Wind Turbine Noise Issues:

Application of Overseas Experience to the Australian Market

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Wind Turbines & Noise

- Benign noise source but quiet locations
- Noise sources
  - aerodynamic → broadband noise
  - mechanical → tonal noise
- Changes with wind speed

Noise Assessment - General

- Fixed
  - Assessed against a set limit
  - Varies according to location (urban, rural etc.)
- Comparative
  - Assessed against existing (background) level
  - Margin of allowed exeedence

Noise Assessment – Wind Turbines

- Variation in b/g level with wind speed
- Variation in source level with wind speed
- Issue of low b/g noise levels

Specific Guidance for Wind Farms

- Danish Statutory Order

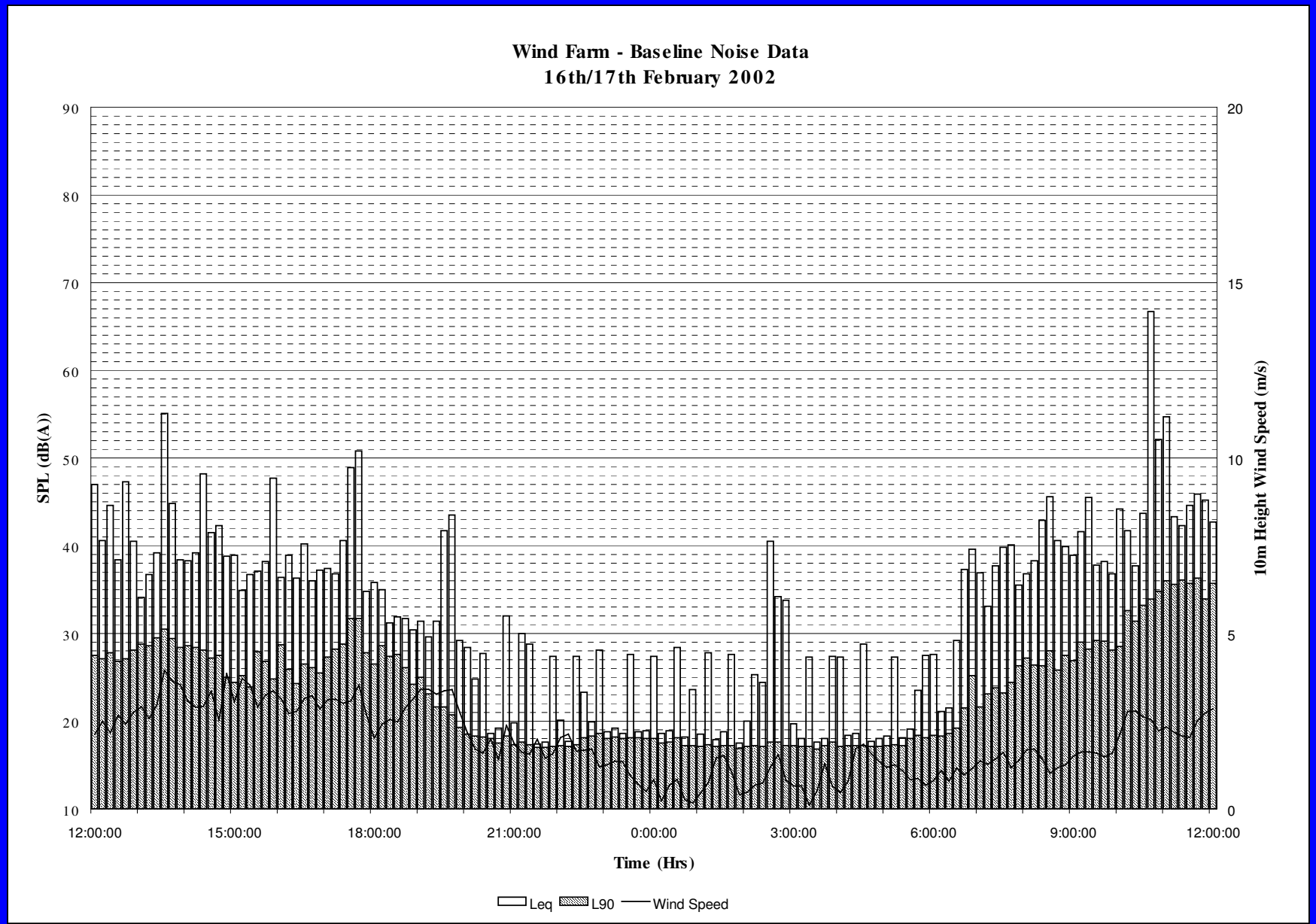
- ETSU-R-97 (UK), NZS 6808 (NZ)
- Draft SA & TAS
  - X dB or 5 dB above b/g, whichever is greater
    - X may depend on time of day and other factors (ETSU)
    - X may depend on involvement with site (ETSU)
    - B/G varies with wind speed and other factors – use average
  - Simplified criterion
    - 35 dB @ 10m/s (V_{10})
    - Removes requirement for b/g measurements
    - Not explicitly stated in TAS draft

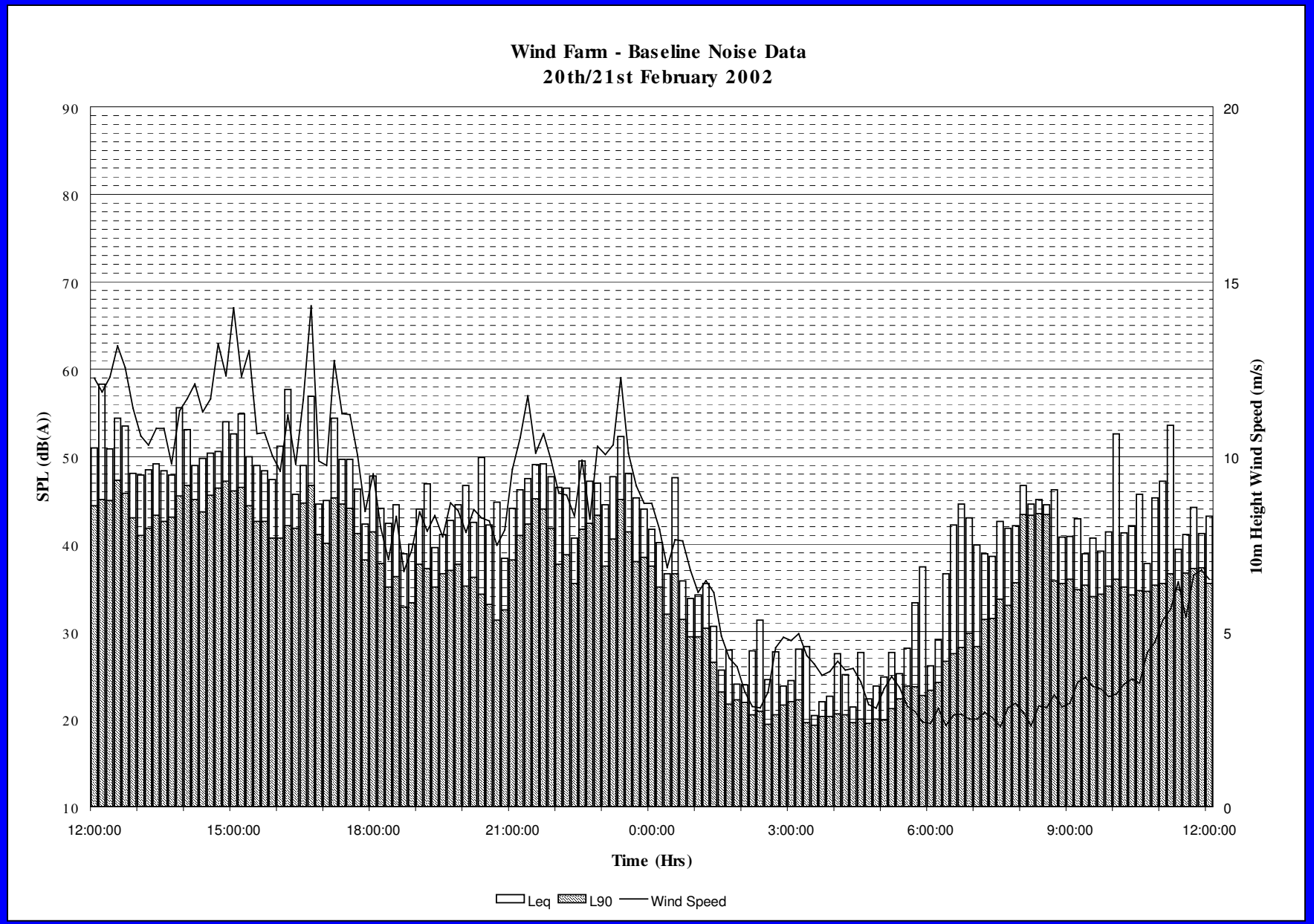
Environmental Impact Assessment

- Legislation / guidance
- Quantify baseline
- Prediction
- Assessment
- Mitigation

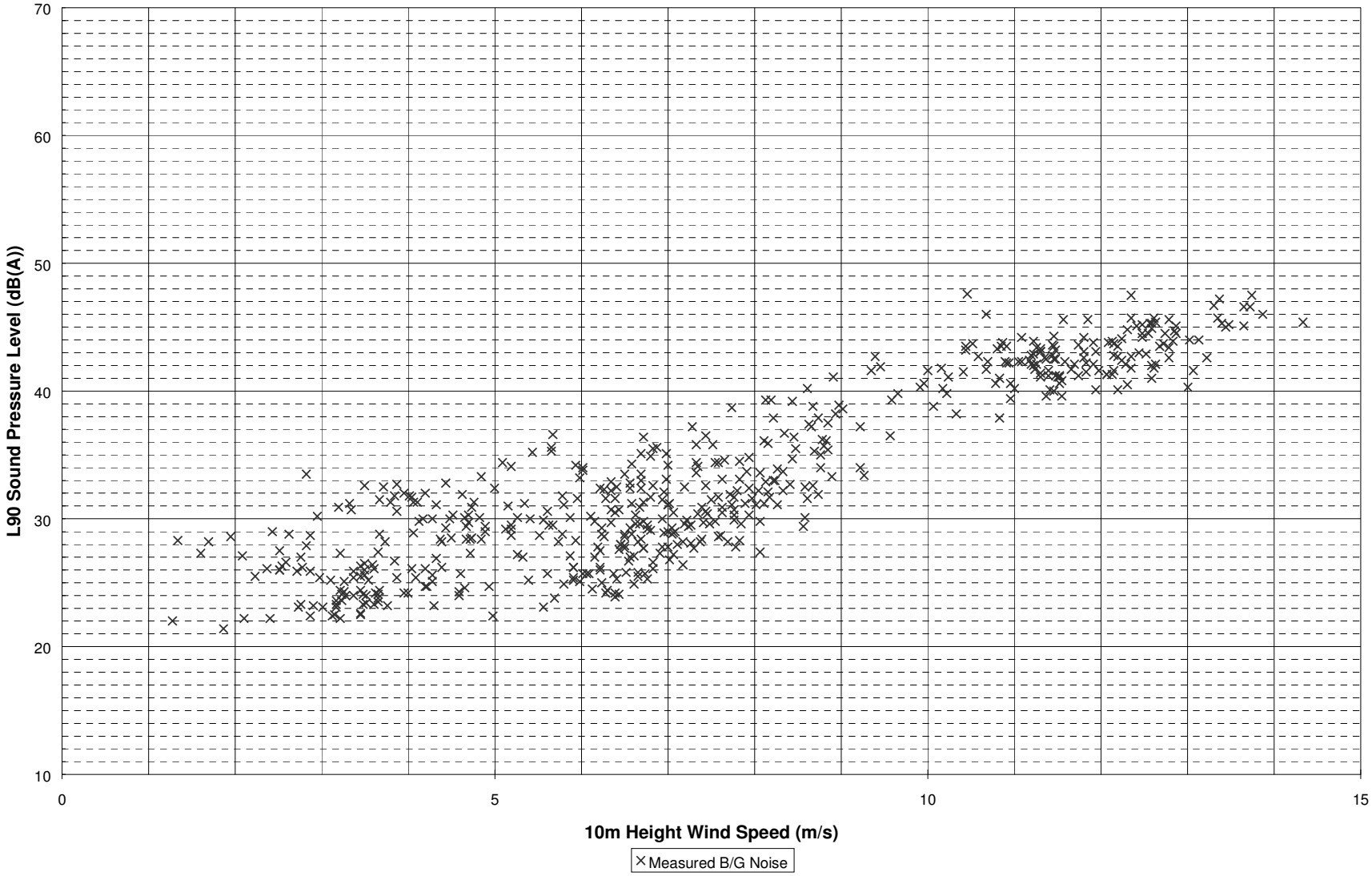
Baseline

- Successive 10 min. L_{A90} noise levels (NZ - L_{A95})
- Successive 10 min. *synchronised* w/s & w/dir
- Leave for two weeks
- Plot variation of noise & wind with time
- Plot noise against wind speed
- Take wind direction into account?

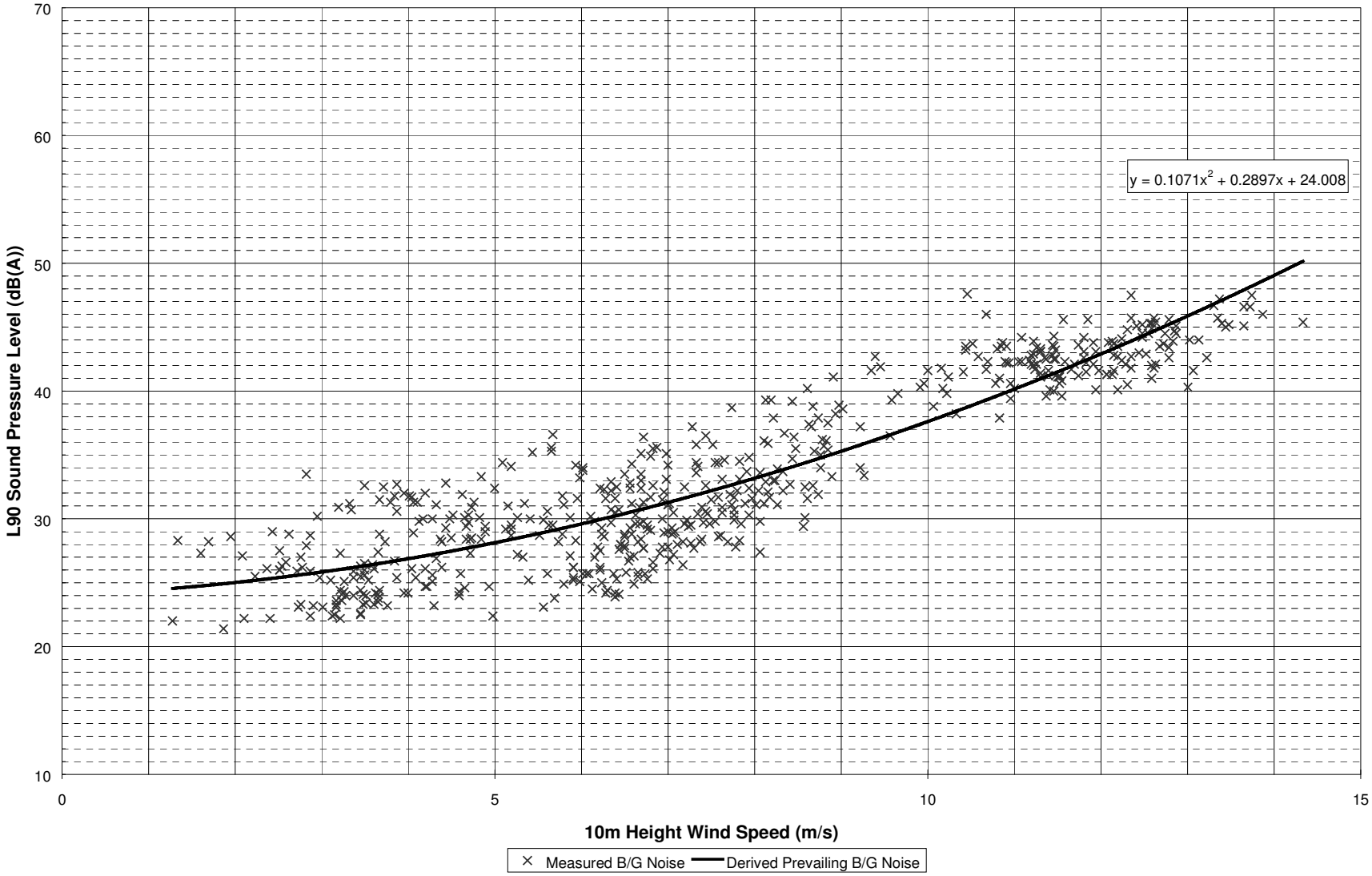

Wind Farm - Baseline Noise Data
16th/17th February 2002
SPL (dB(A))
10m Height Wind Speed (m/s)
Time (Hrs)
90
80
70
60
50
40
30
20
10
20
15
10
5
0
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
Leq
L90
Wind Speed


Wind Farm - Baseline Noise Data
20th/21st February 2002
SPL (dB(A))
10m Height Wind Speed (m/s)
Time (Hrs)
90
80
70
60
50
40
30
20
10
20
15
10
5
0
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
Leq
L90
Wind Speed

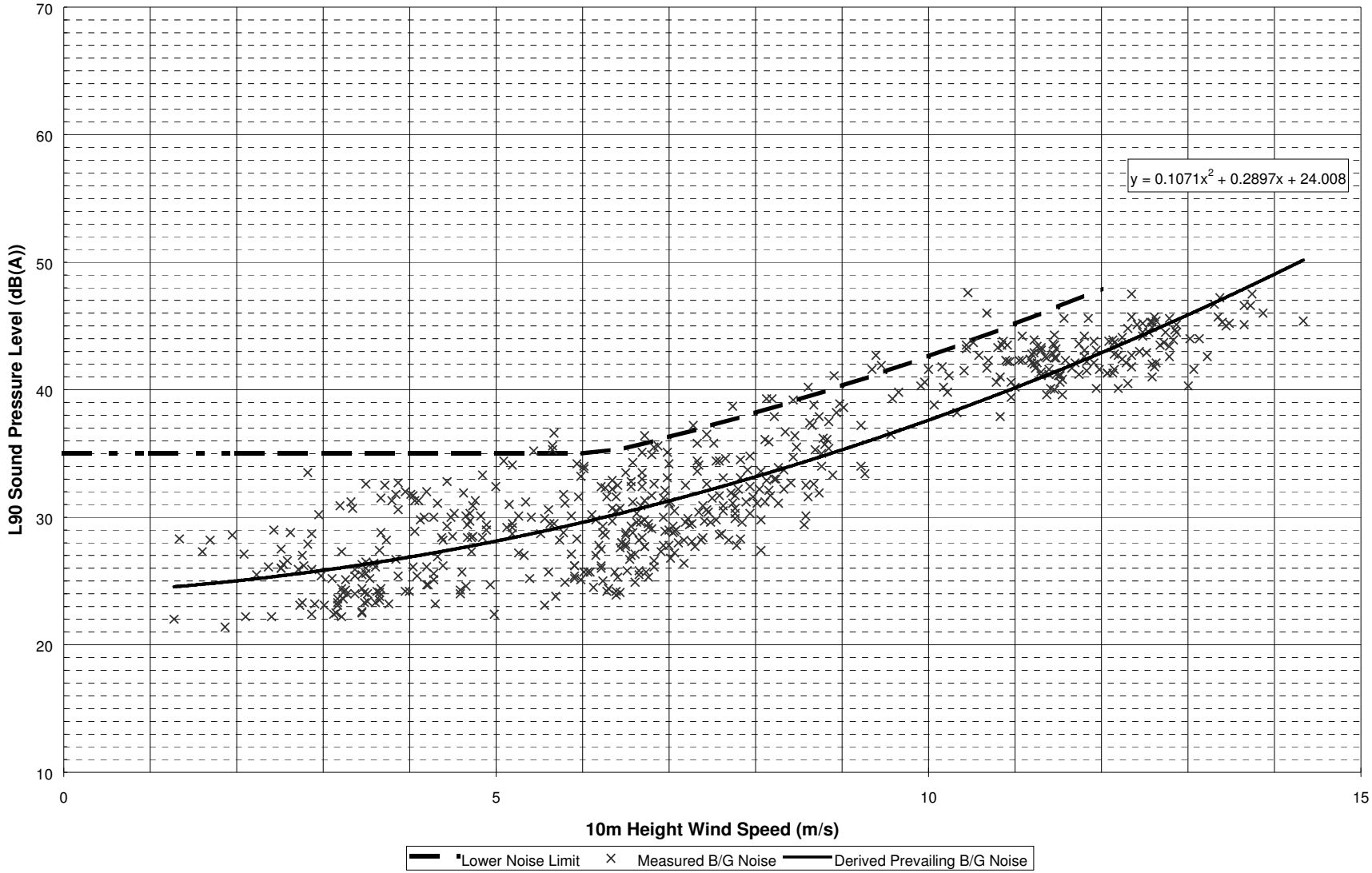
Wind Farm Noise Assessment
Background Noise vs Wind Speed



Wind Farm Noise Assessment
Background Noise vs Wind Speed
(Amenity Hours)



Wind Farm Noise Assessment
Noise Limits and Background Noise vs Wind Speed
(Amenity Hours)



Environmental Impact Assessment

- Legislation / guidance
- Quantify baseline
- Prediction

Prediction

- Predicted noise level = Source sound power level + ……

Source Sound Level

- Measurement Standard
  - IEC 61400-11 Wind Turbine Generator Systems Part 11: Acoustic noise measurement techniques

Source Sound Level

- Data
  - Sound *power* level @ 8 m/s @ 10m height
  - Variation of noise with wind
  - Octave or 1/3 octave band spectrum
  - Analysis of tonal noise

Prediction

20 log d + 11

✓

Hard Ground – Worst Case

- $L_P = L_W + D - A_{geo} - A_{atm} - A_{gr} - A_{scr} - A_{misc}$

Downwind – worst case

Increases with frequency

Very little for downwind

Downwind Bending

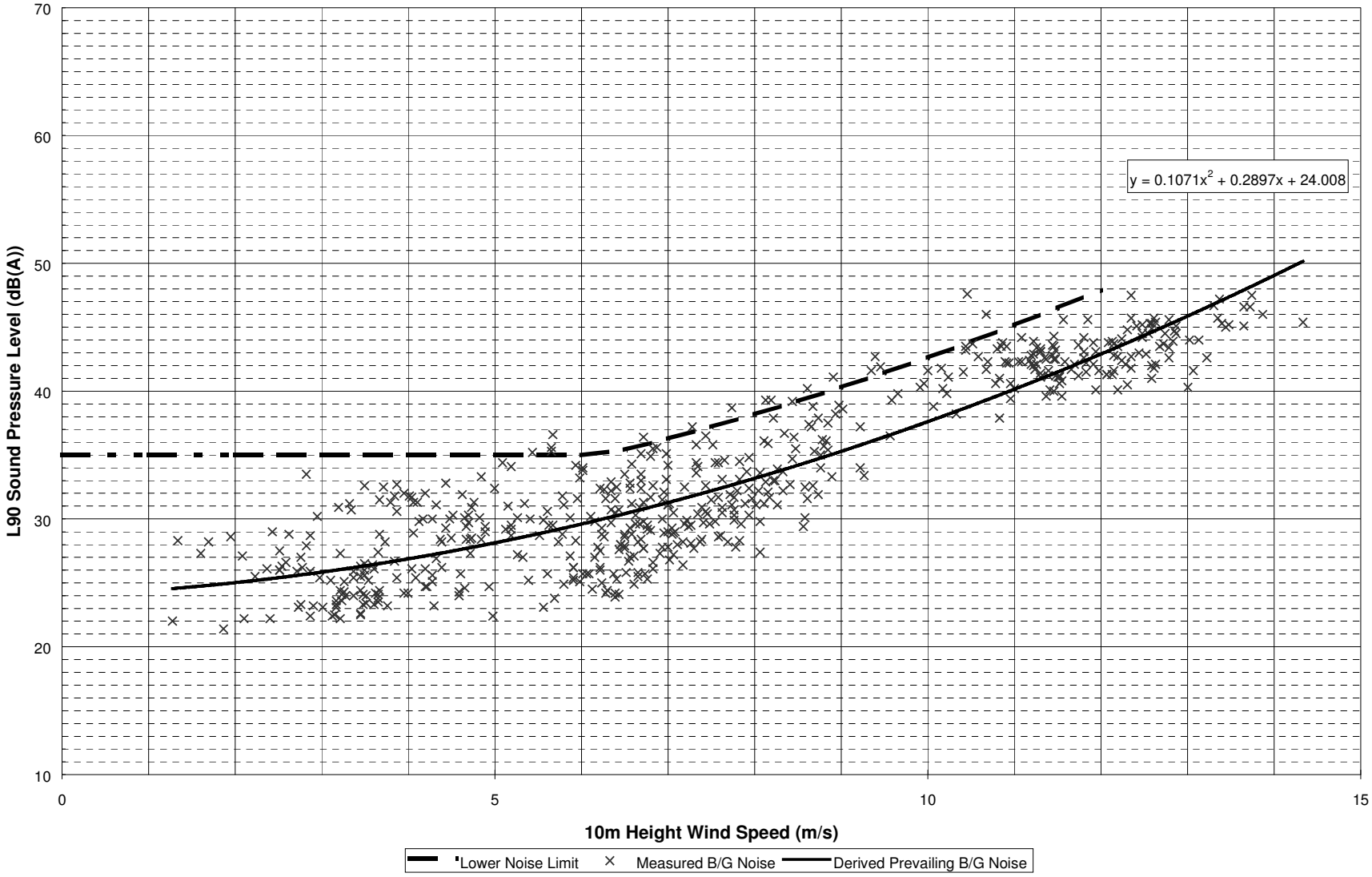
Prediction Models

- Simple (Robust)
  - IEA
  - Danish Statutory Order
  - NZS 6808
  - Windfarmer
- Complex
  - ISO 9613
  - Concawe
  - ENM
  - Nordforsk

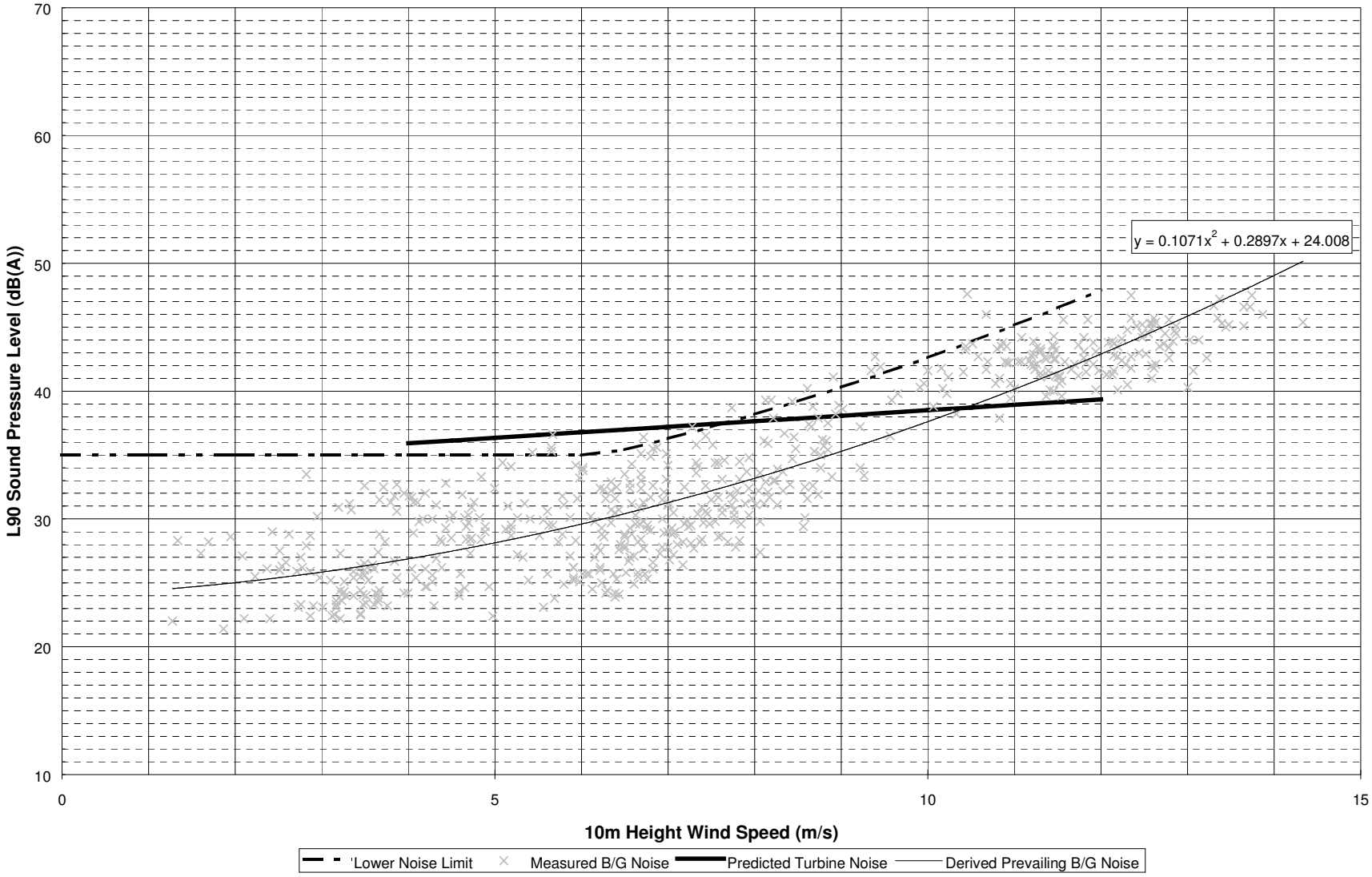
Environmental Impact Assessment

- Legislation / guidance
- Quantify baseline
- Prediction
- Assessment
  - Comparison of Predicted Level with:
    - Statutory or guideline limits
    - Baseline
  - Over range of wind speeds

Wind Farm Noise Assessment
Noise Limits and Background Noise vs Wind Speed
(Amenity Hours)



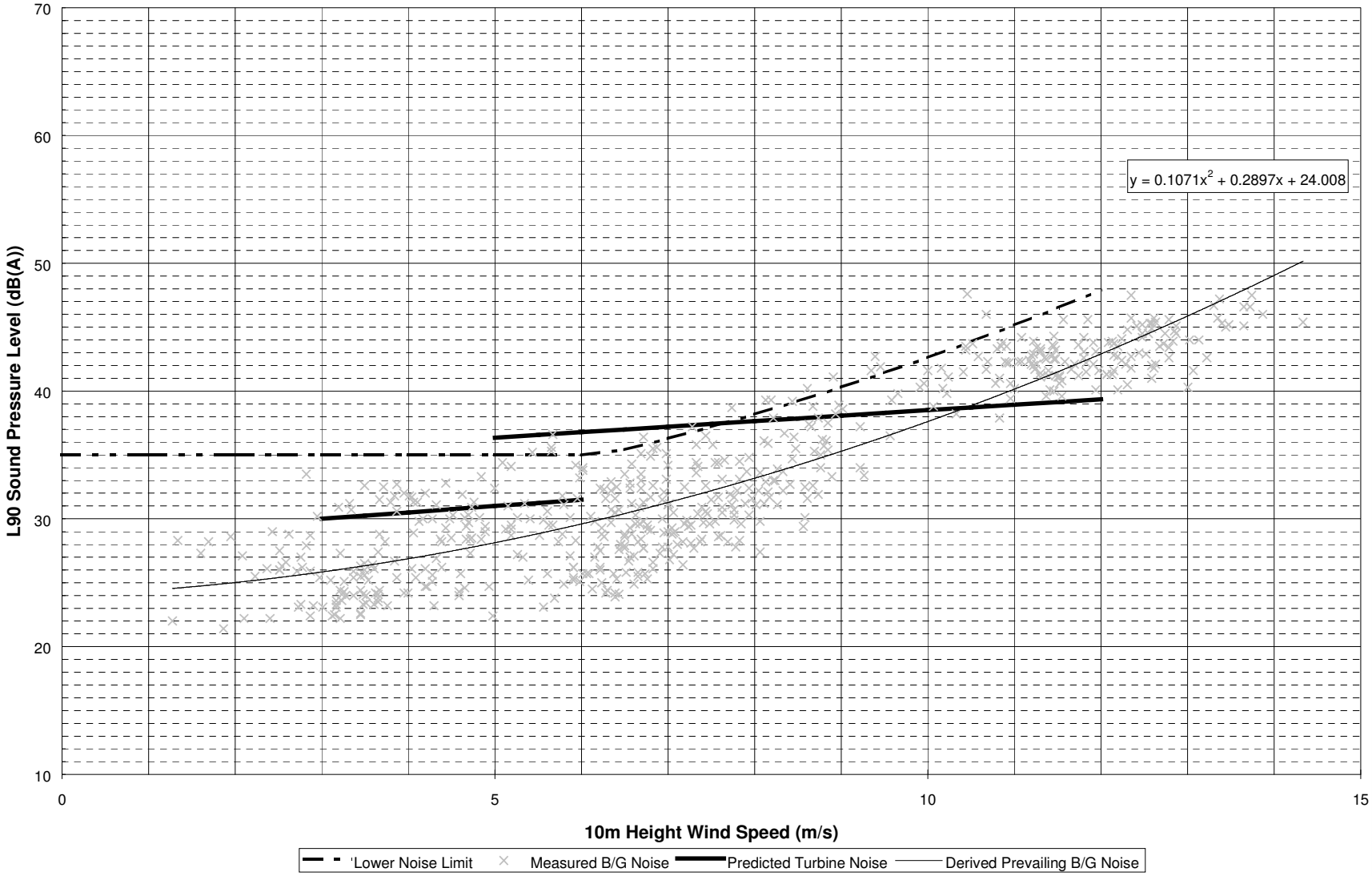
Wind Farm Noise Assessment
Predicted Turbine Noise and Background Noise vs Wind Speed



Mitigation

- Increase separation distance
- Remove turbines
- Turbine type

Wind Farm Noise Assessment
Predicted Turbine Noise and Background Noise vs Wind Speed
(Amenity Hours)



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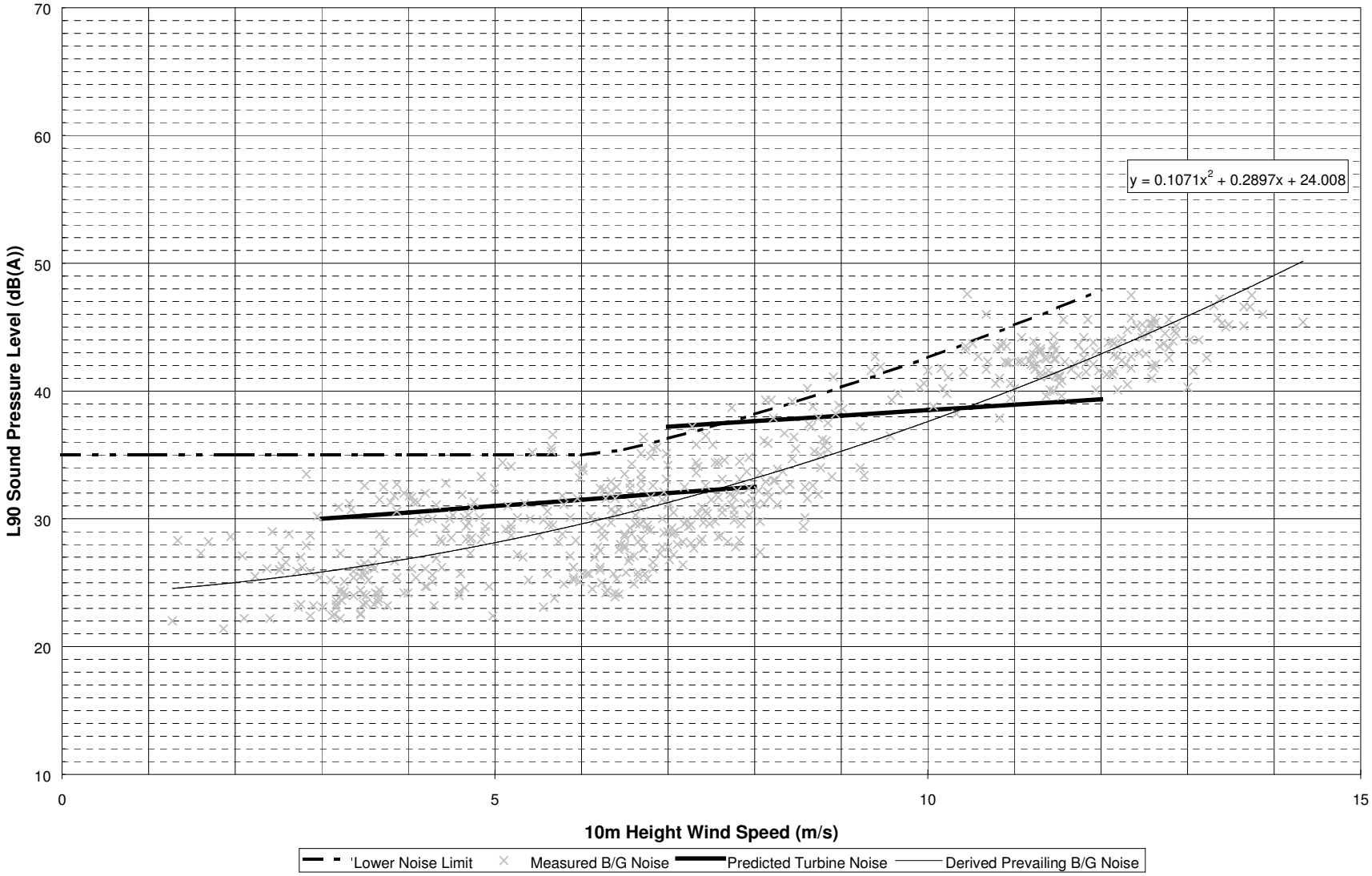

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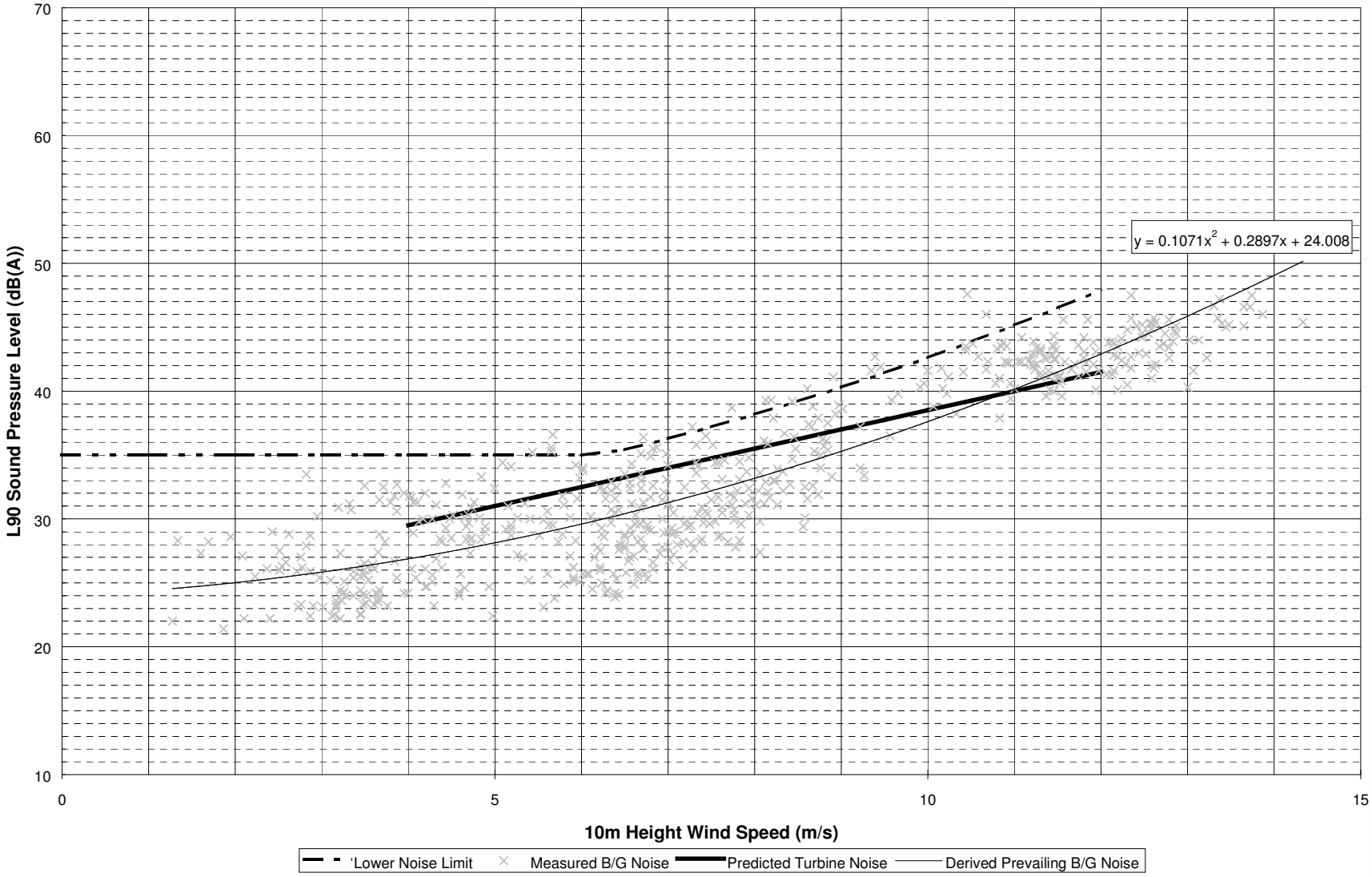

Summary & Conclusions

- Assessment based on appropriate standards and/or guidance
- Allowing for mitigation where necessary
- Produces quantification of potential impact for decision makers and residents.