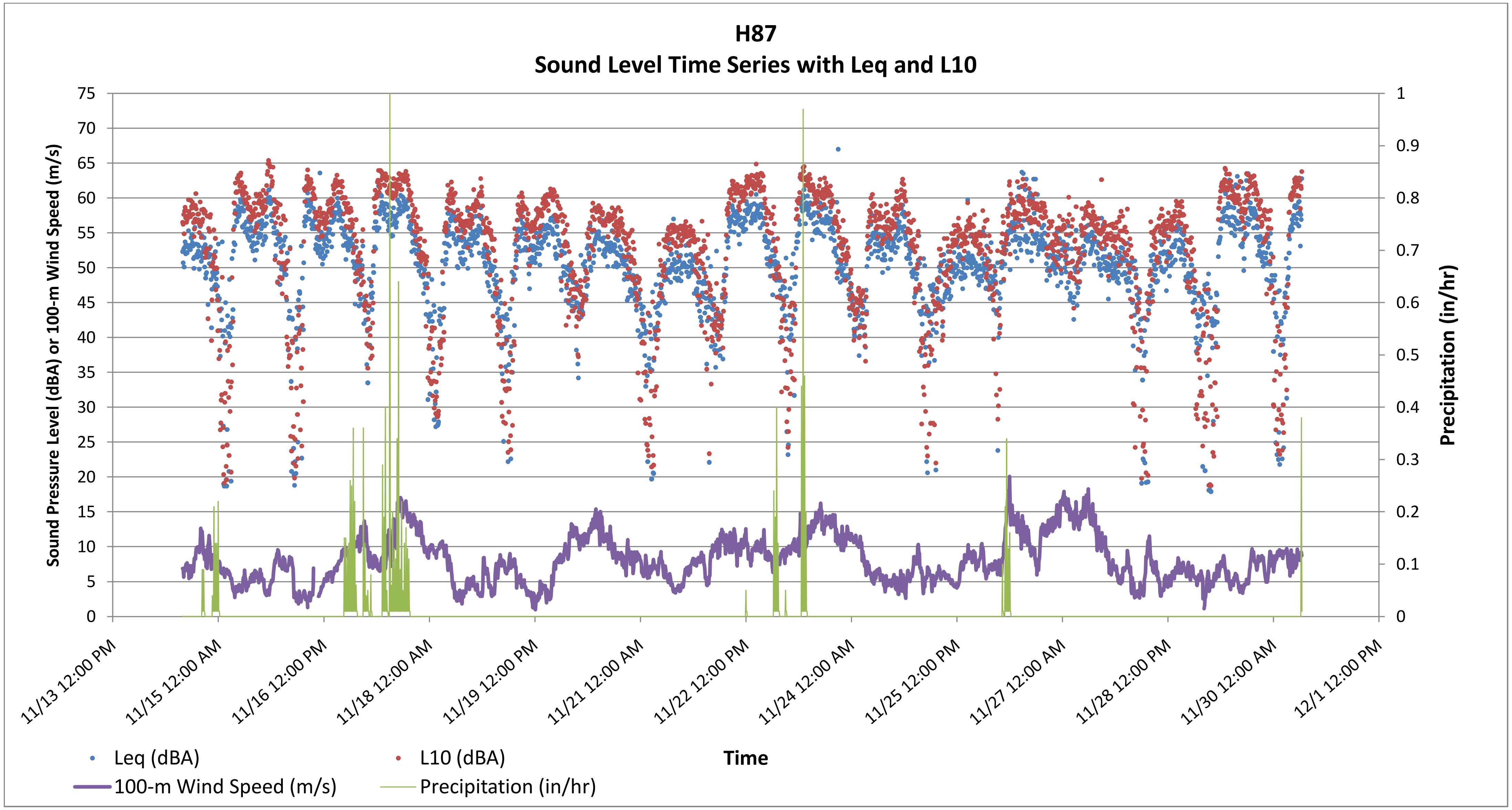
H87 - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

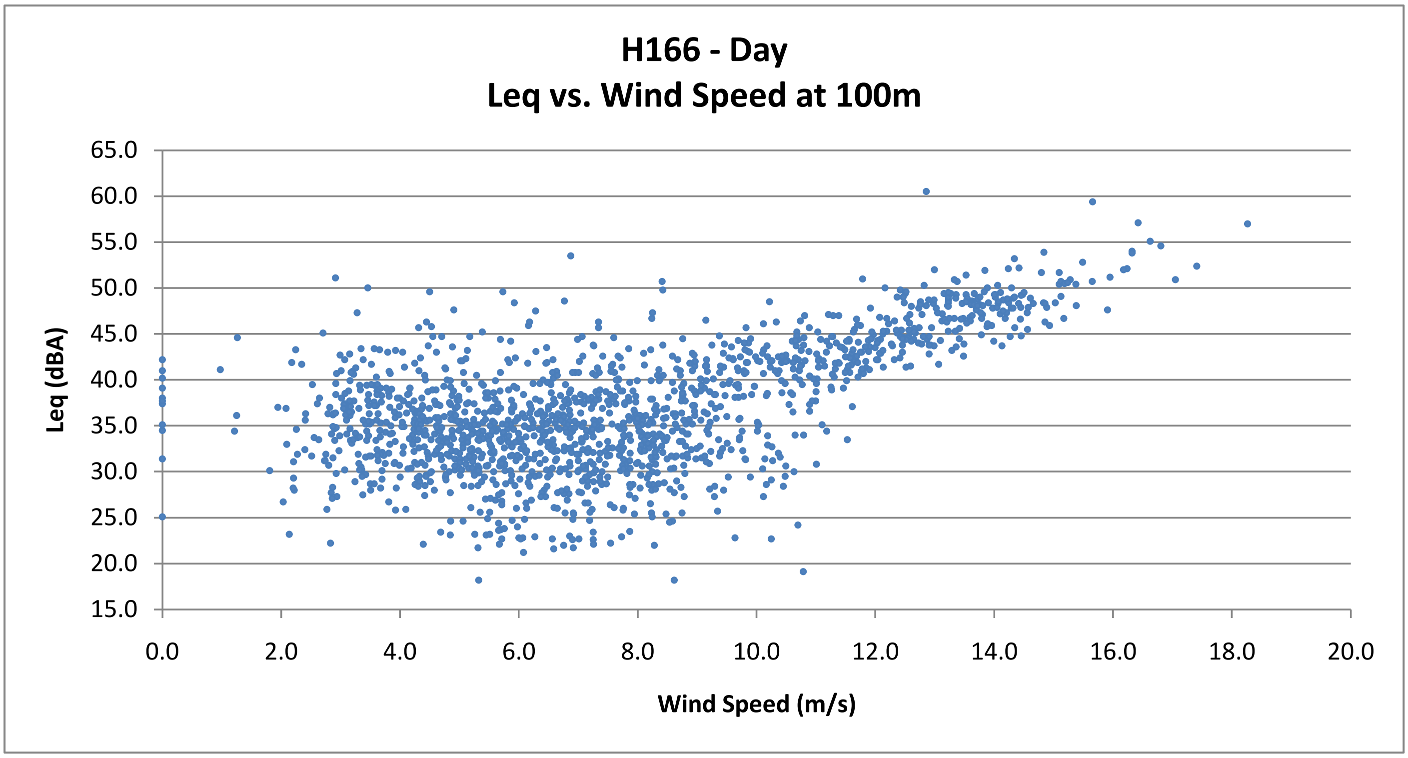
H87 - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

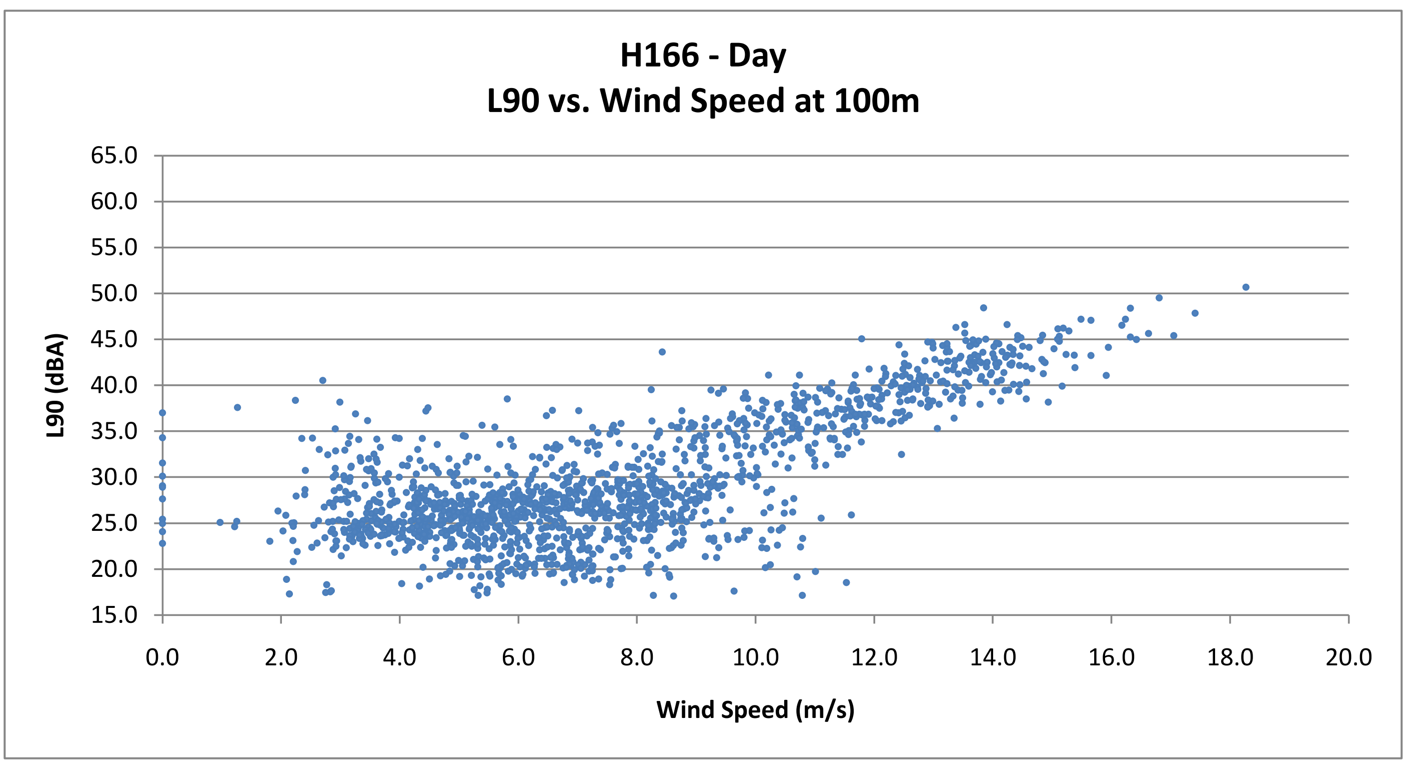


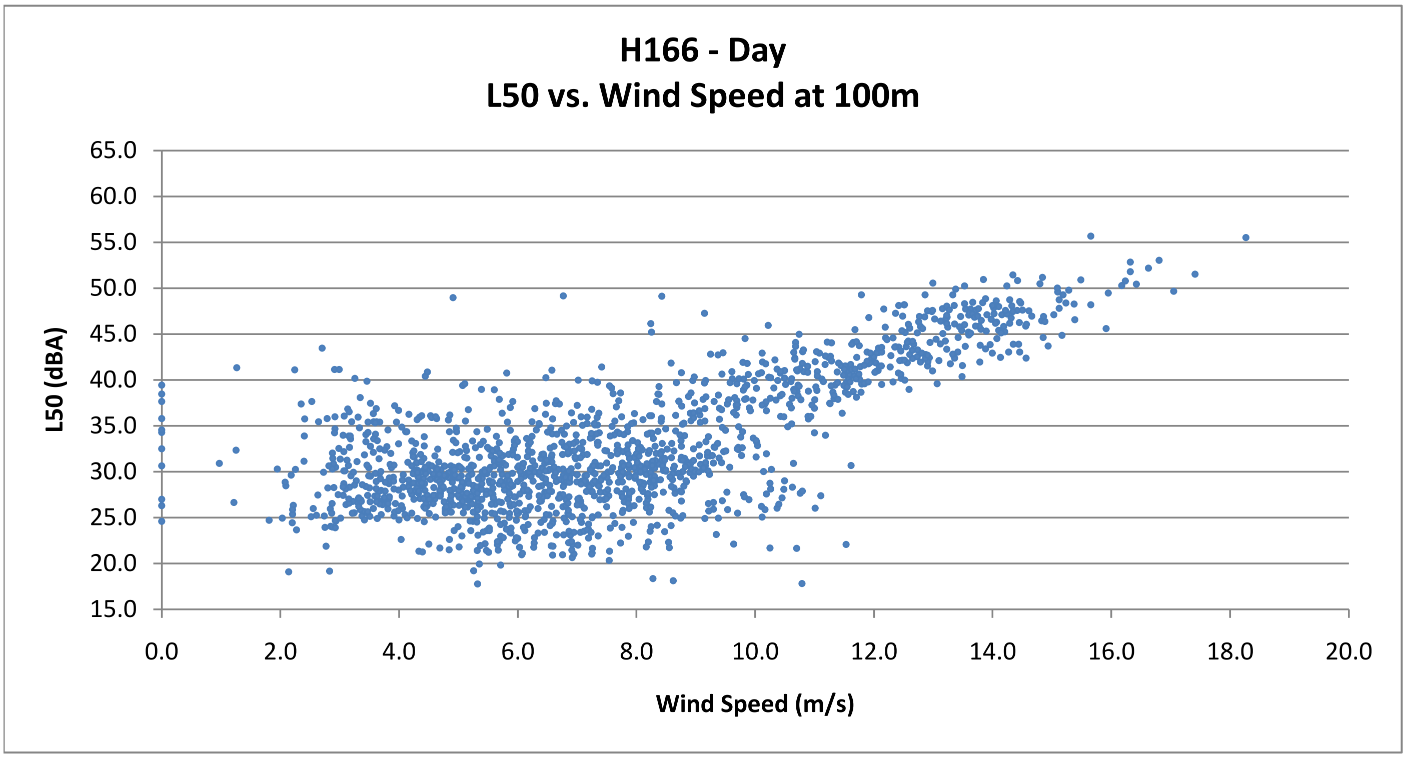
H87
Sound Level Time Series
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

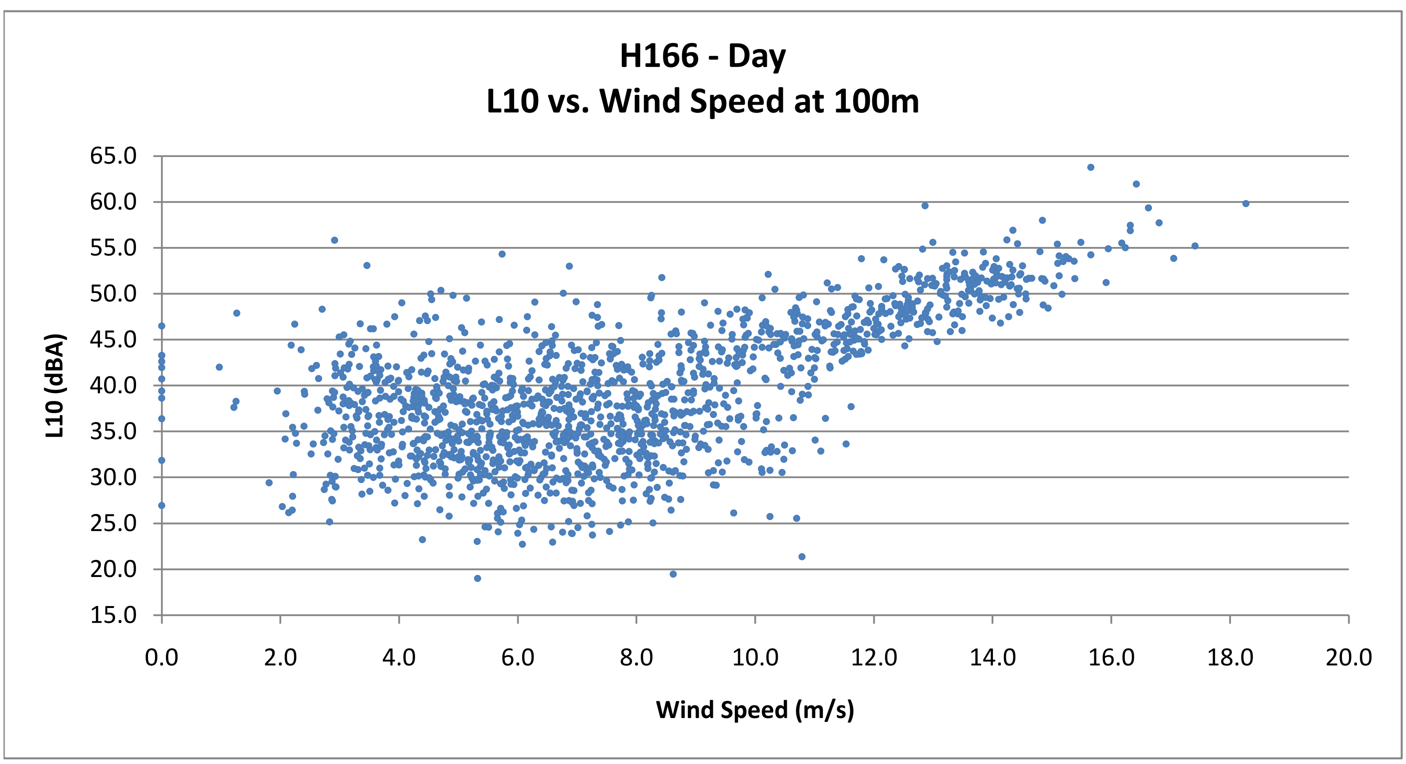


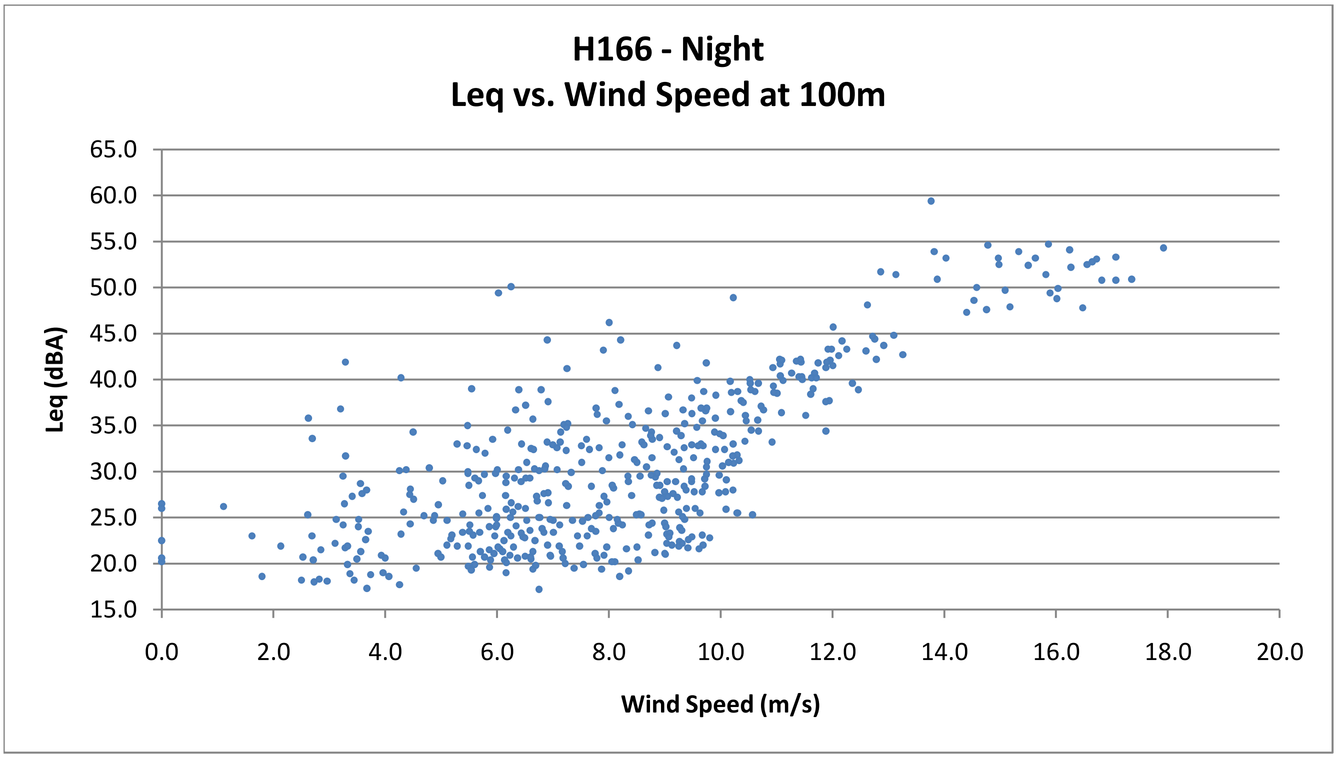
H87
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

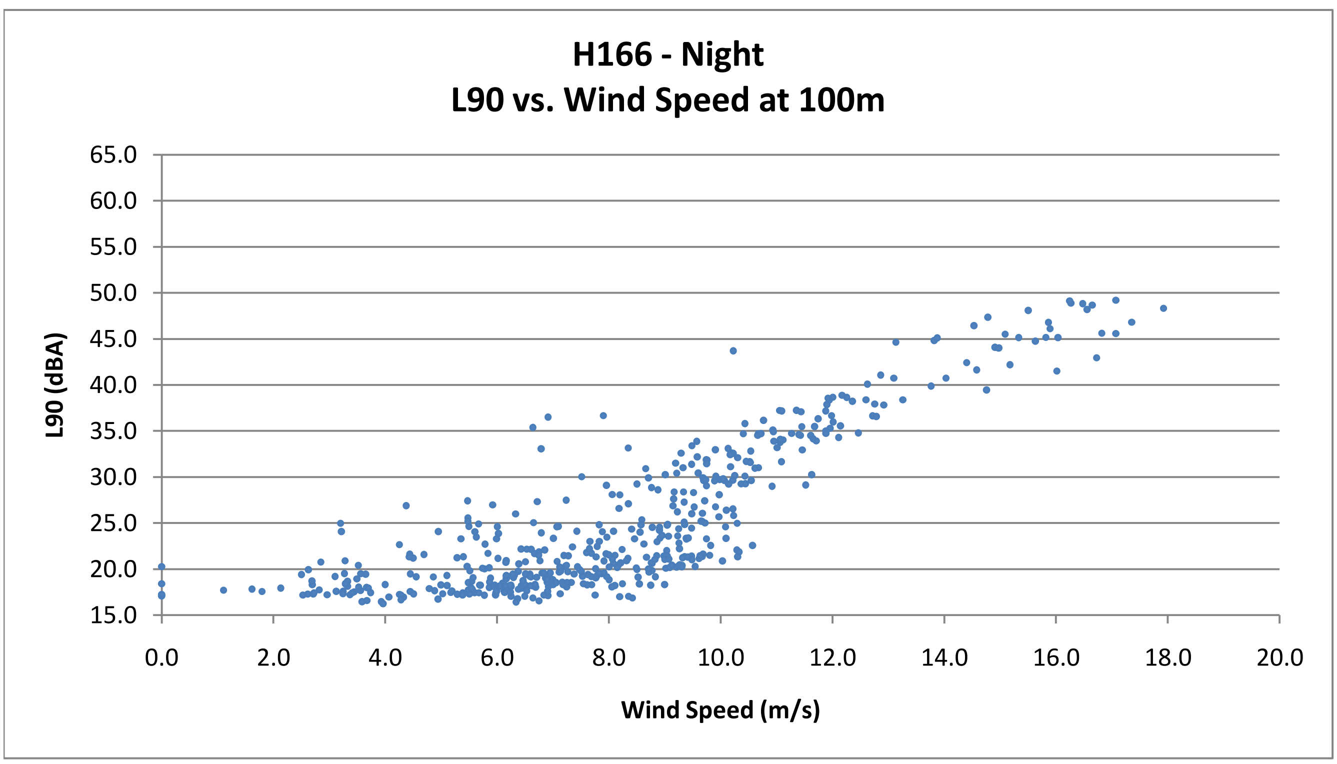

H166 - Day
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

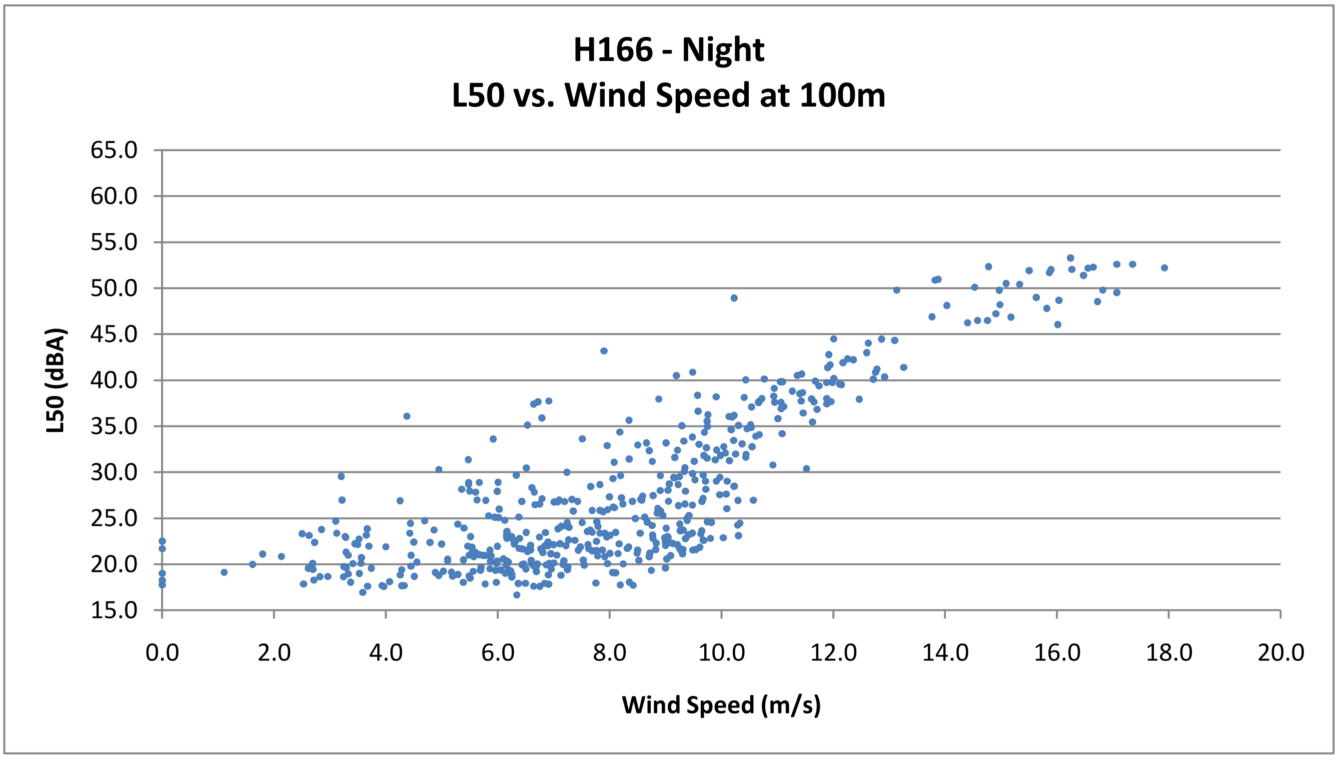

H166 - Day
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

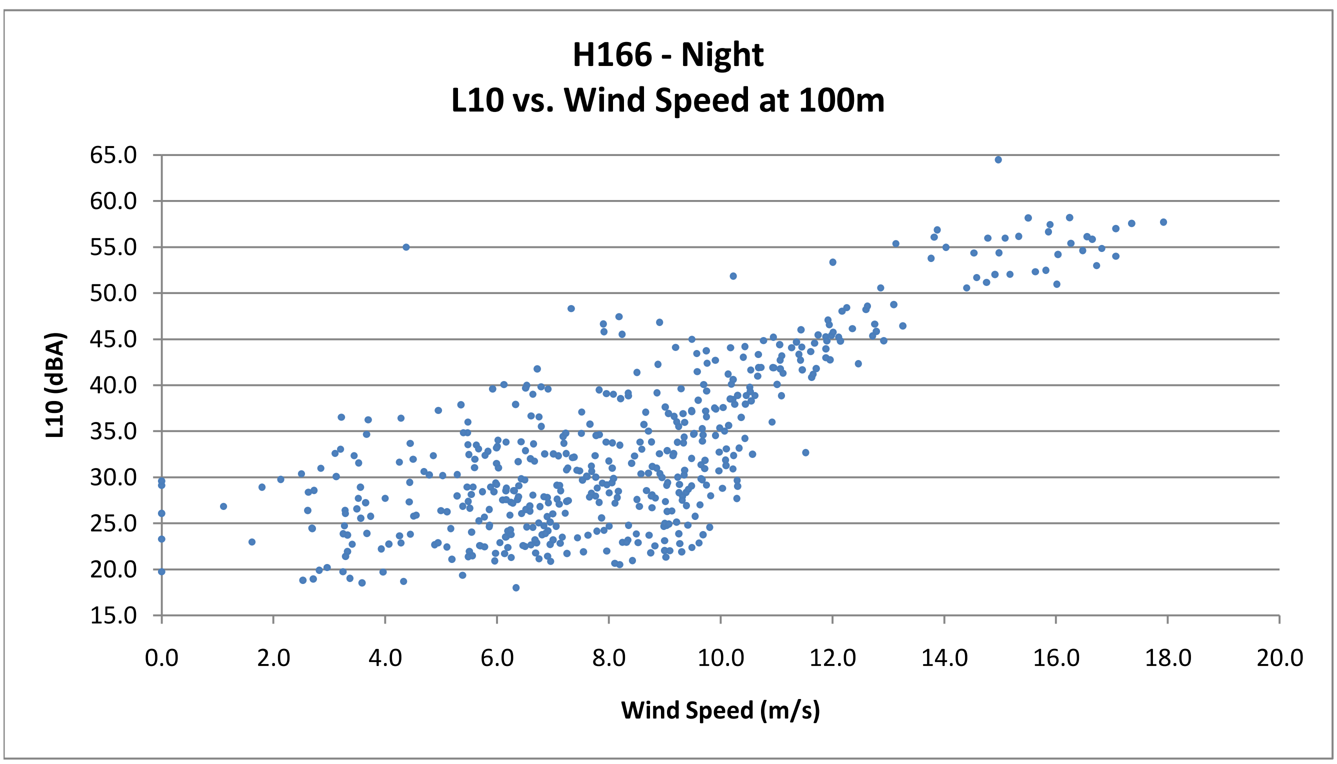

H166 - Day
L50 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L50 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

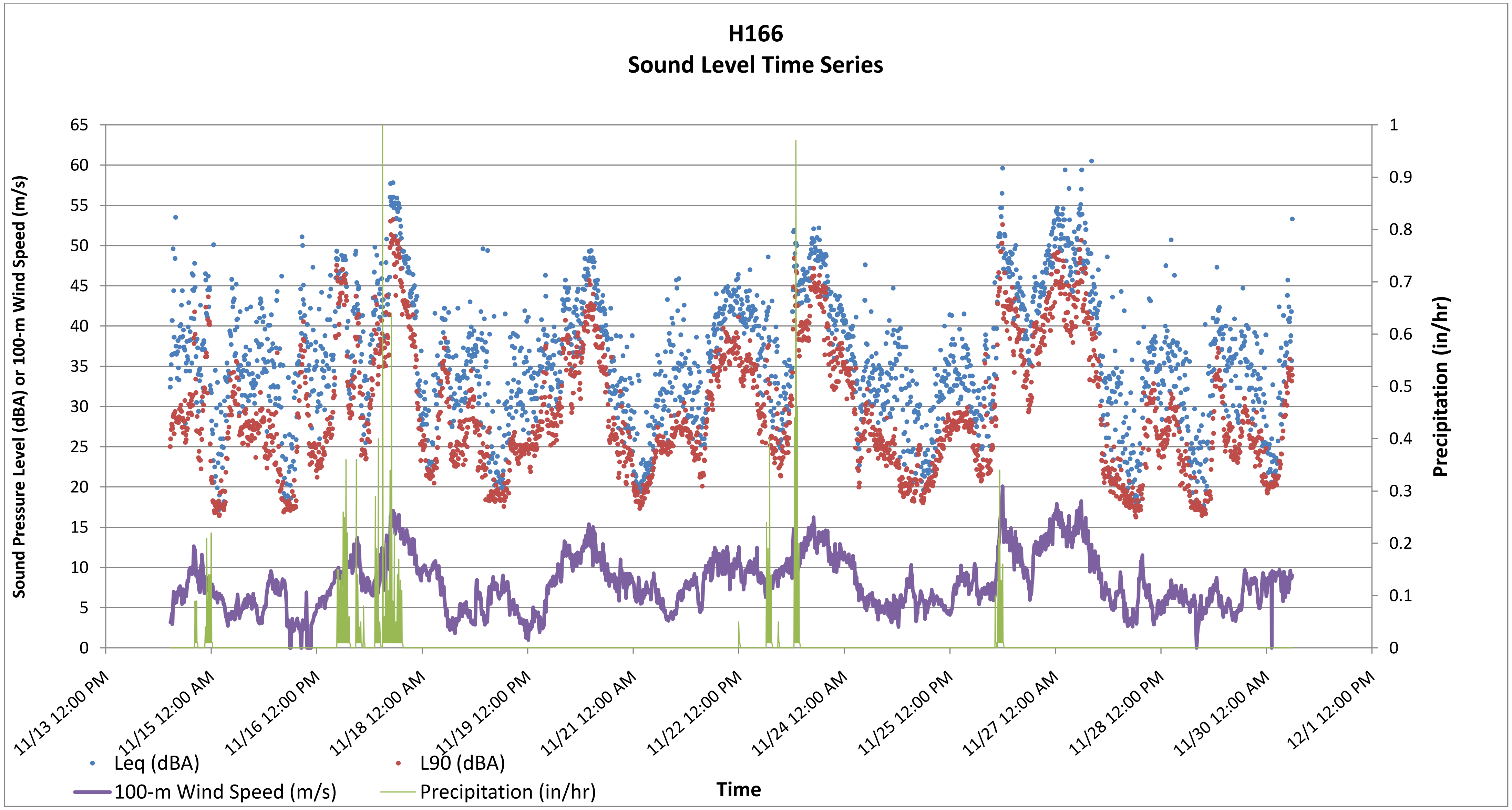

H166 - Day
L10 vs. Wind Speed at 100m
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L10 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

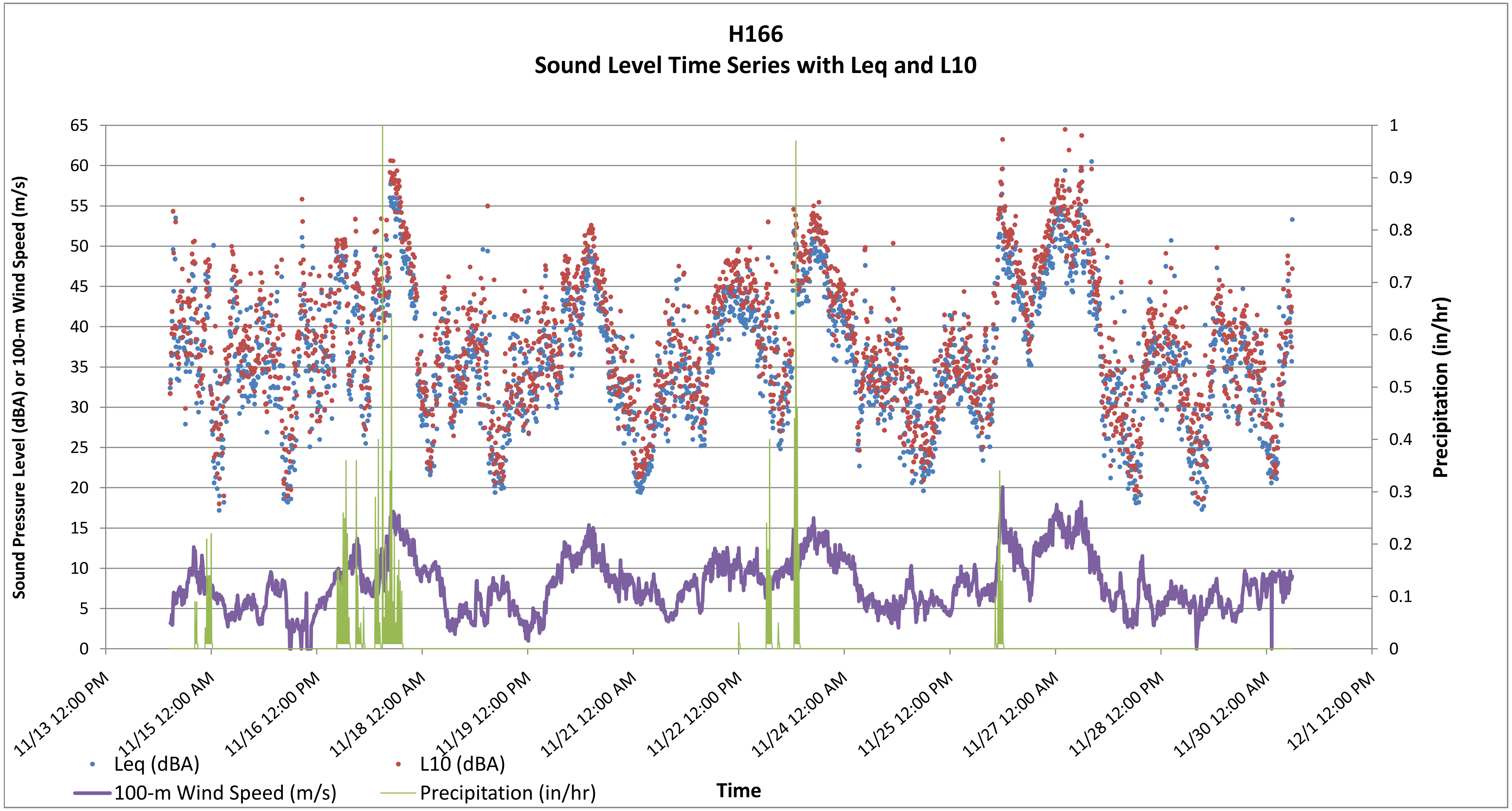

H166 - Night
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H166 - Night
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

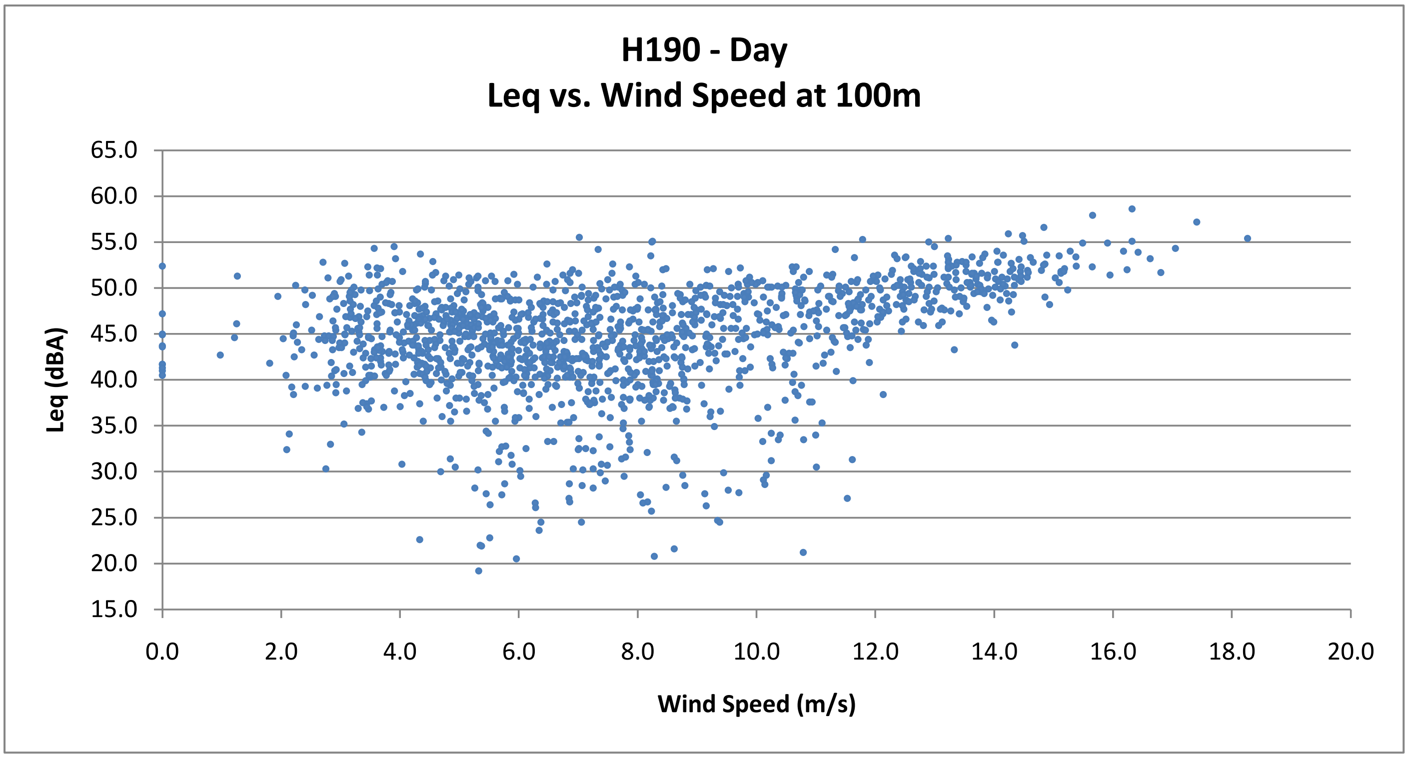

H166 - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

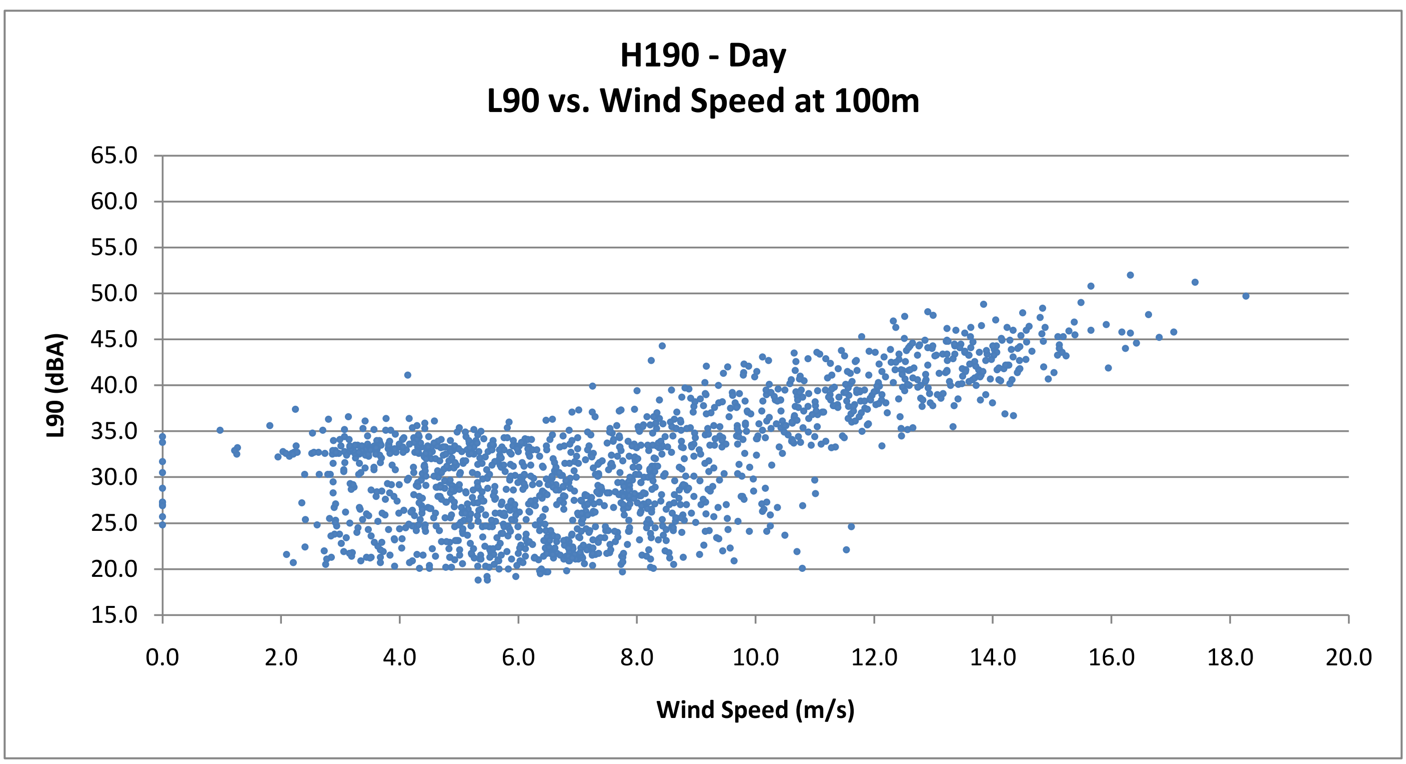

H166 - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

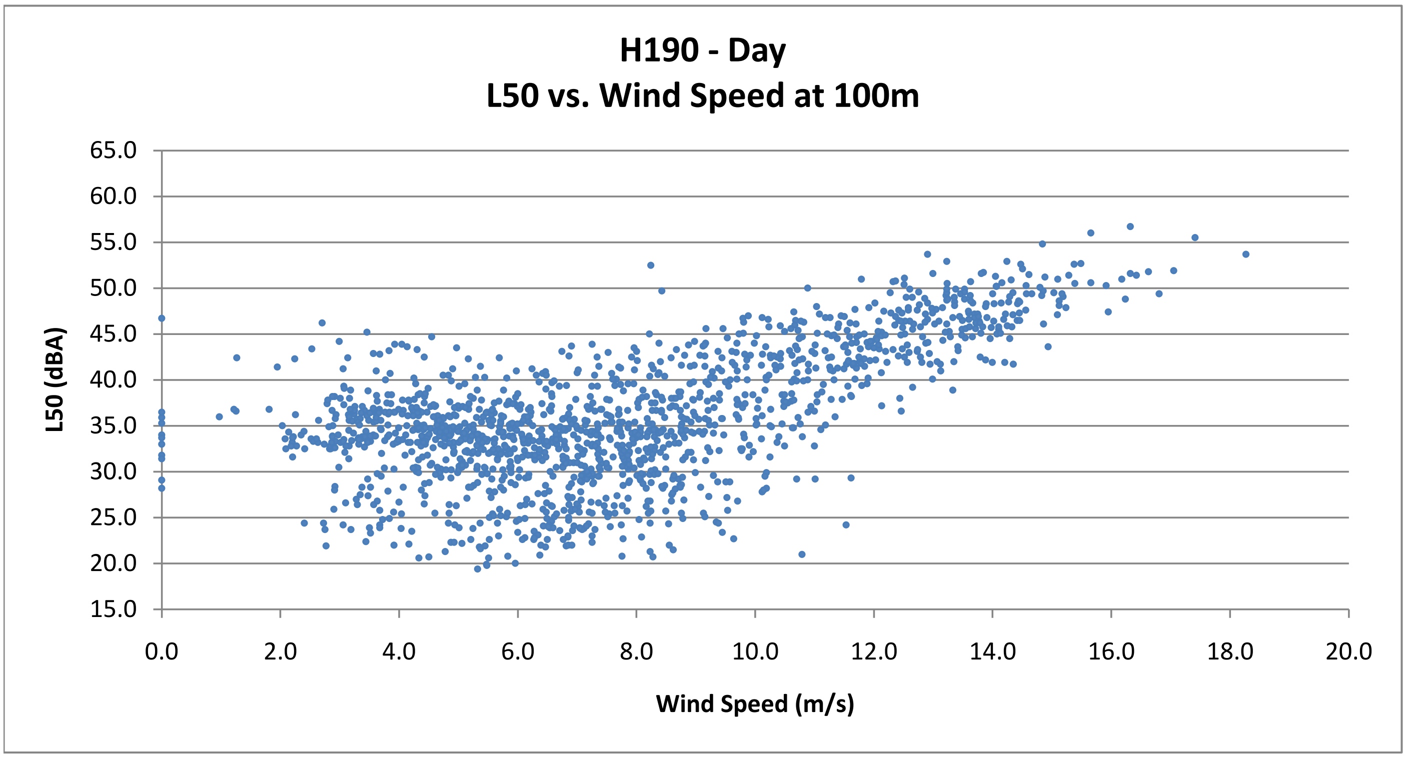

H166
Sound Level Time Series
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)
Time

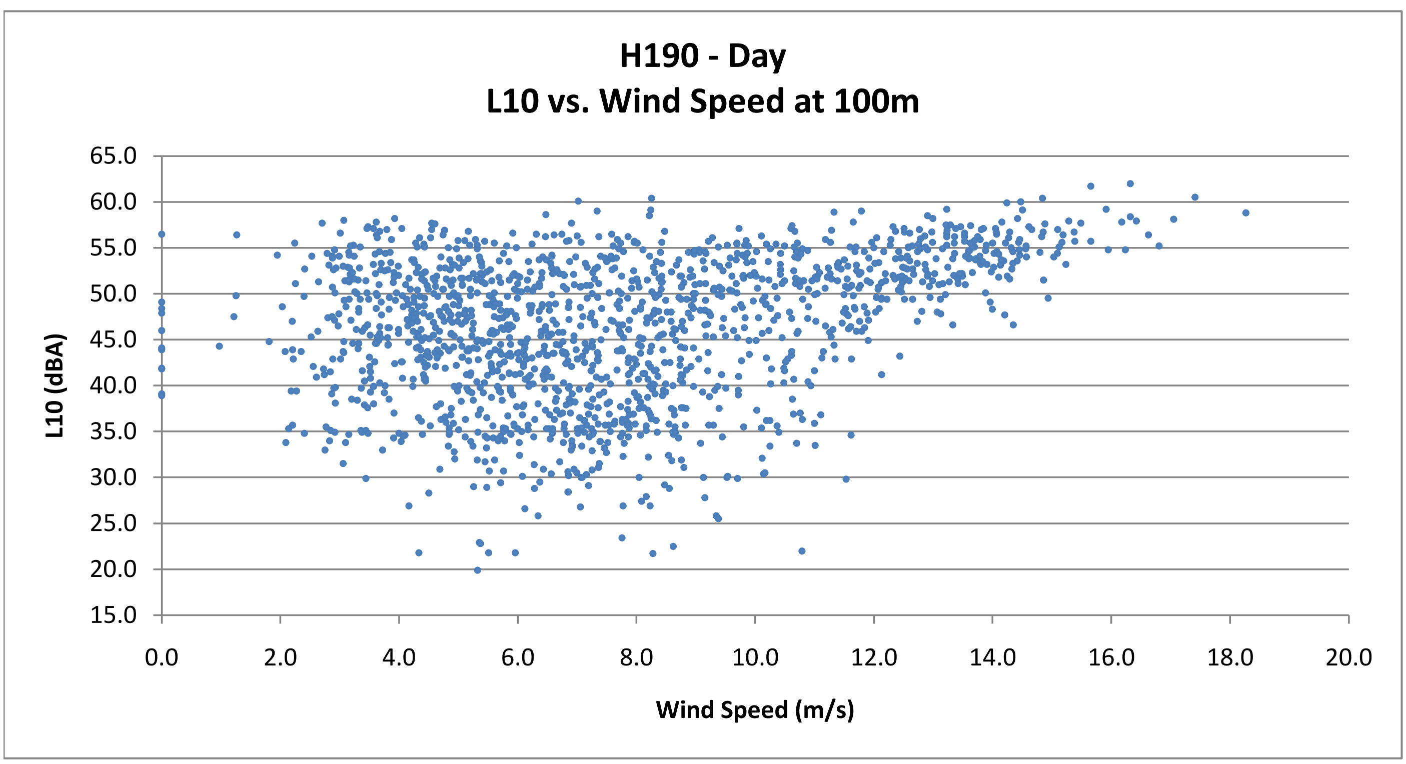


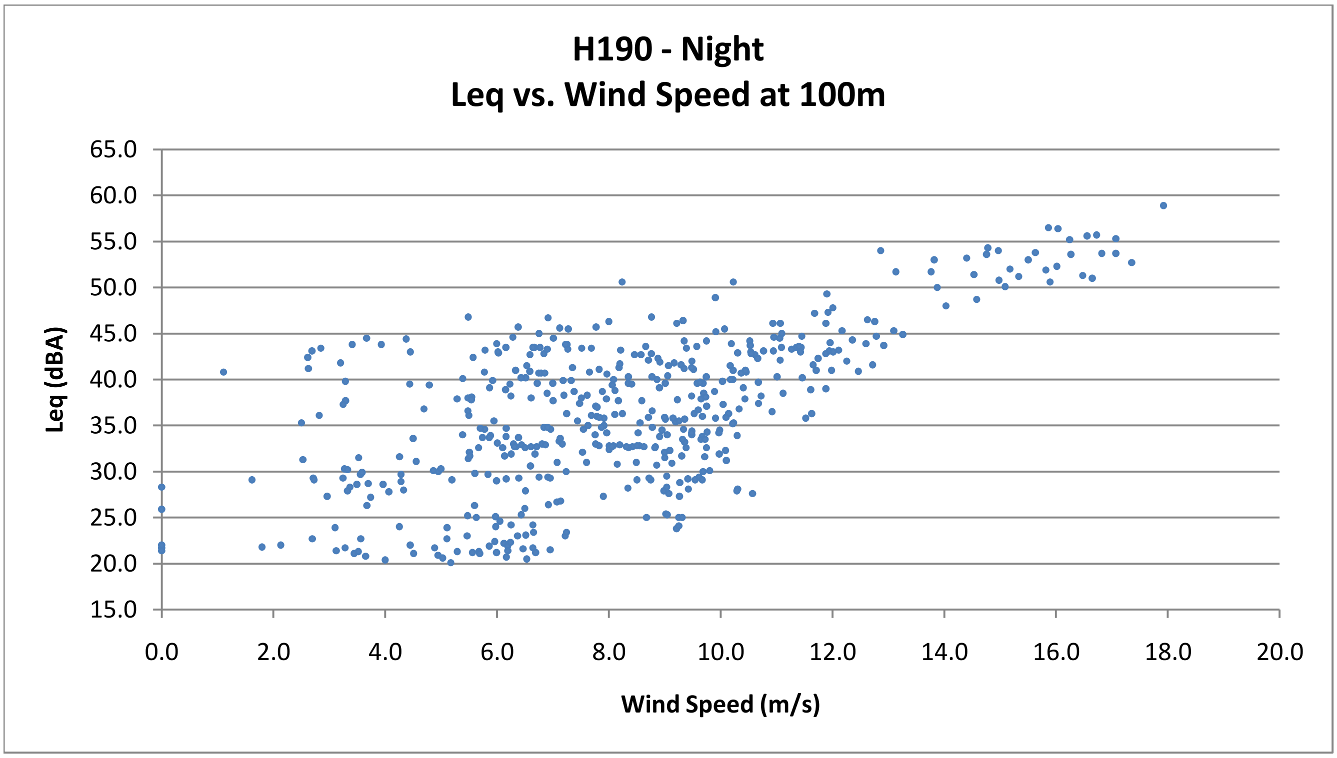
H166
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

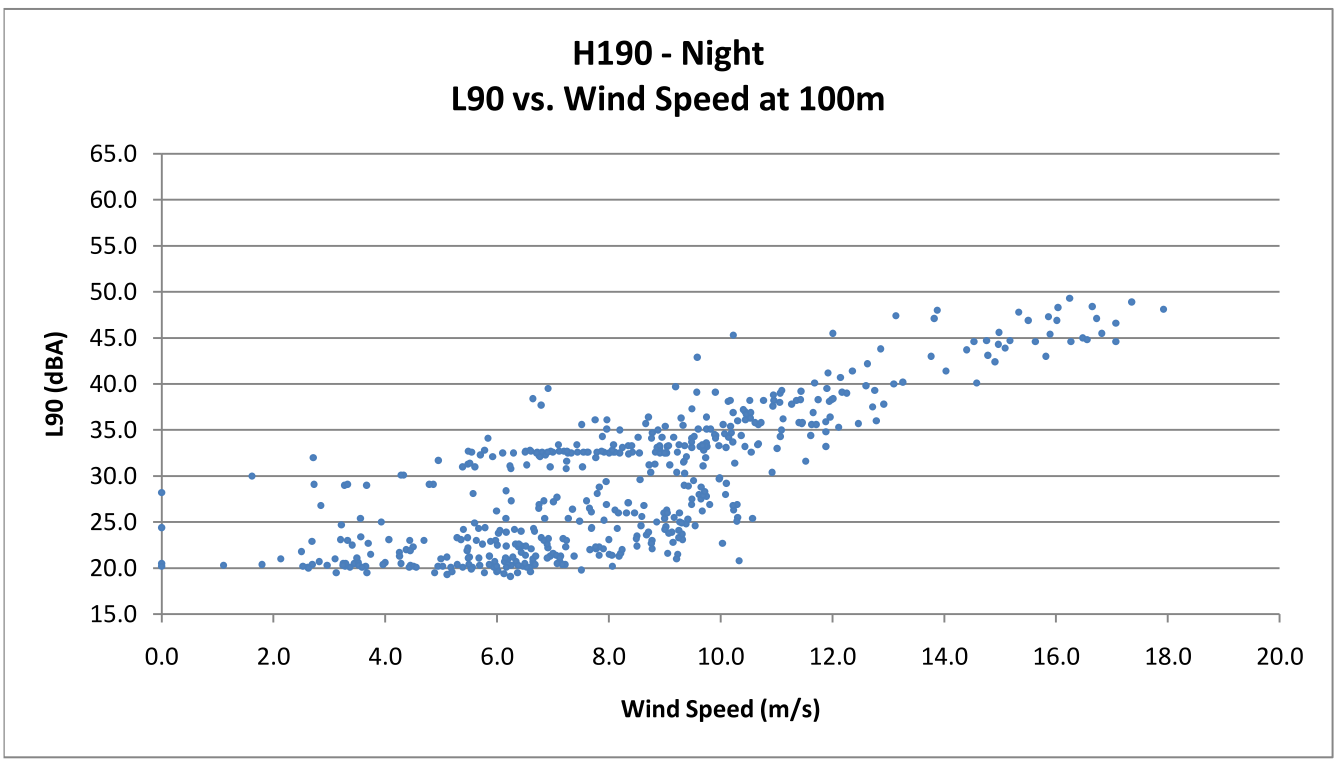

H190 - Day
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

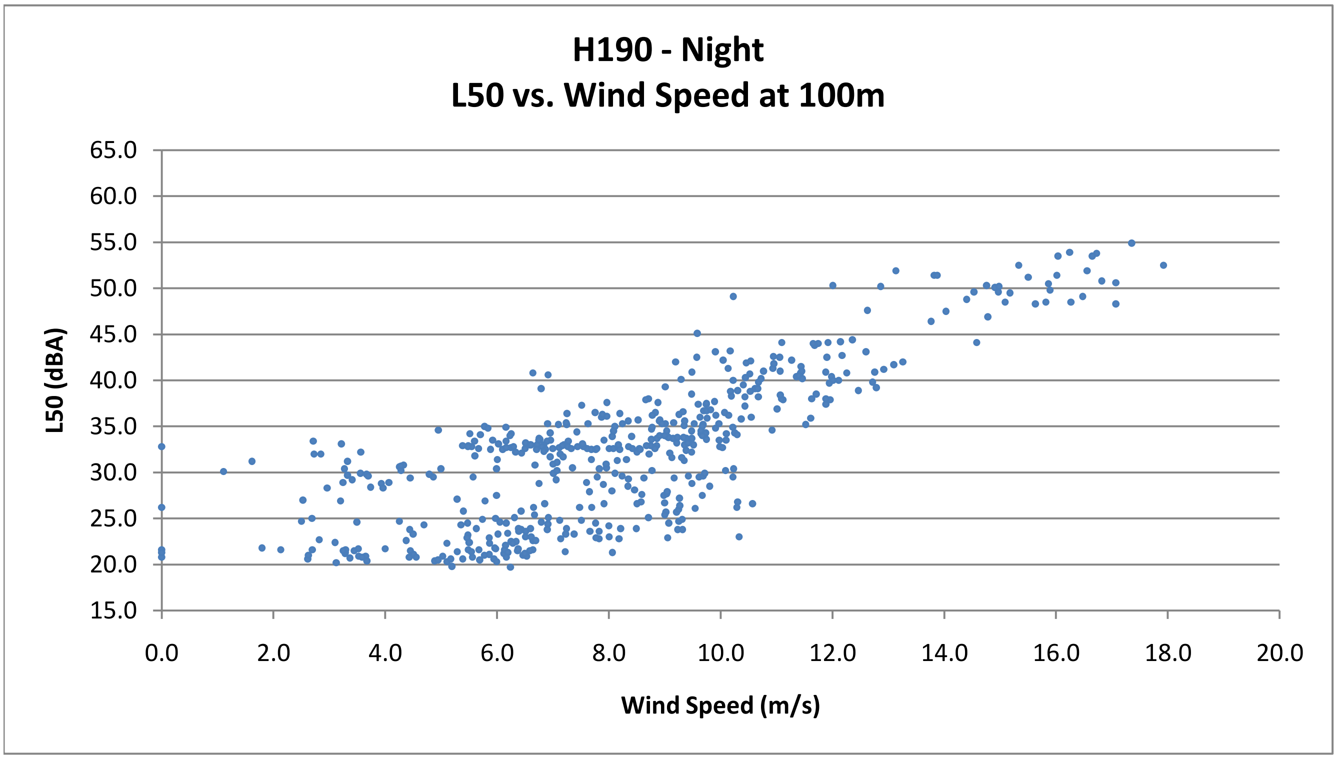

H190 - Day
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

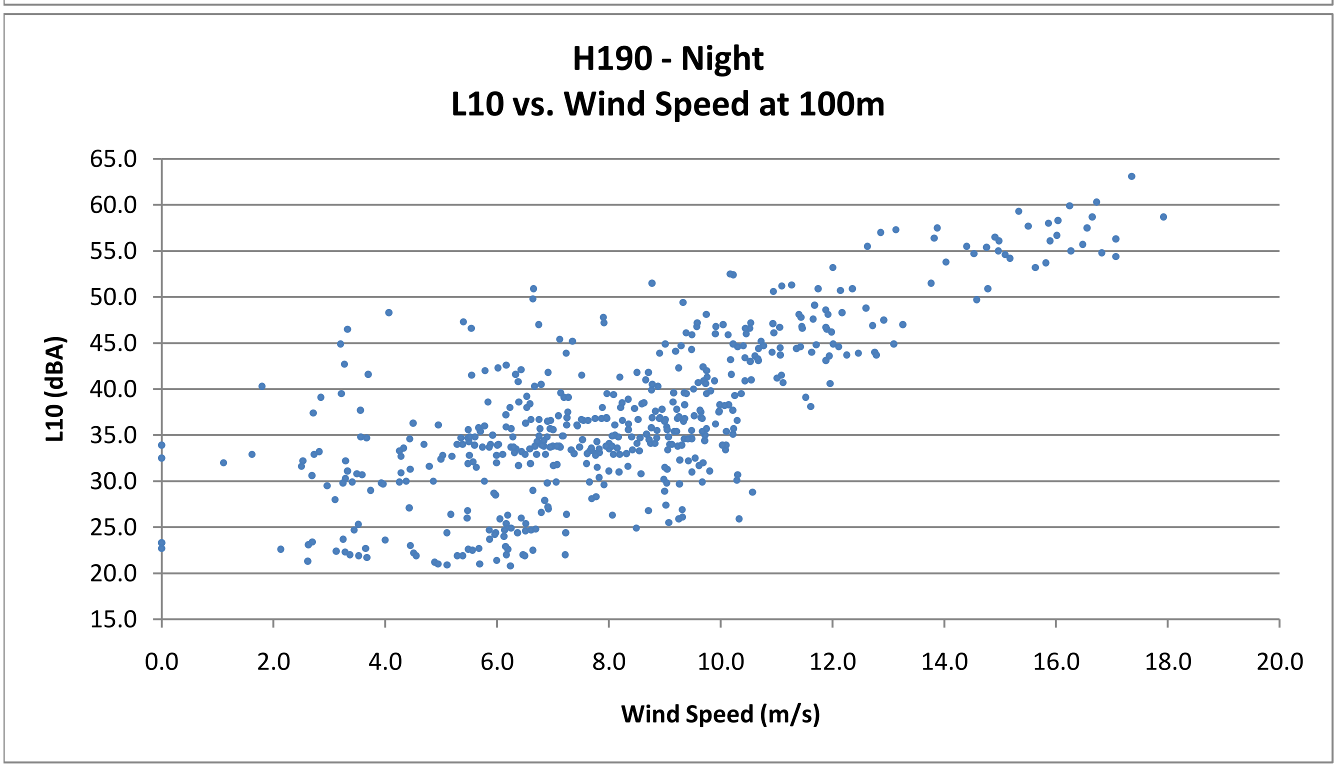

H190 - Day
L50 vs. Wind Speed at 100m
L50 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

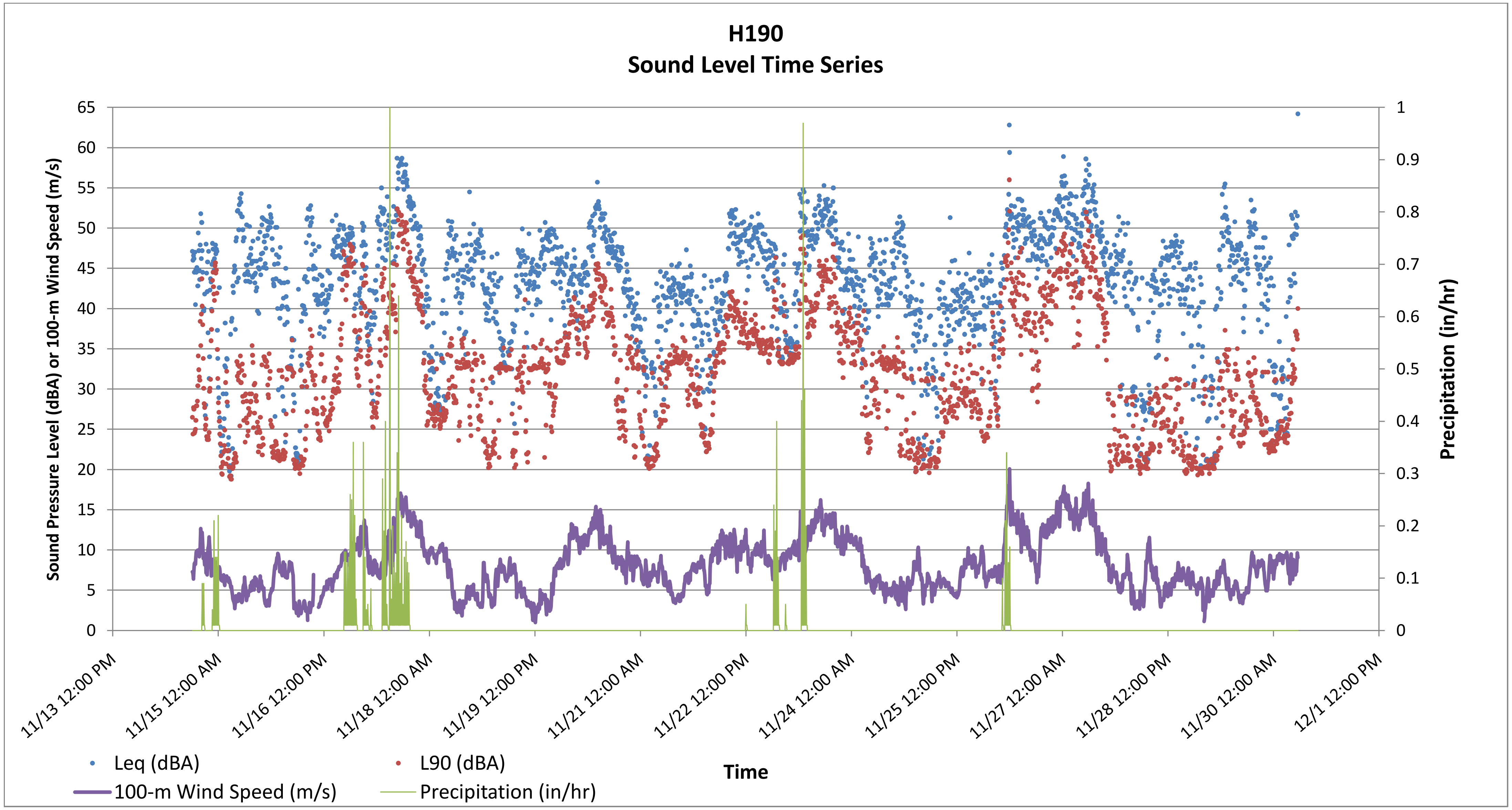

H190 - Day
L10 vs. Wind Speed at 100m
L10 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

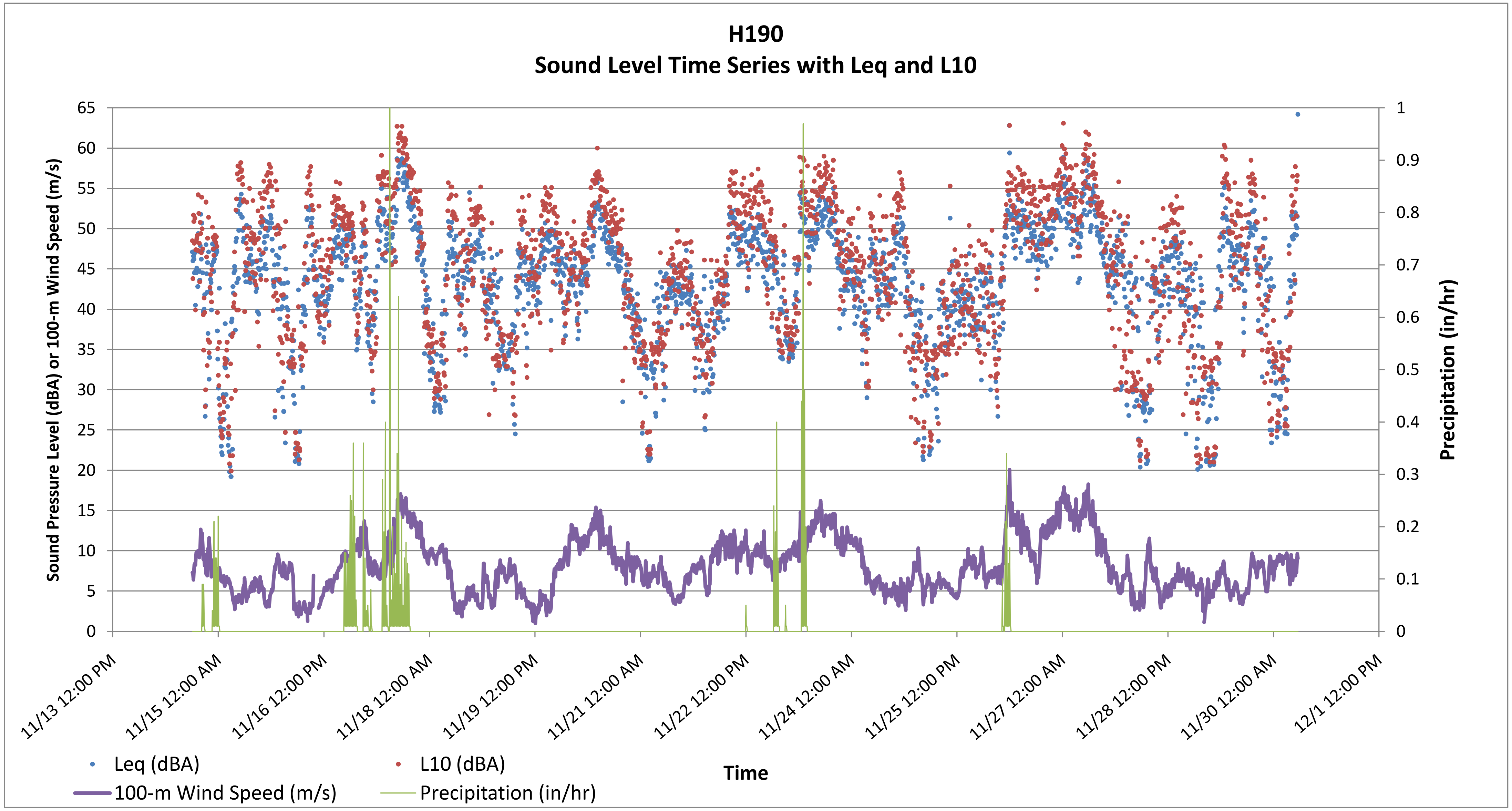

H190 - Night
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H190 - Night
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

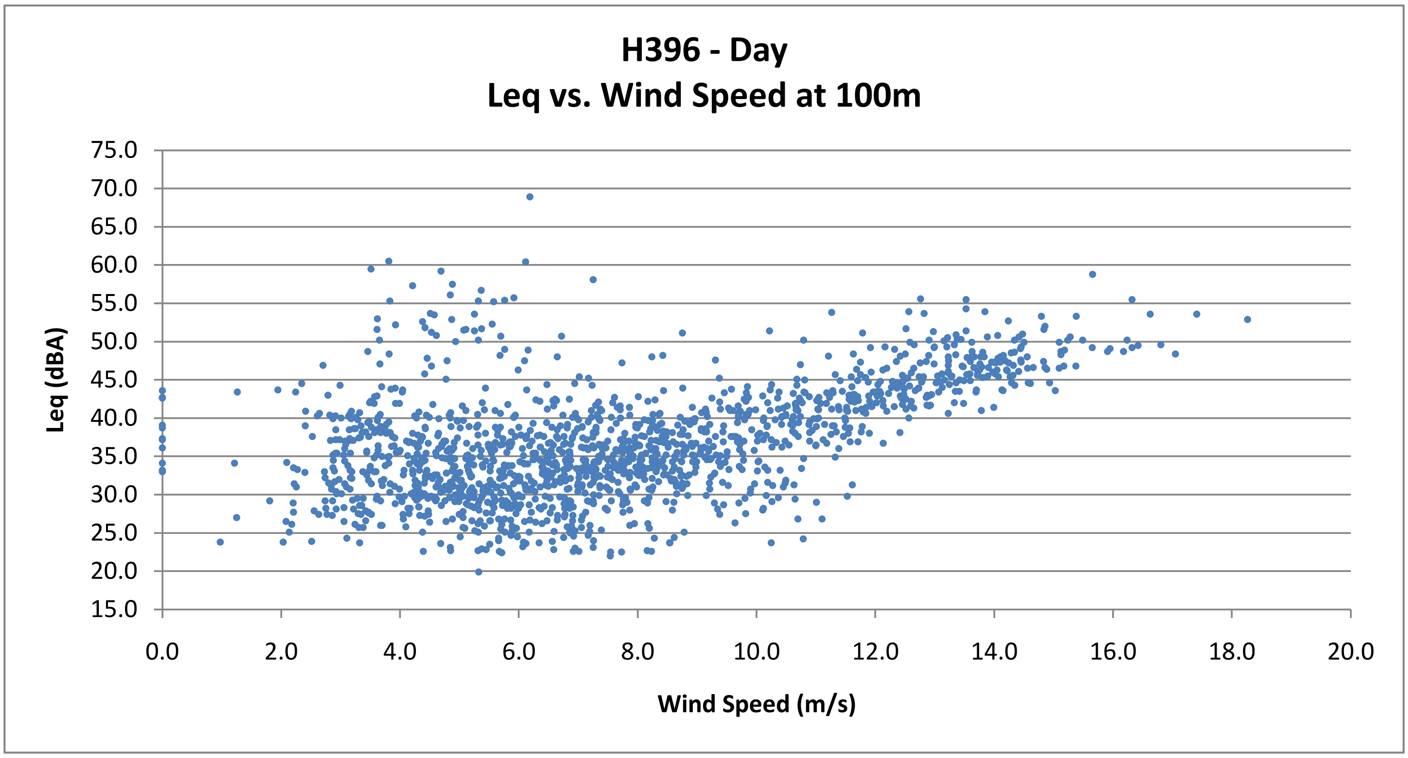

H190 - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
Wind Speed (m/s)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0

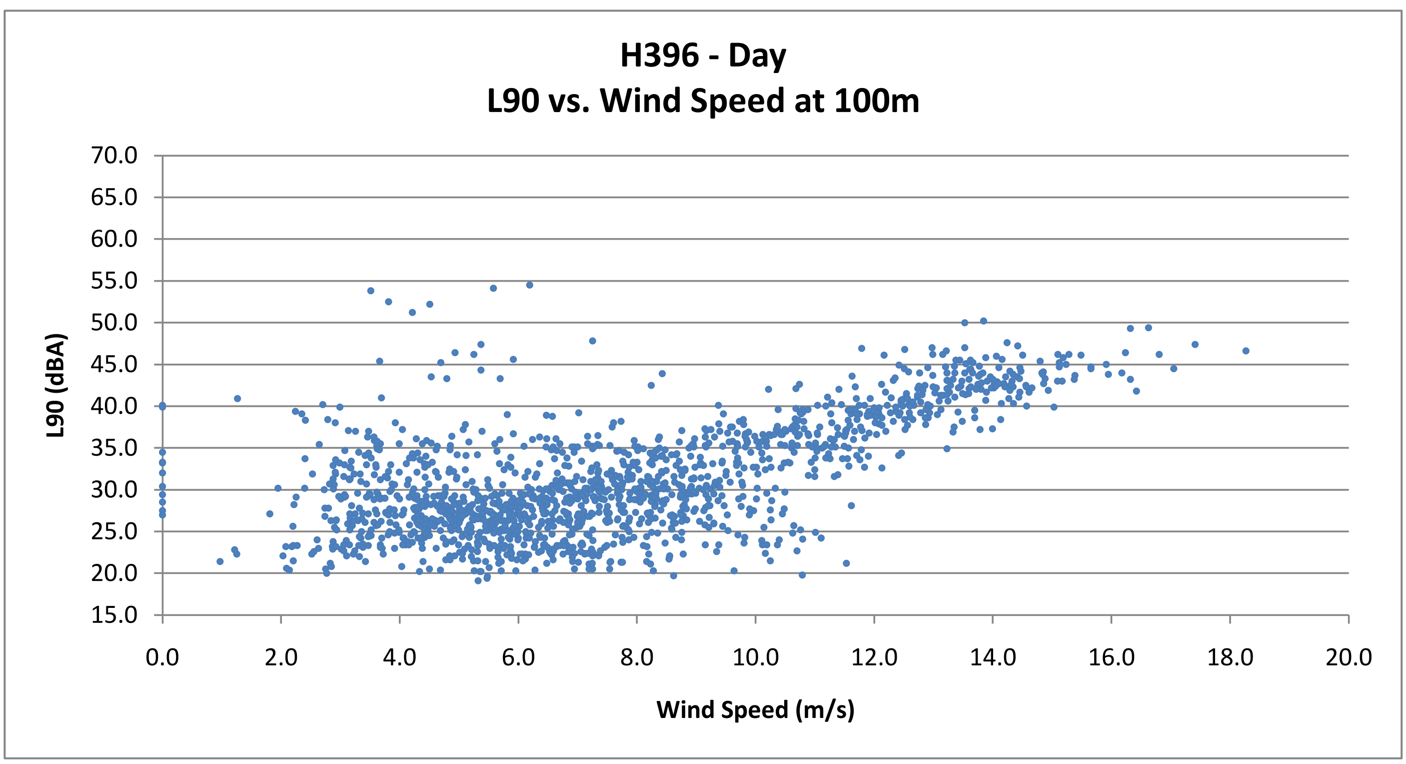

H190 - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
Wind Speed (m/s)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0

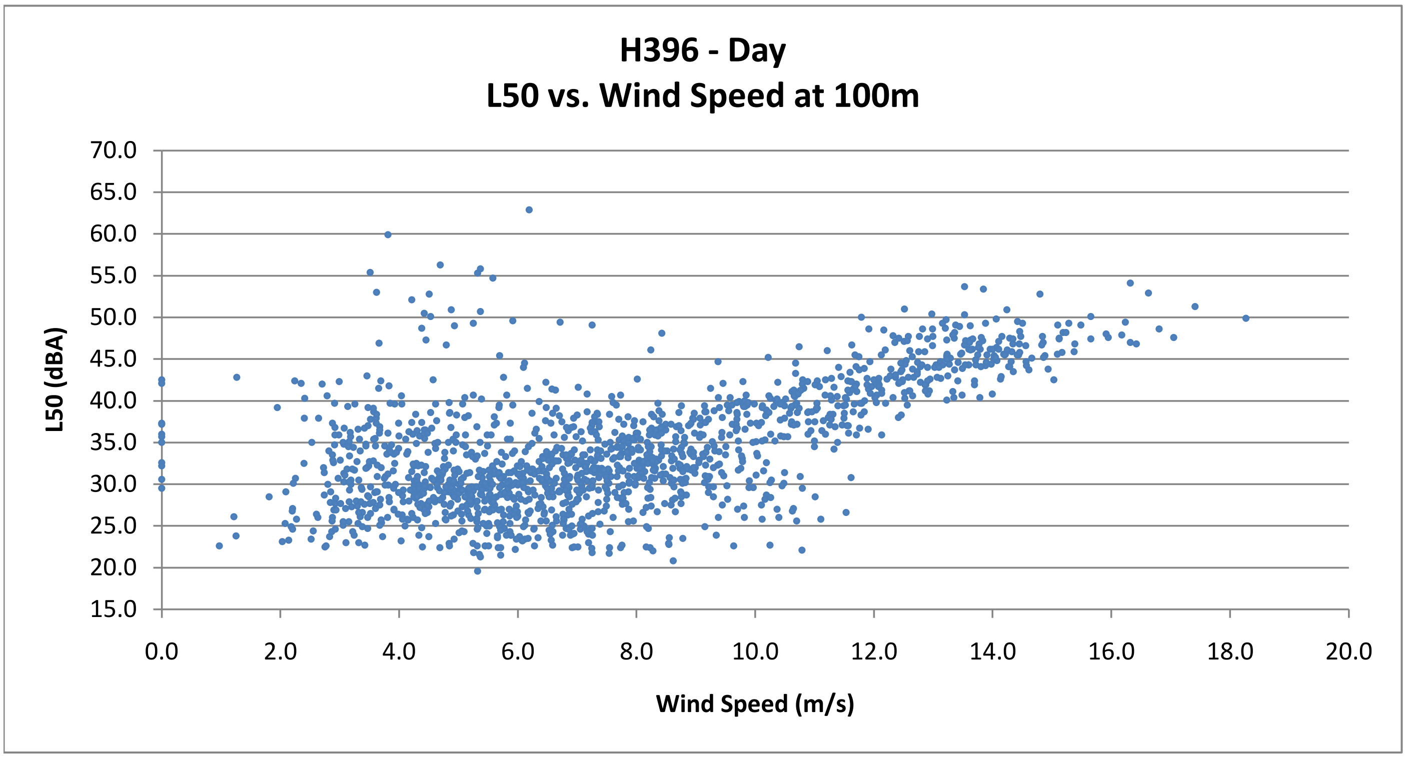

H190
Sound Level Time Series
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

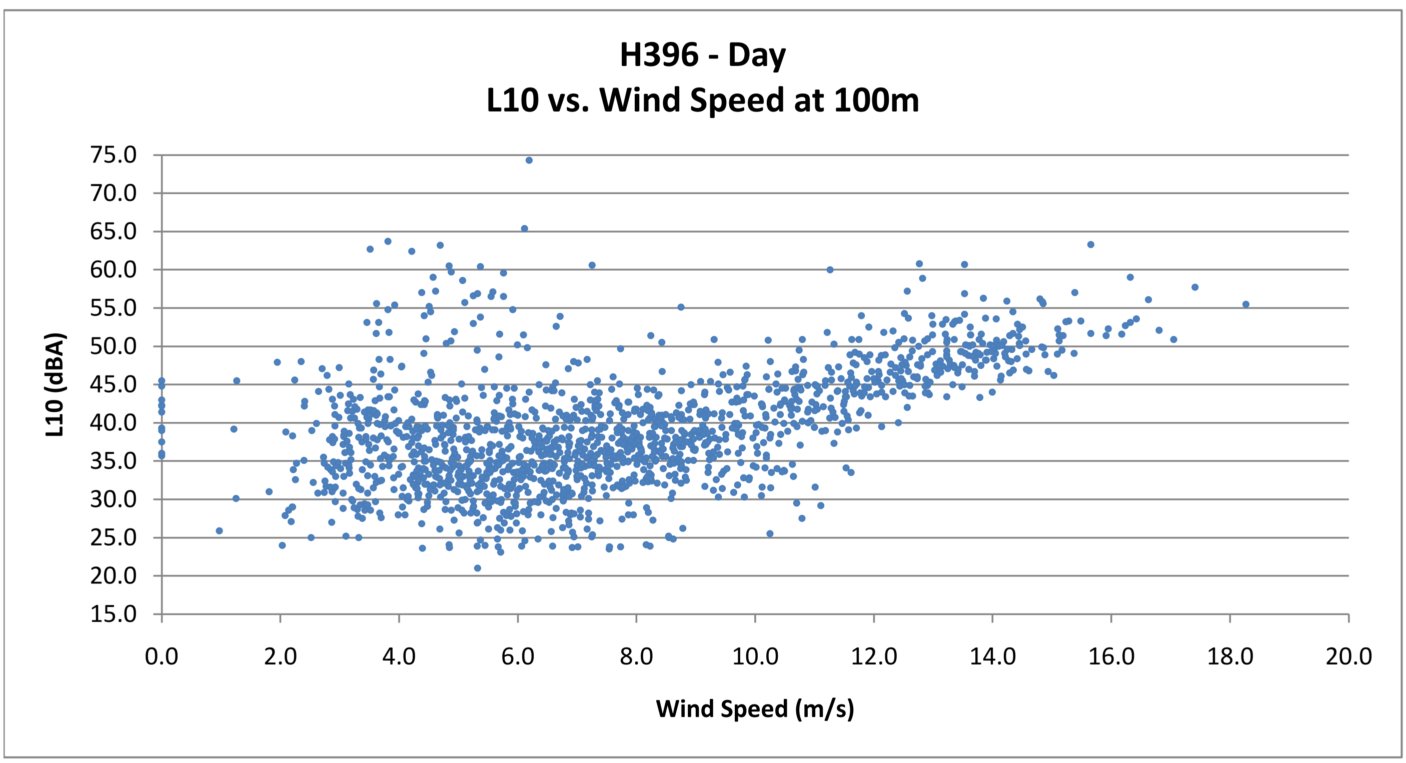


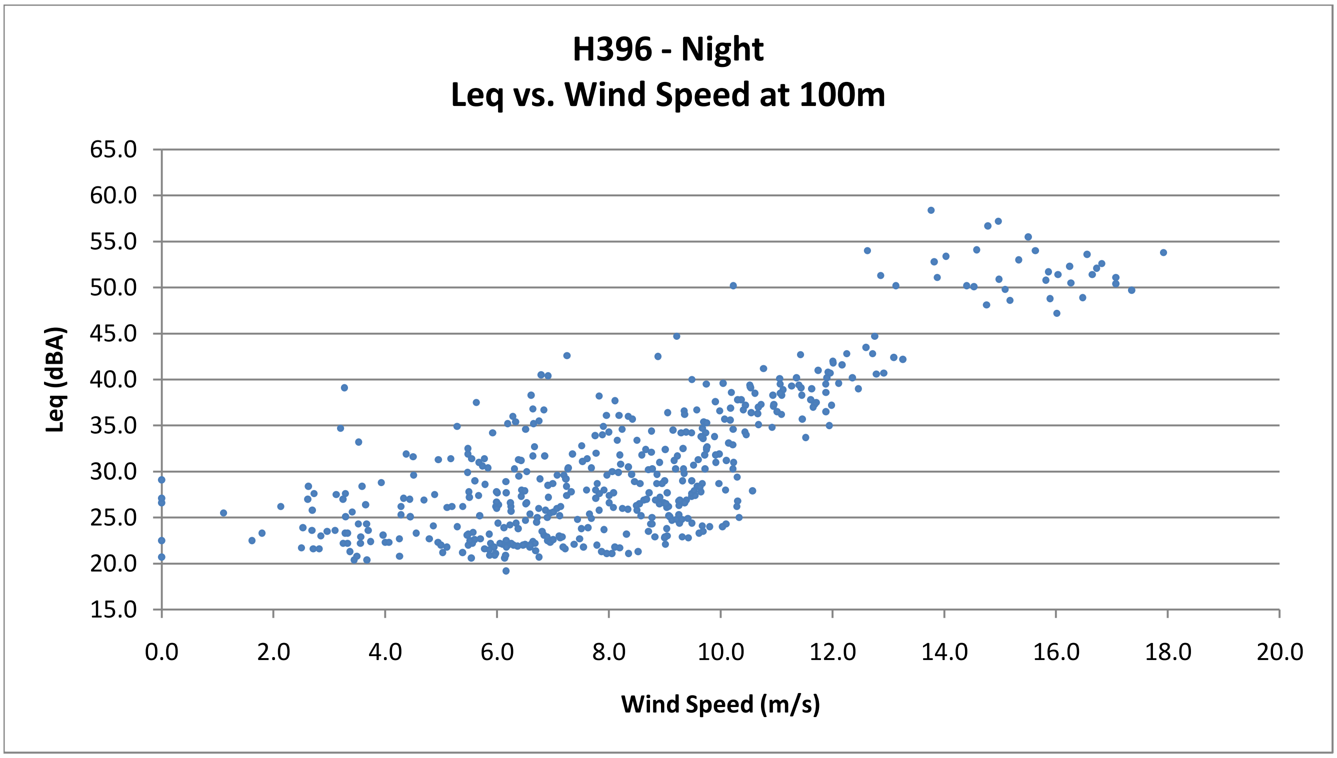
H190
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

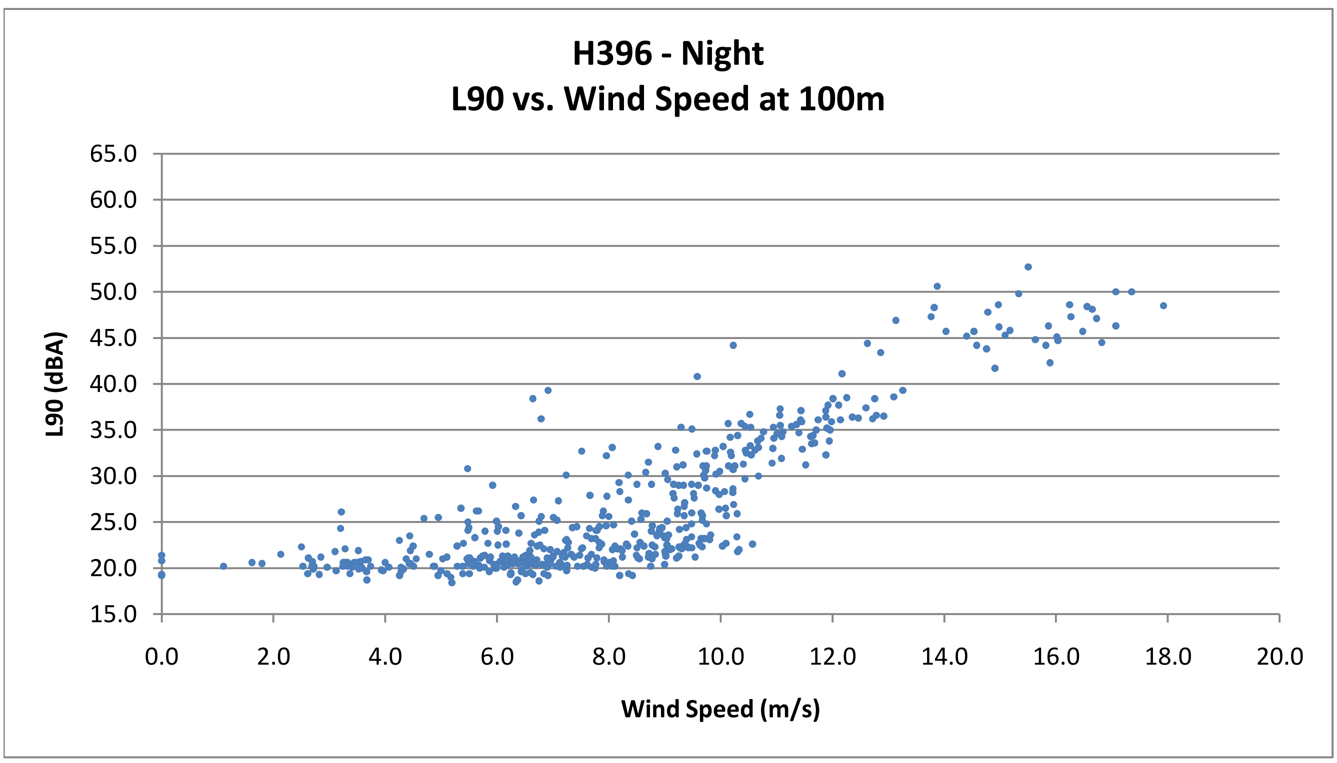

H396 - Day
Leq vs. Wind Speed at 100m
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
Leq (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

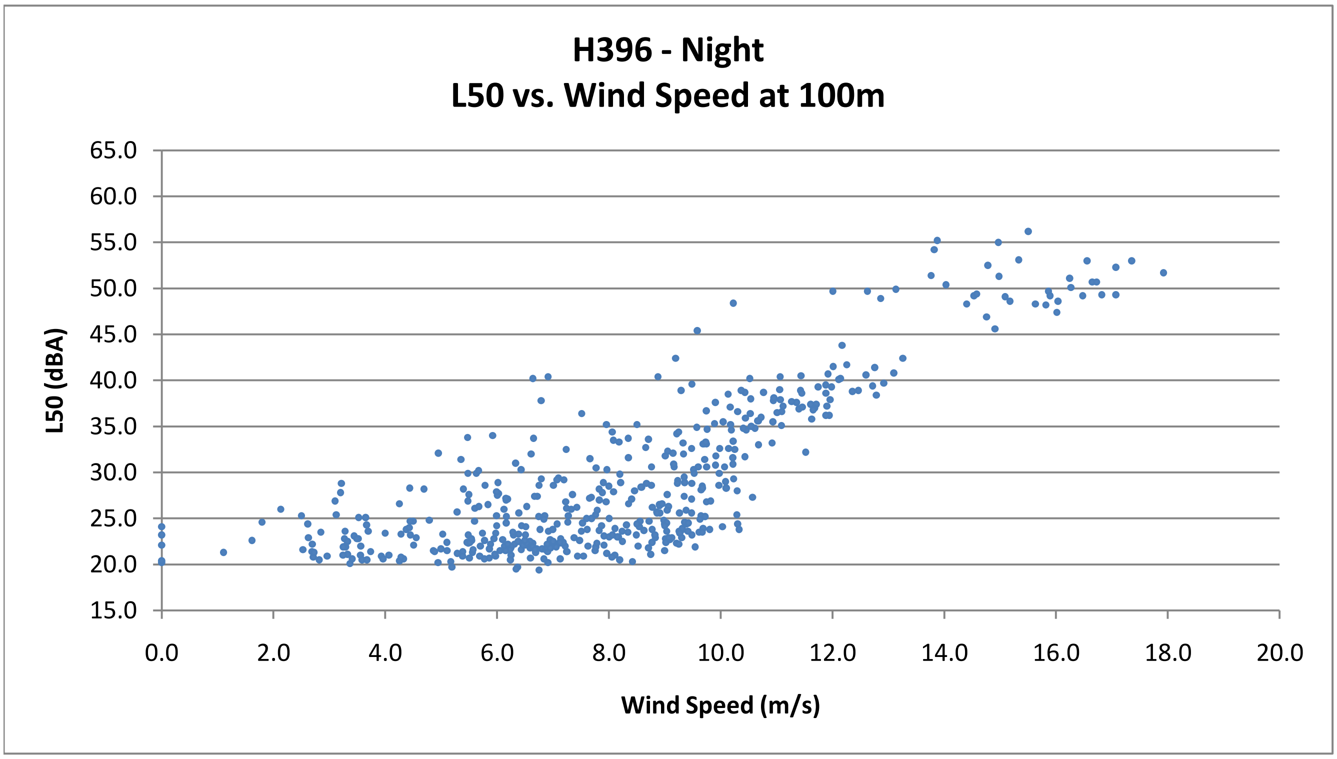

H396 - Day
L90 vs. Wind Speed at 100m
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L90 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

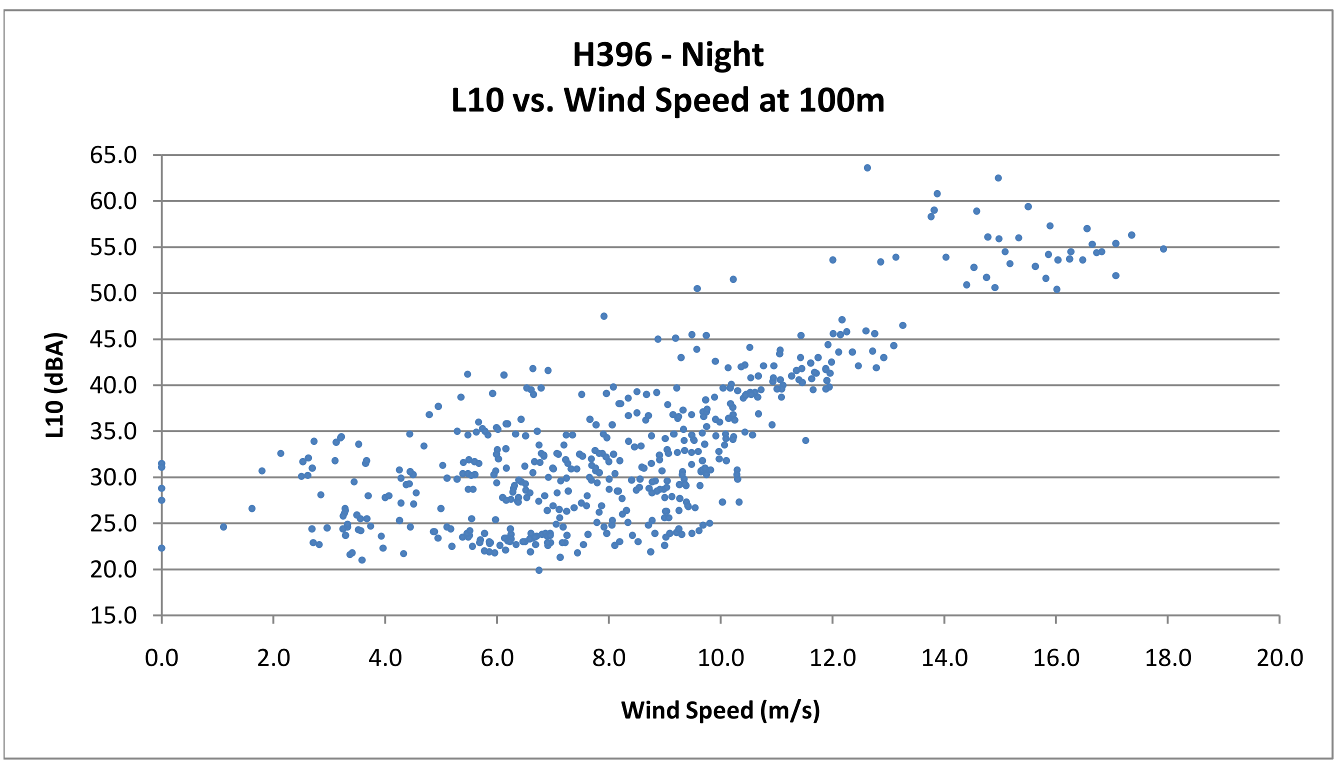

H396 - Day
L50 vs. Wind Speed at 100m
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L50 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

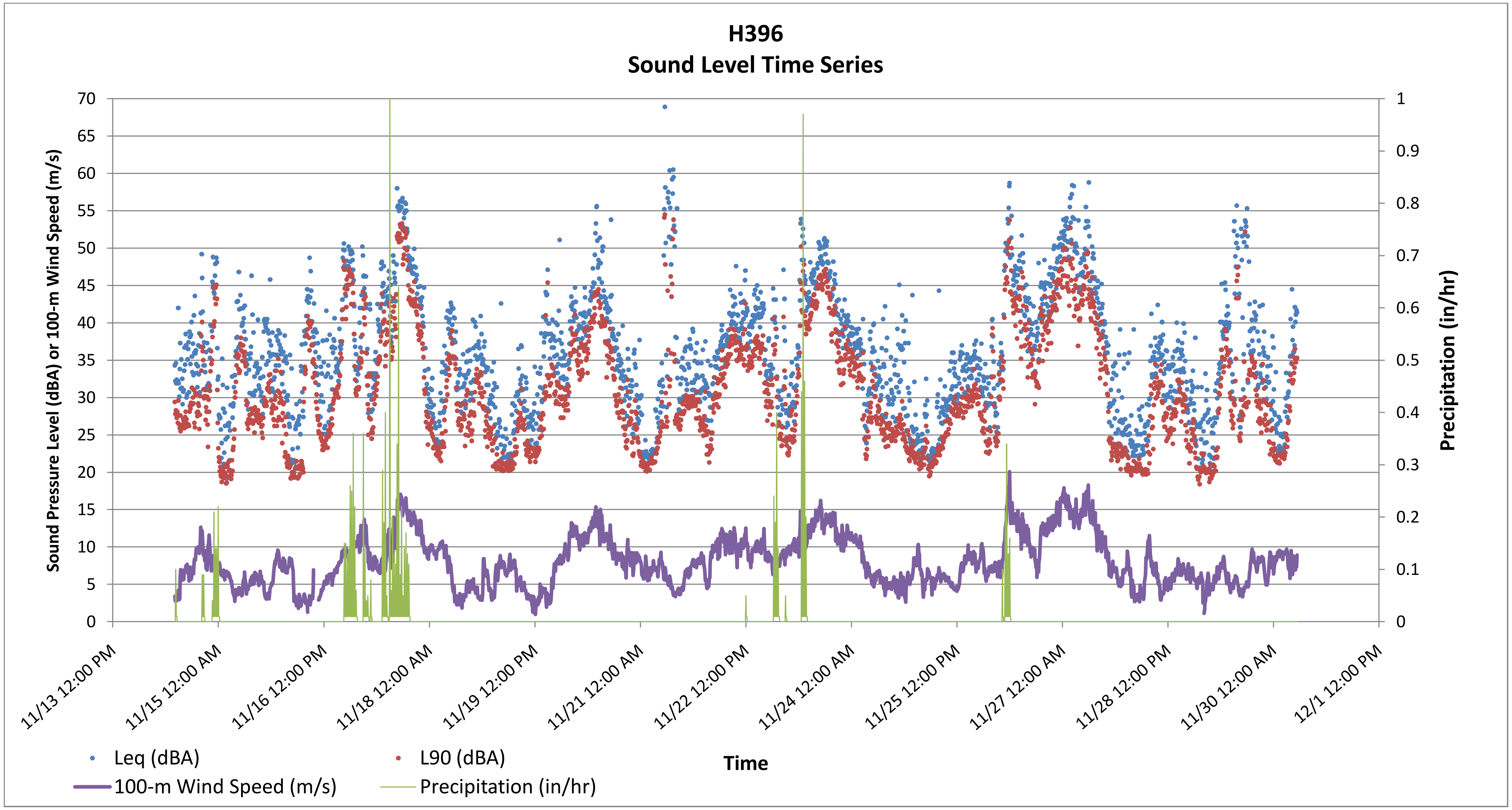

H396 - Day
L10 vs. Wind Speed at 100m
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
L10 (dBA)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)

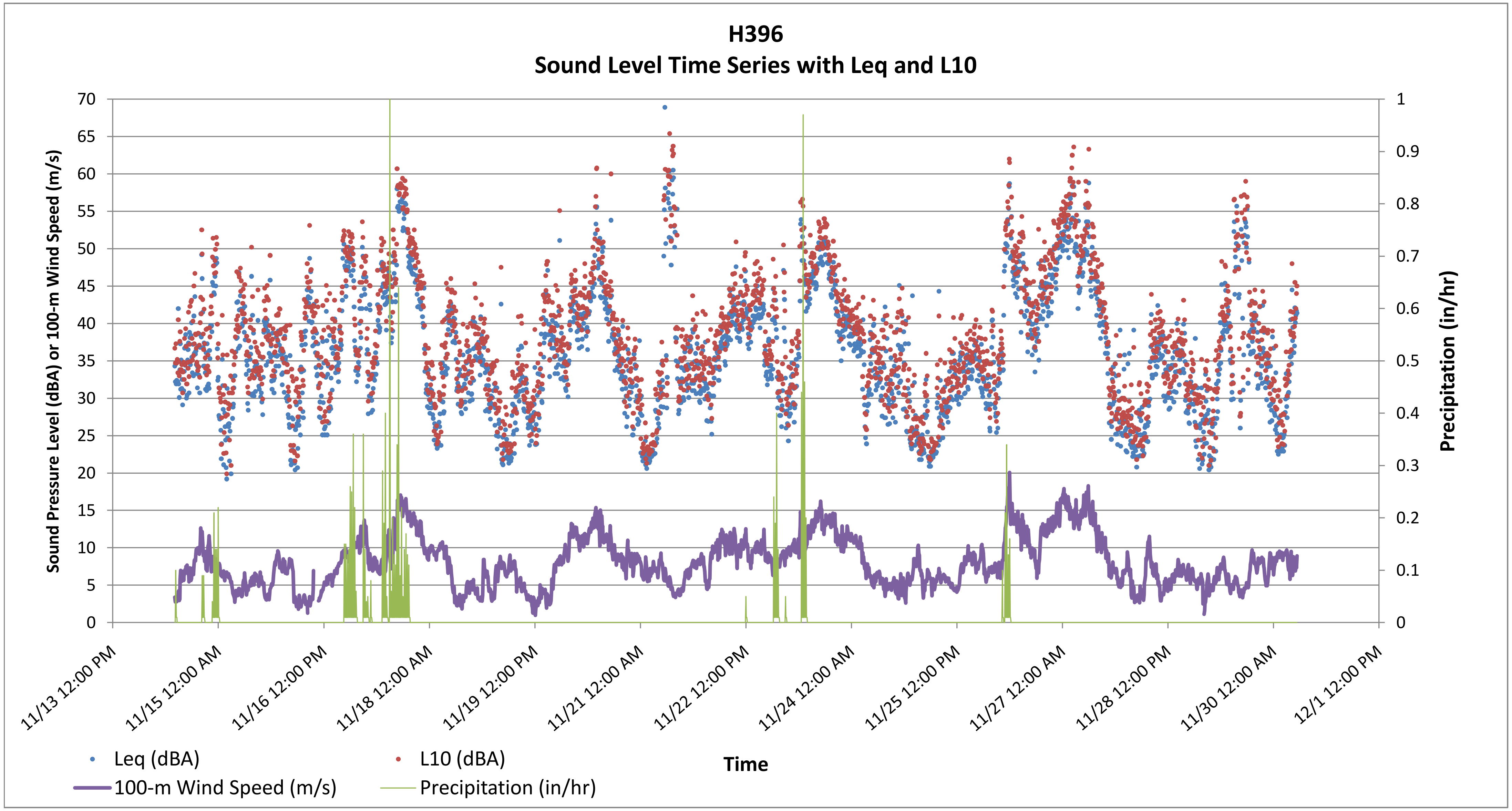

H396 - Night
Leq vs. Wind Speed at 100m
Leq (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H396 - Night
L90 vs. Wind Speed at 100m
L90 (dBA)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Wind Speed (m/s)


H396 - Night
L50 vs. Wind Speed at 100m
L50 (dBA)
Wind Speed (m/s)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0


H396 - Night
L10 vs. Wind Speed at 100m
L10 (dBA)
Wind Speed (m/s)
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0


H396
Sound Level Time Series
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L90 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)



H396
Sound Level Time Series with Leq and L10
Sound Pressure Level (dBA) or 100-m Wind Speed (m/s)
Precipitation (in/hr)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/13 12:00 PM
11/15 12:00 AM
11/16 12:00 PM
11/18 12:00 AM
11/19 12:00 PM
11/21 12:00 AM
11/22 12:00 PM
11/24 12:00 AM
11/25 12:00 PM
11/27 12:00 AM
11/28 12:00 PM
11/30 12:00 AM
12/1 12:00 PM
Time
Leq (dBA)
L10 (dBA)
100-m Wind Speed (m/s)
Precipitation (in/hr)

# Horse Creek Photo Log

**View 1 of H22**

**View 2 of H22**

**View 3 of H22**

**View 1 of H45**

**View 2 of H45**

**View 3 of H45**

**View 1 of H87**

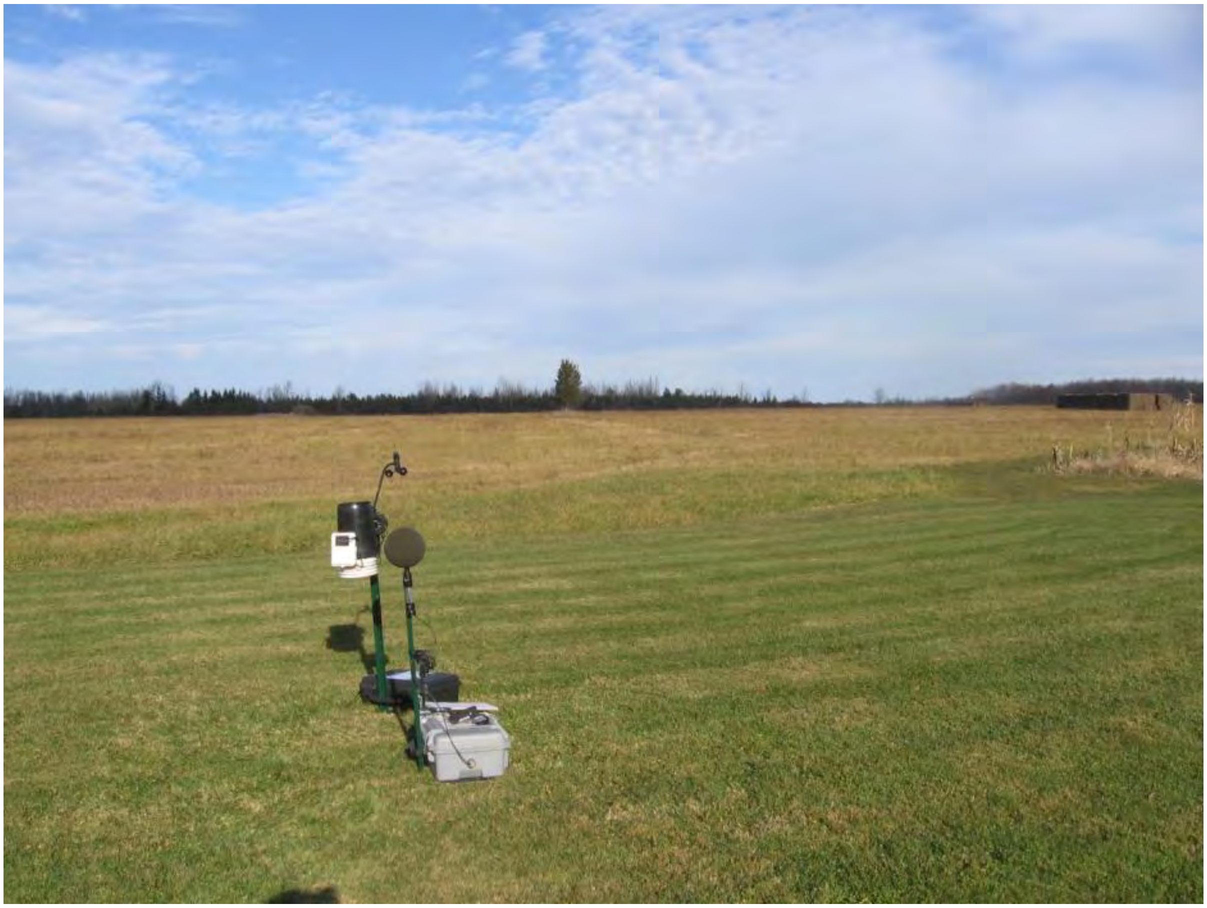
**View 2 of H87**

**View 3 of H87**

**View 4 of H87**

**View 1 of H166**

**View 2 of H166**



**View 3 of H166**

**View 1 of H190**

**View 2 of H190**

**View 3 of H190**

**View 1 of H396**

**View 2 of H396**