Appendix A
Model performance statistics

APPENDIX

The statistics used to measure meteorological model performance in this paper are based on those used by Willmott (1981) and Pielke (1984), as described below.

Predicted Mean $P_{mean} = \sum_{i=1}^{N} P_i$, where P_i are the predictions.

Observed Mean $O_{mean} = \sum_{i=1}^{N} O_i$, where O_i are the observations.

Predicted Standard Deviation $P_{std} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(P_i - P_{mean})^2}$.

Observed Standard Deviation $O_{std} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(O_i - O_{mean})^2}$.

Pearson Correlation Coefficient $r = \frac{N\left(\sum_{i=1}^{N} O_i P_i\right) - \left(\sum_{i=1}^{N} O_i\right)\left(\sum_{i=1}^{N} P_i\right)}{\sqrt{\left[N\left(\sum_{i=1}^{N} O_i^2\right) - \left(\sum_{i=1}^{N} O_i\right)^2\right]\left[N\left(\sum_{i=1}^{N} P_i^2\right) - \left(\sum_{i=1}^{N} P_i\right)^2\right]}}$.

Root Mean Square Error $RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)^2}$.

Systematic Root Mean Square Error $RMSE_S = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\hat{P}_i - O_i)^2}$.

Unsystematic Root Mean Square Error $RMSE_U = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\hat{P}_i - P_i)^2}$.

Index of Agreement $IOA = 1 - \frac{\sum_{i=1}^{N}(P_i - O_i)^2}{\sum_{i=1}^{N}\left(|P_i - O_{mean}| + |O_i - O_{mean}|\right)^2}$.

Measures of Skill $SKILL_E = \frac{RMSE_U}{O_{std}}$, $SKILL_V = \frac{P_{std}}{O_{std}}$ and $SKILL_R = \frac{RMSE}{O_{std}}$.

Note that N is the number of observations and $\hat{P}_i = a + bO_i$ is the linear regression fitted formula with intercept (a) and slope (b).

The Robust Highest Concentration $RHC = C(R) + (\overline{C} - C(R))\ln((3R-1)/2)$ pollution statistic is from Cox and Tikvart (1990), with $C(R)$ the R^{th} highest concentration and $\overline{C}$ the mean of the top R-1 concentrations. The value of $R = 11$ is used here so that $\overline{C}$ is the average of the top-ten concentrations, which is an accepted statistic for evaluation of model performance (Hanna, 1989). The RHC is preferred to the actual peak value because it mitigates the undesirable influence of unusual events, while still representing the magnitude of the maximum concentration (unlike percentiles or averages over the top-percentiles). The statistical performance measures used here for pollution with the Kincaid and Indianapolis datasets are the same as those used by Olesen (1995) in the Model Validation Kit.

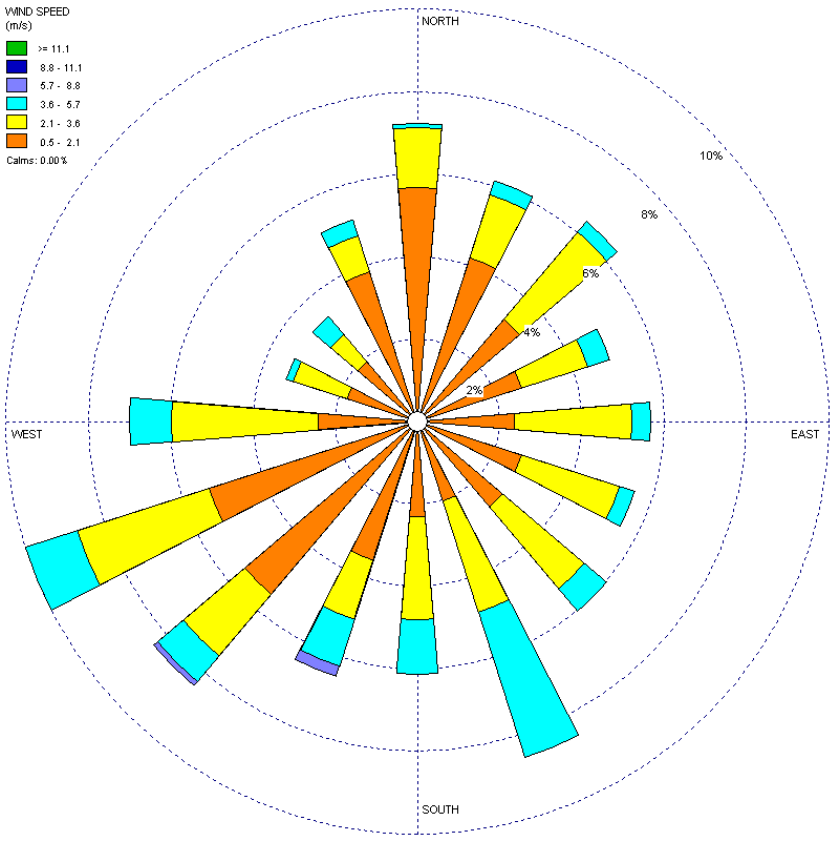
Appendix B

Wind roses – seasonal and long term average

2004 conditions

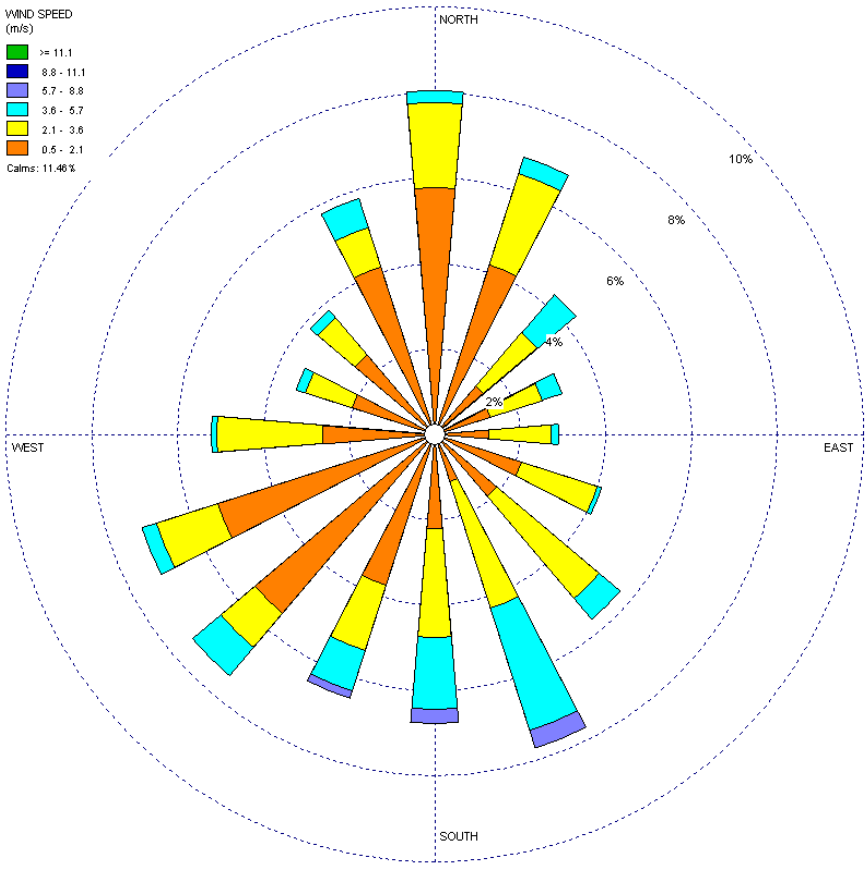
Predicted

LMPS Autumn

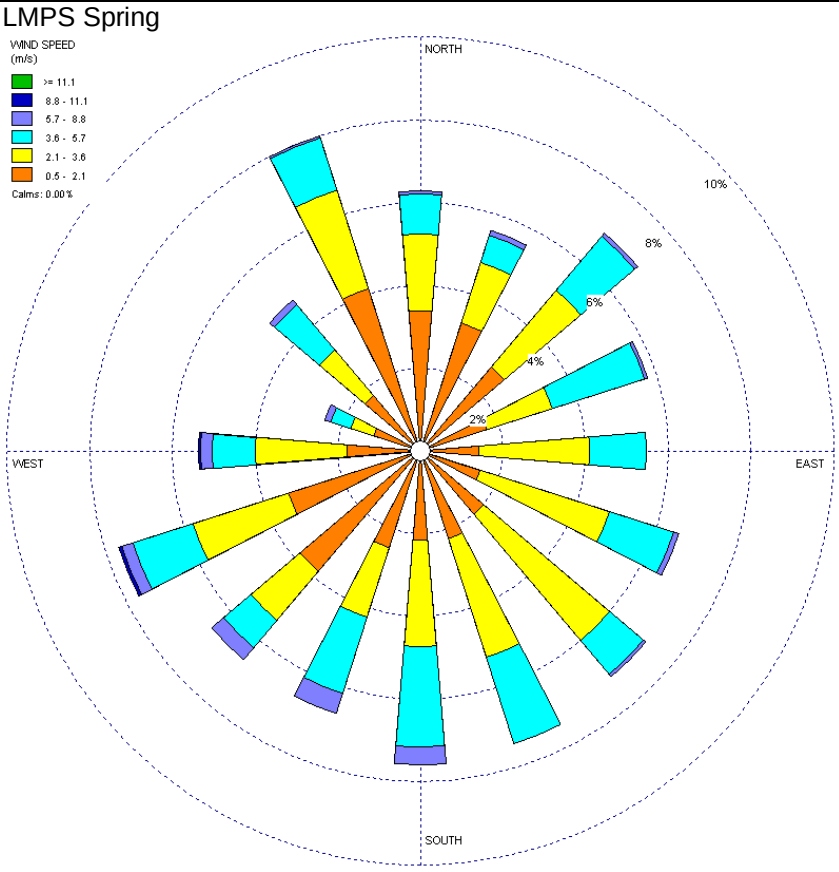


Observed

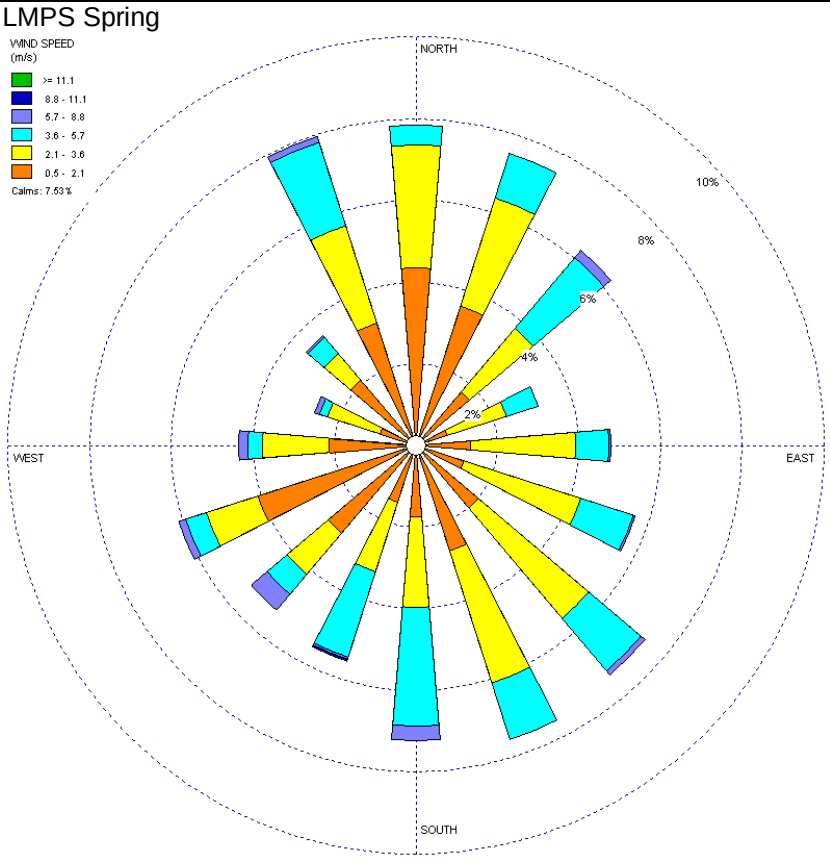
LMPS Autumn



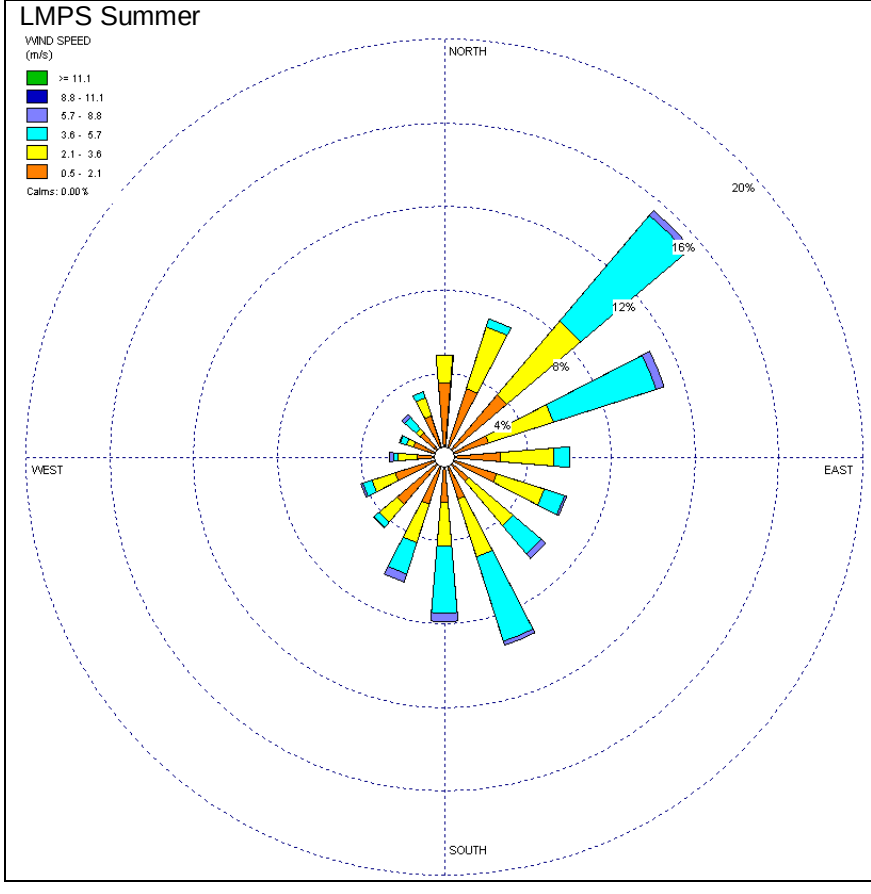
LMPS Spring



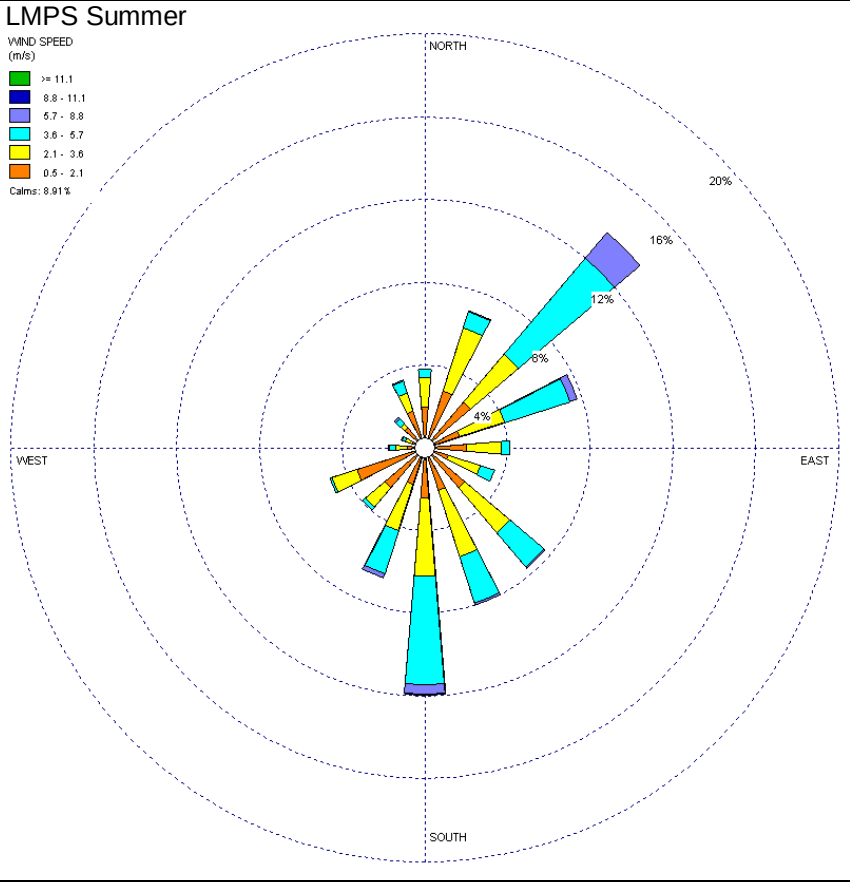
LMPS Spring



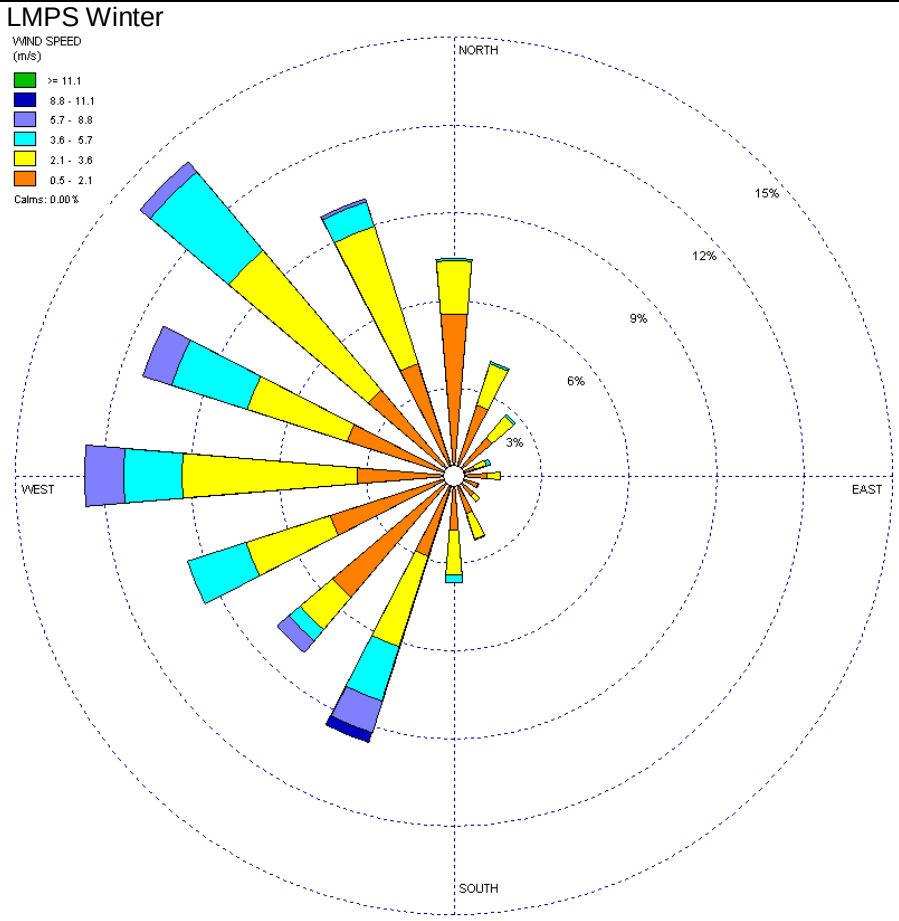
LMPS Summer



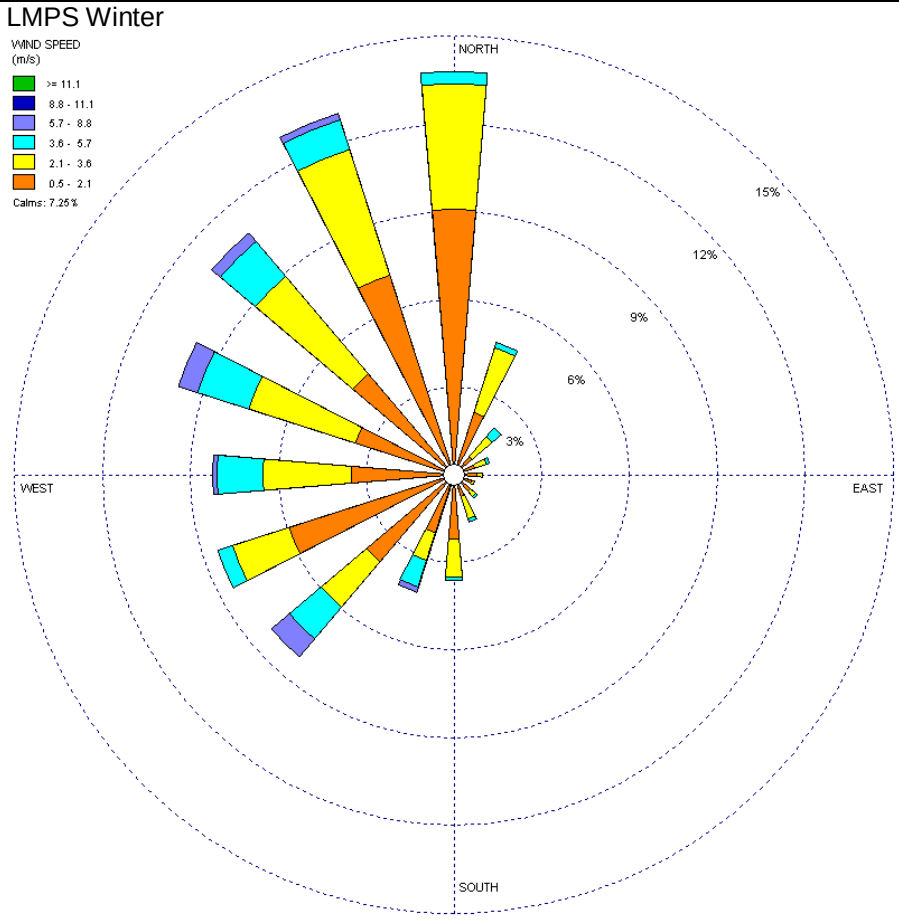
LMPS Summer



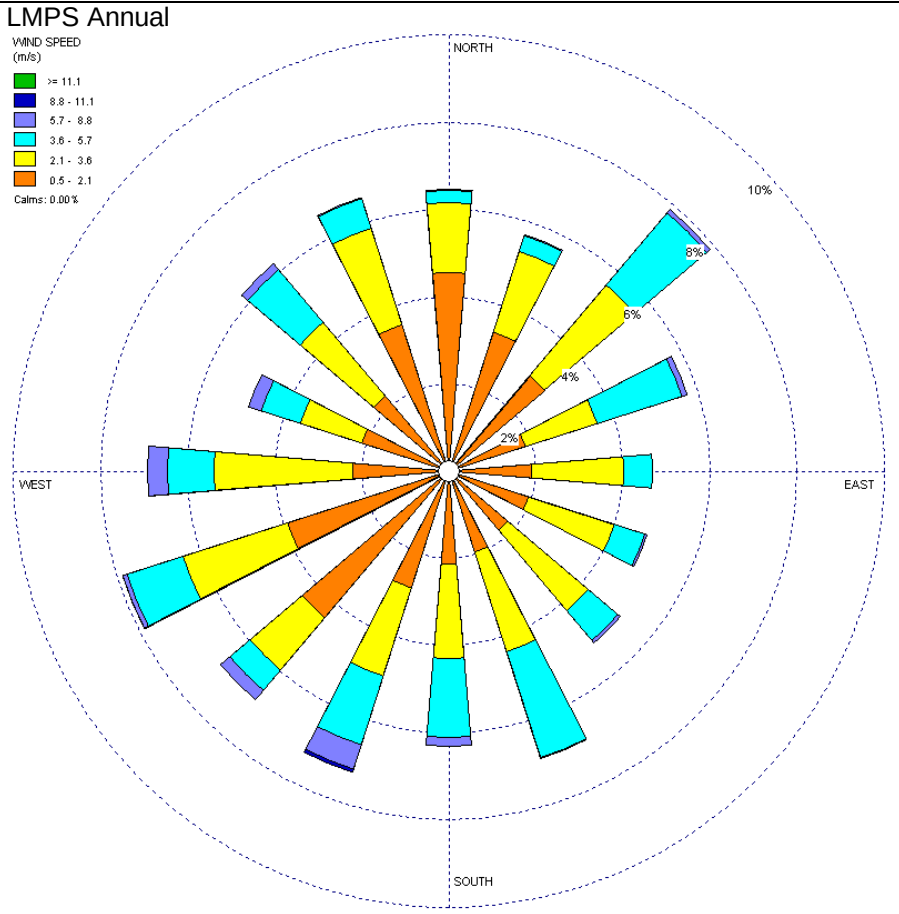
LMPS Winter



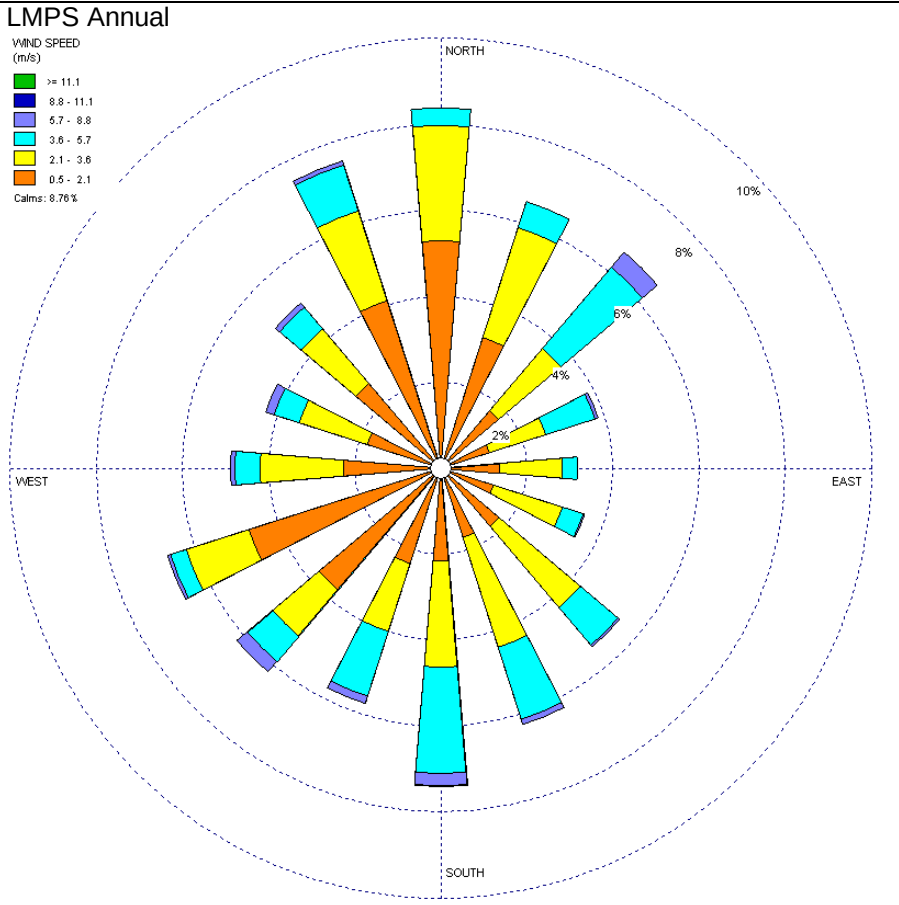
LMPS Winter



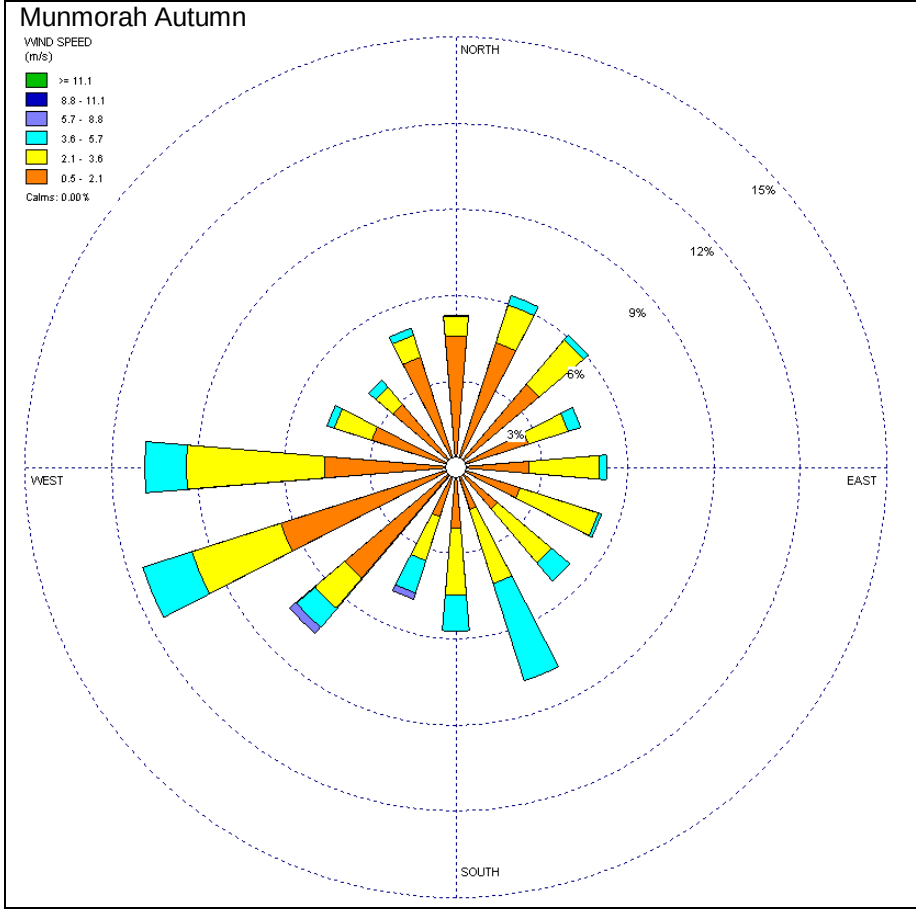
LMPS Annual



LMPS Annual



Munmorah Autumn



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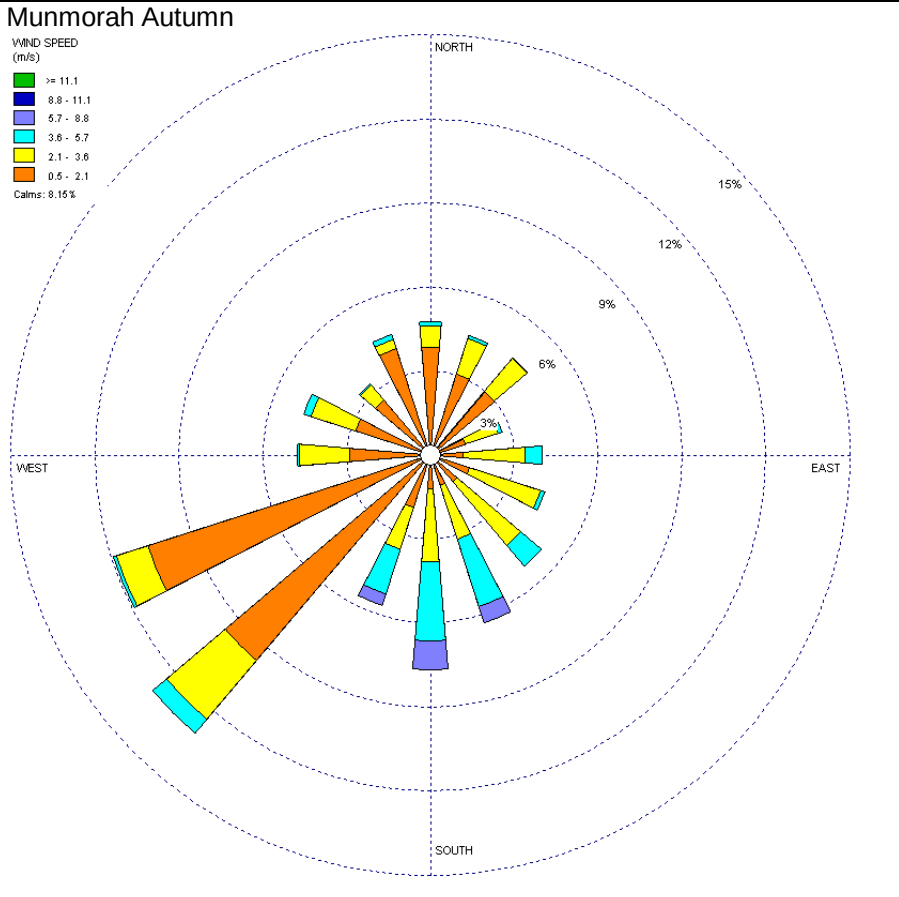

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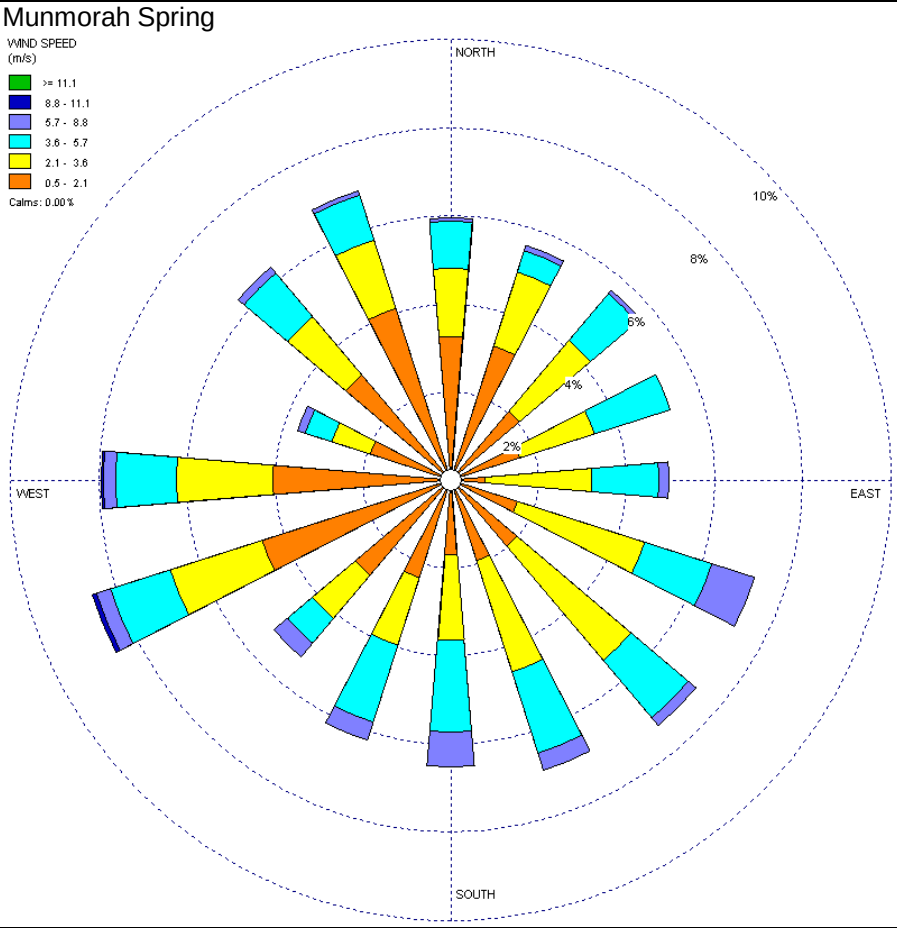

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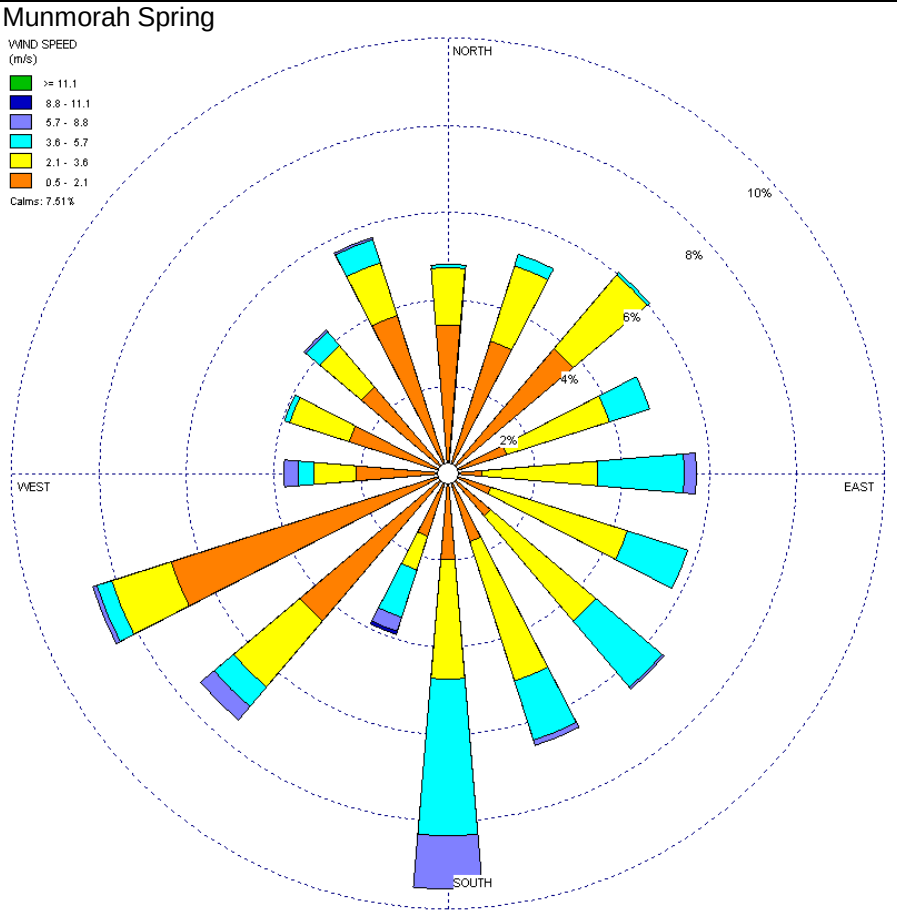

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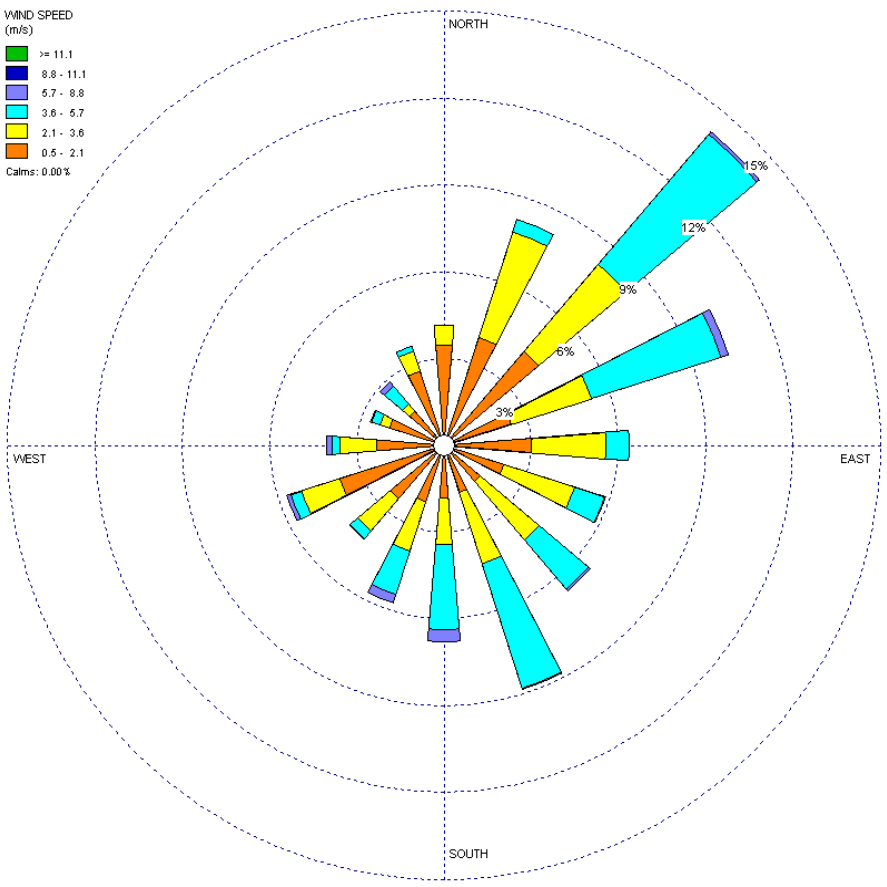

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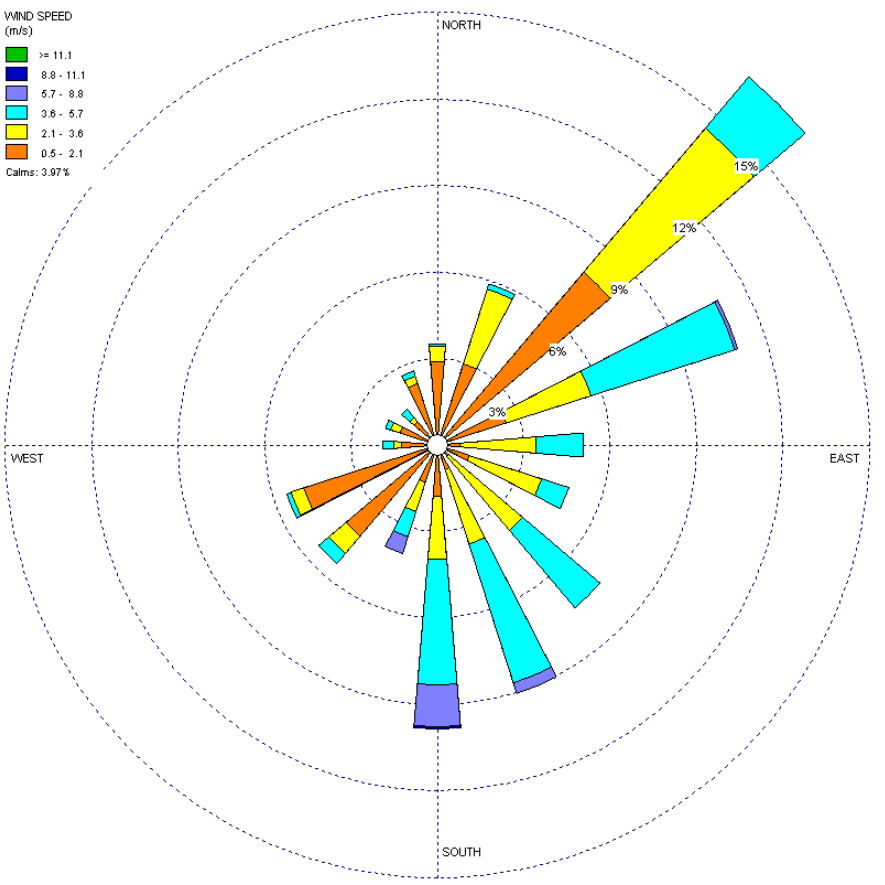

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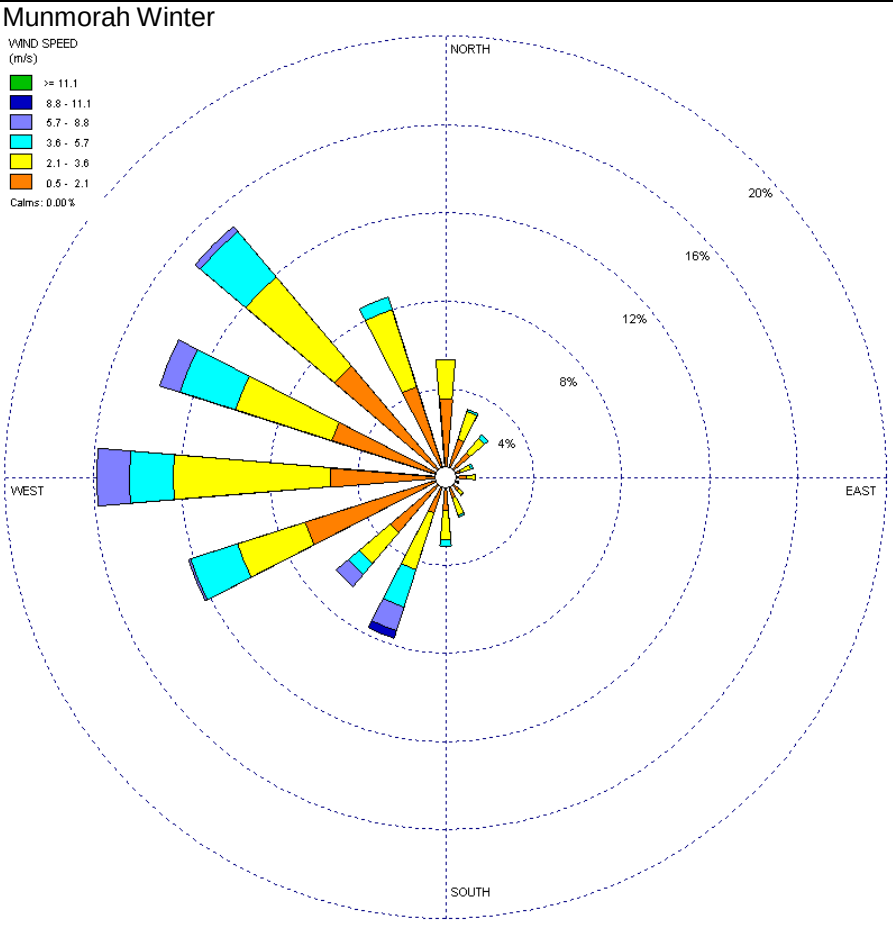

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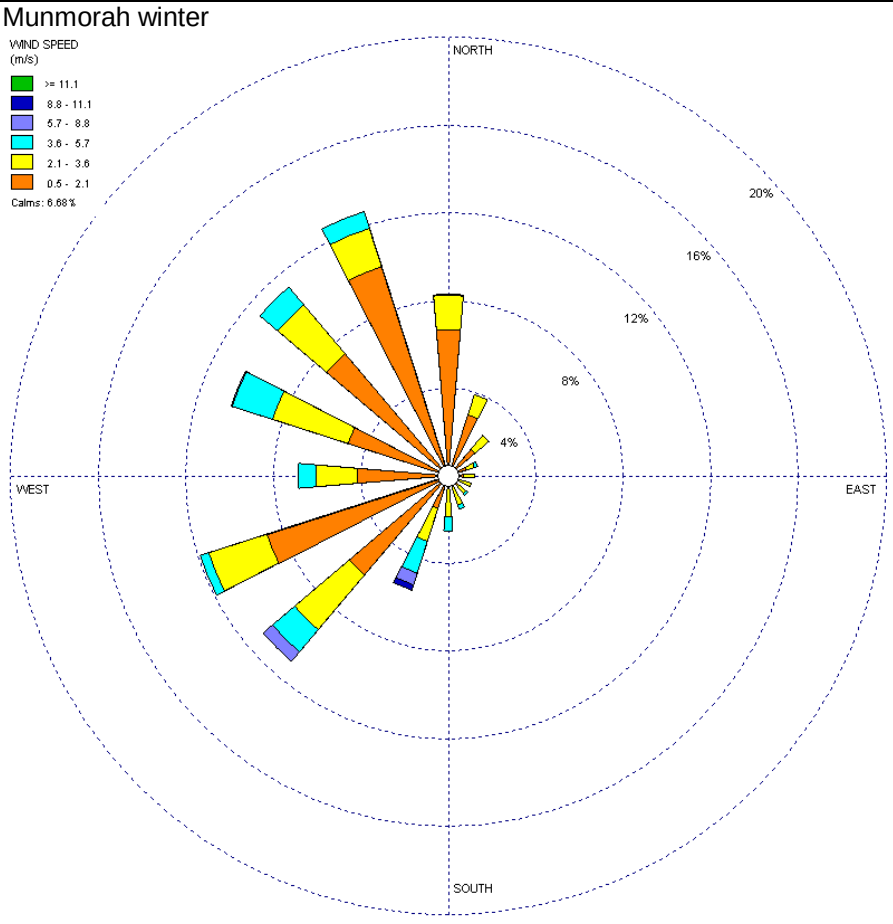

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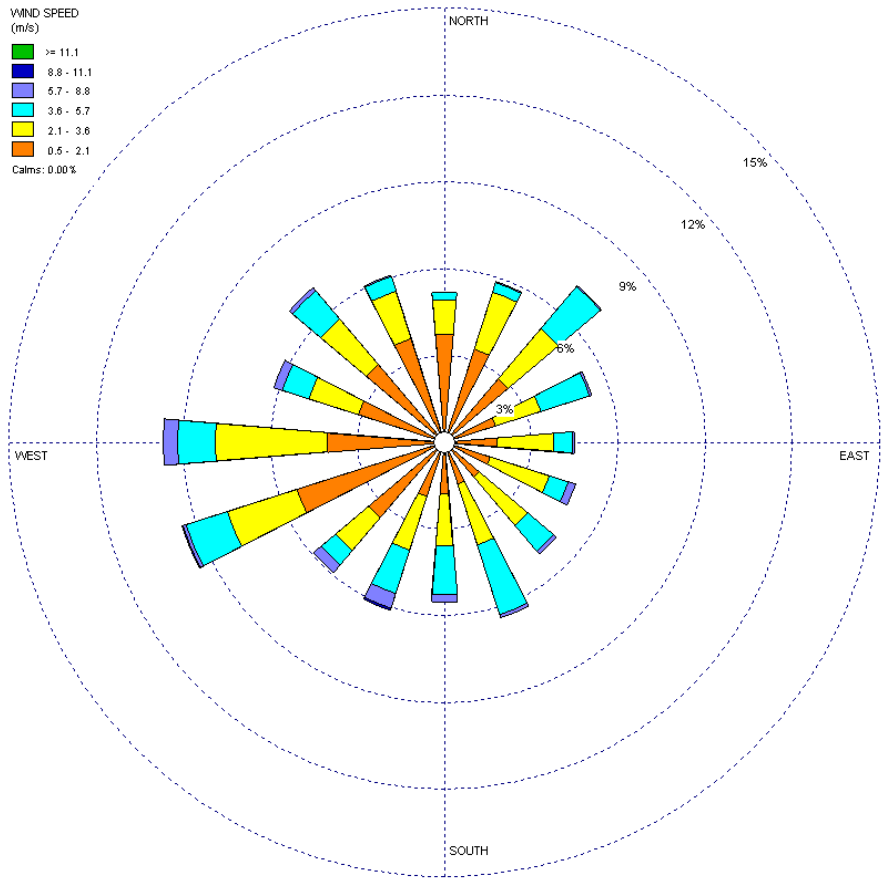
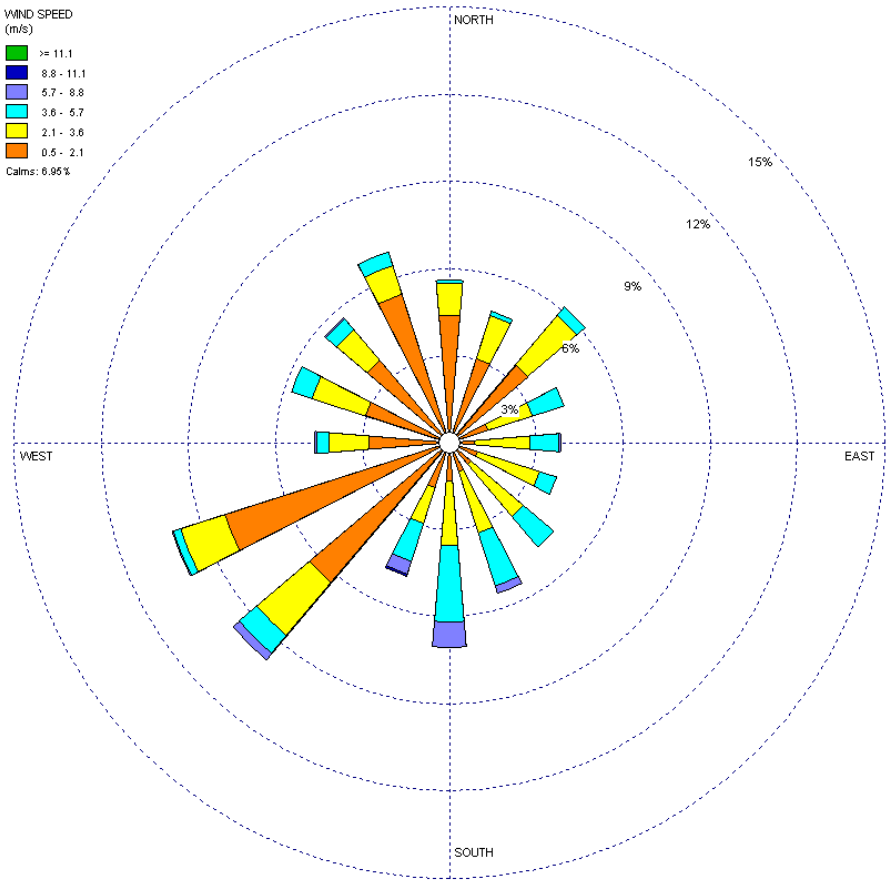
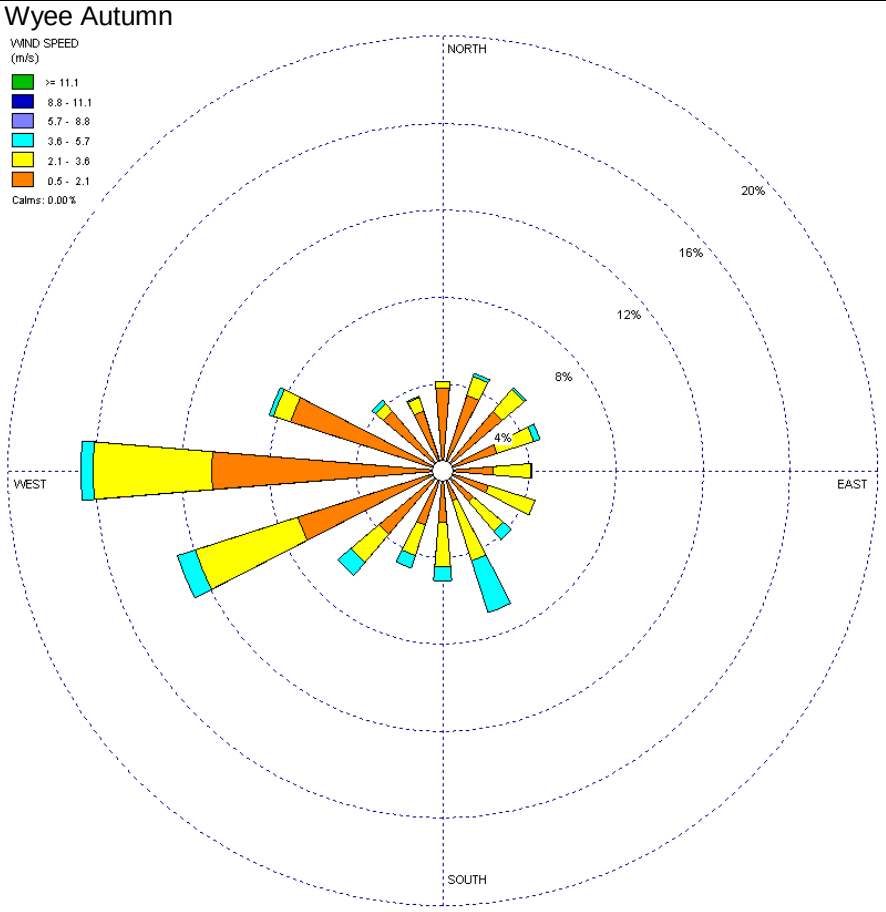


Munmorah Annual



Wyee Autumn



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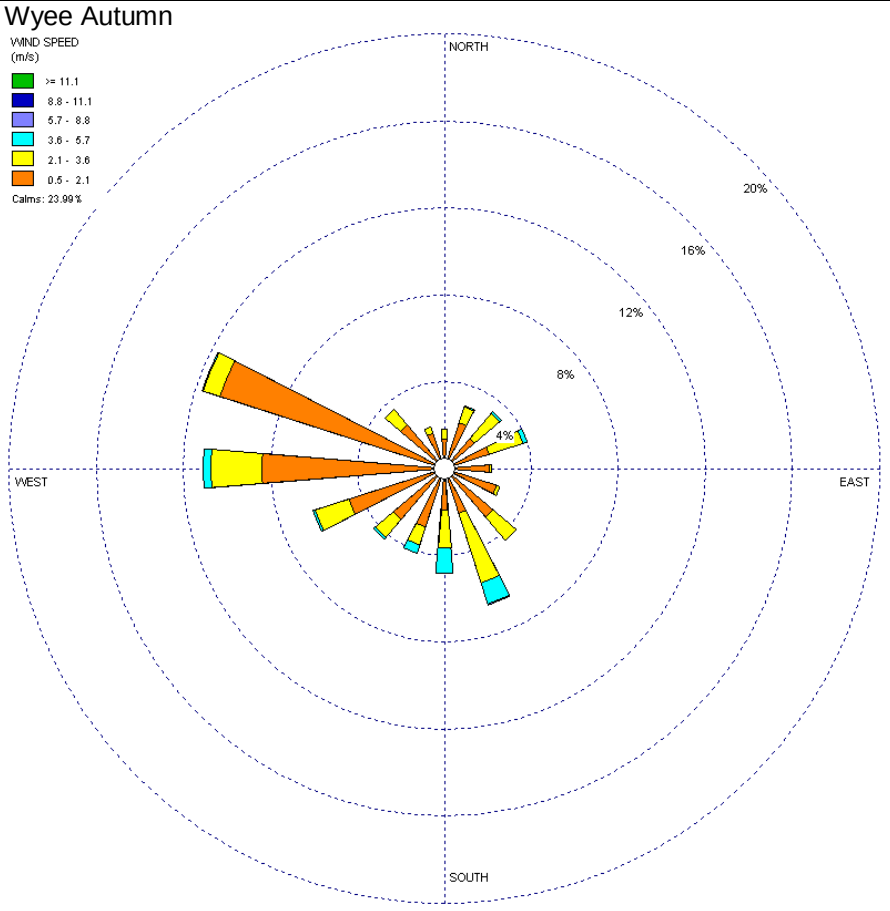

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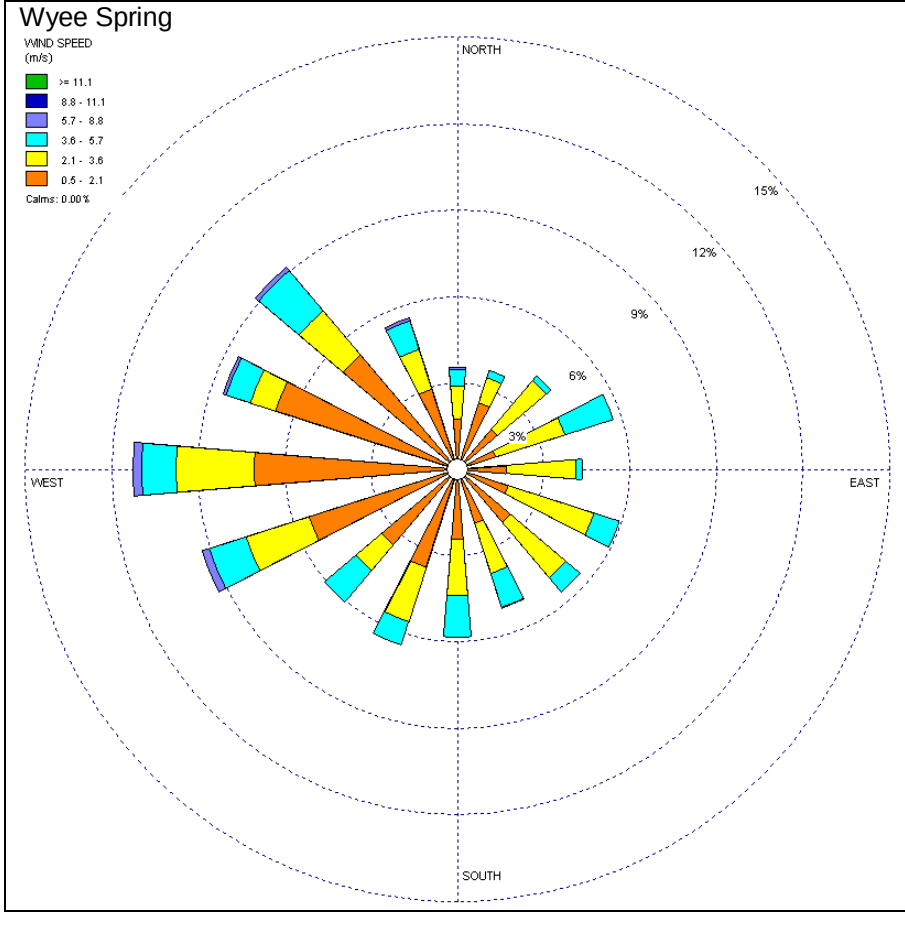

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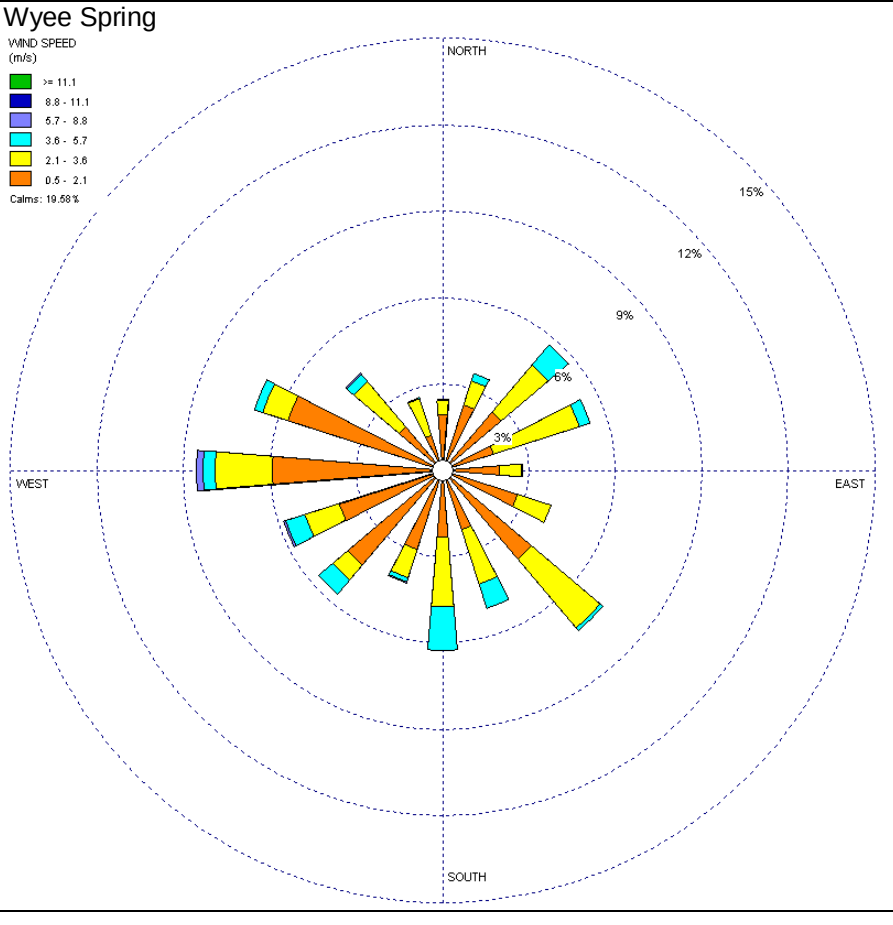

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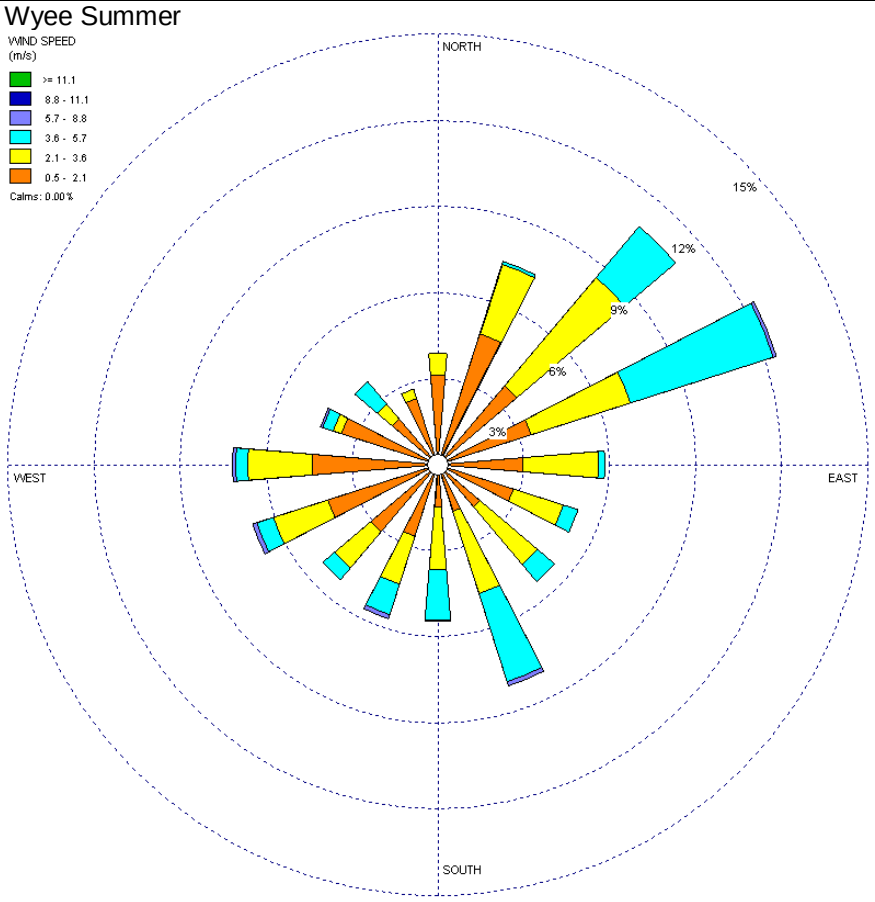

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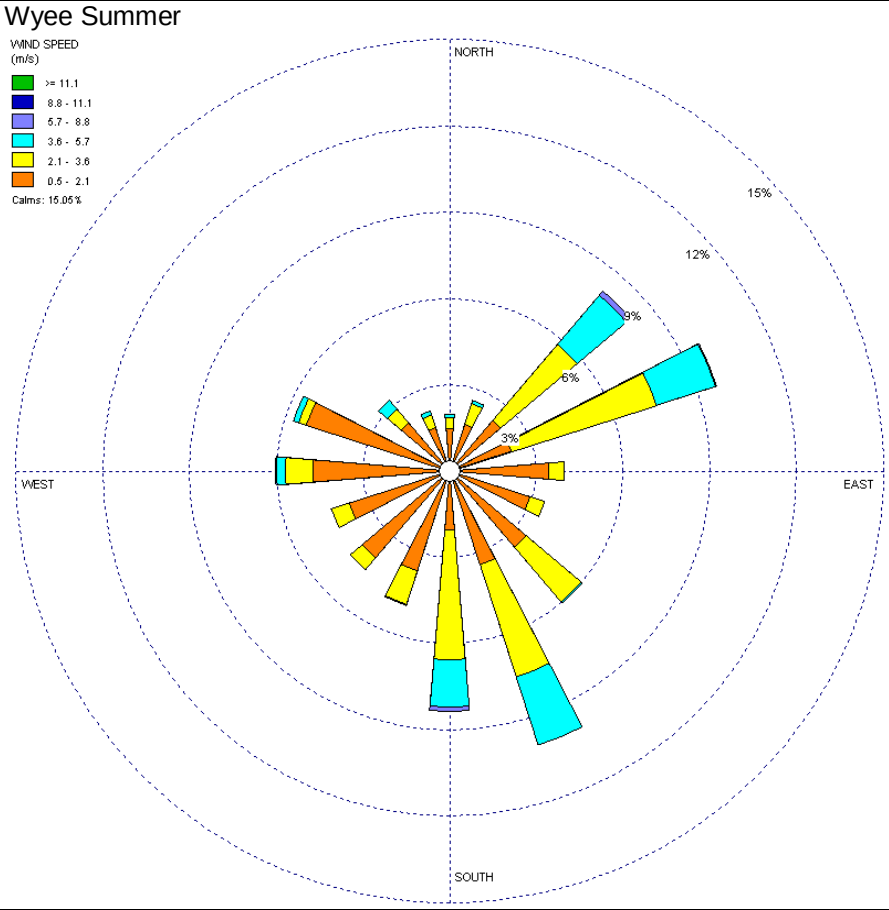

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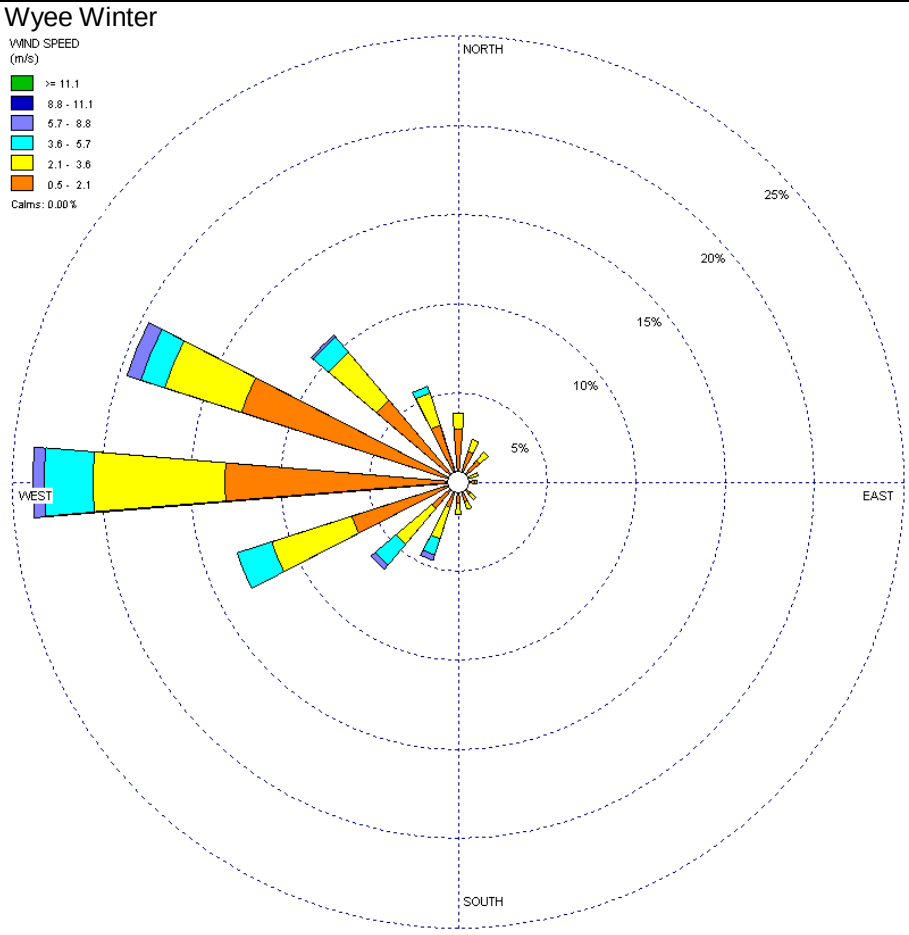

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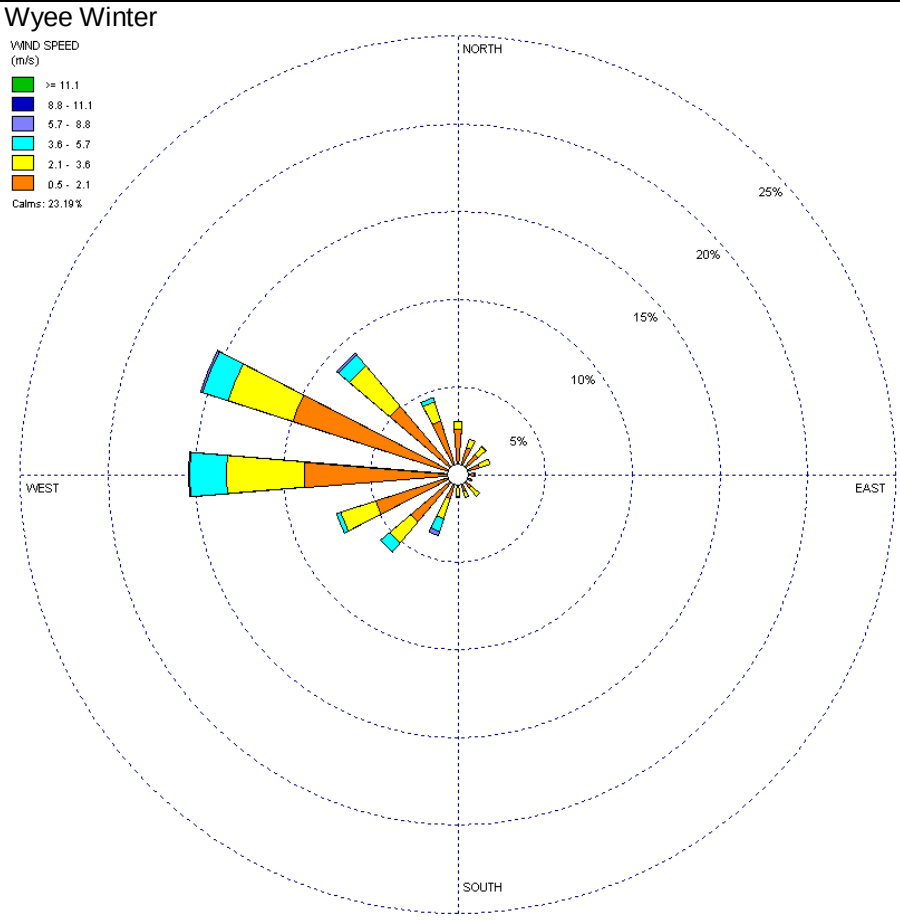

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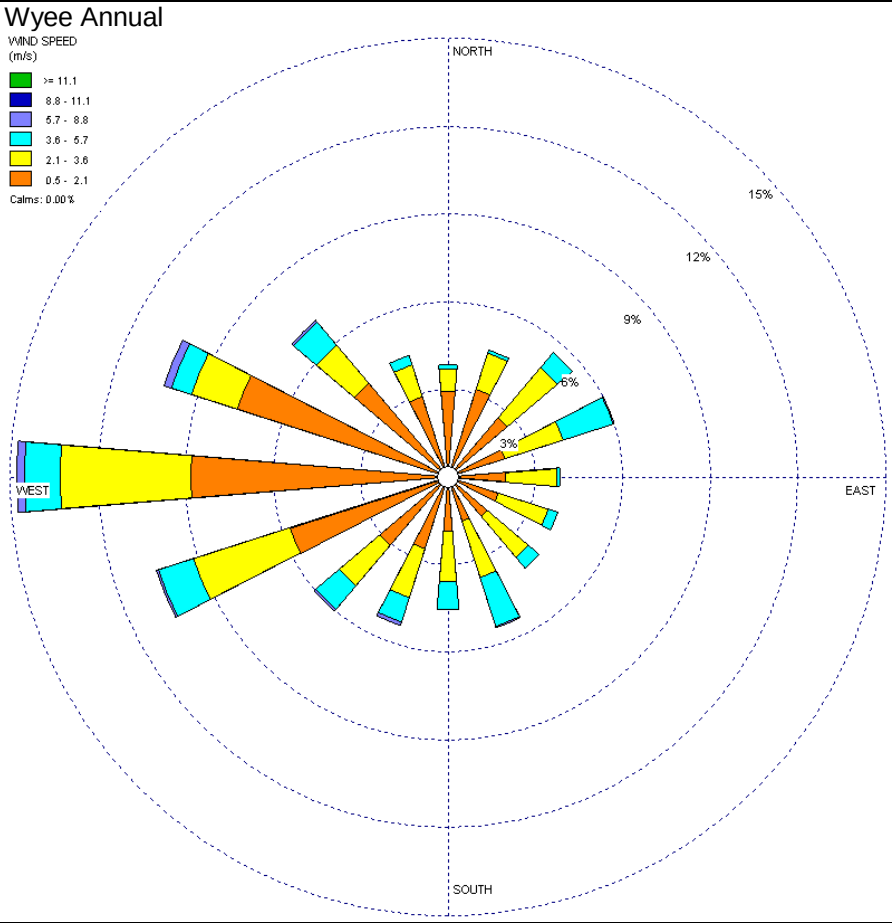

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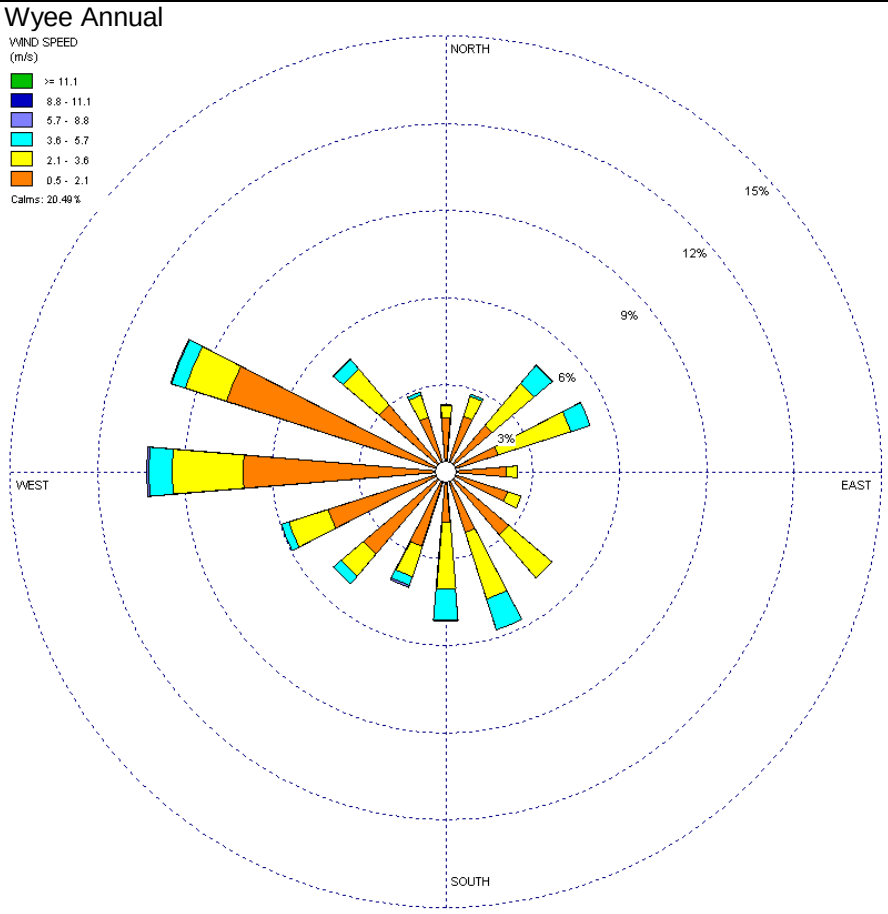
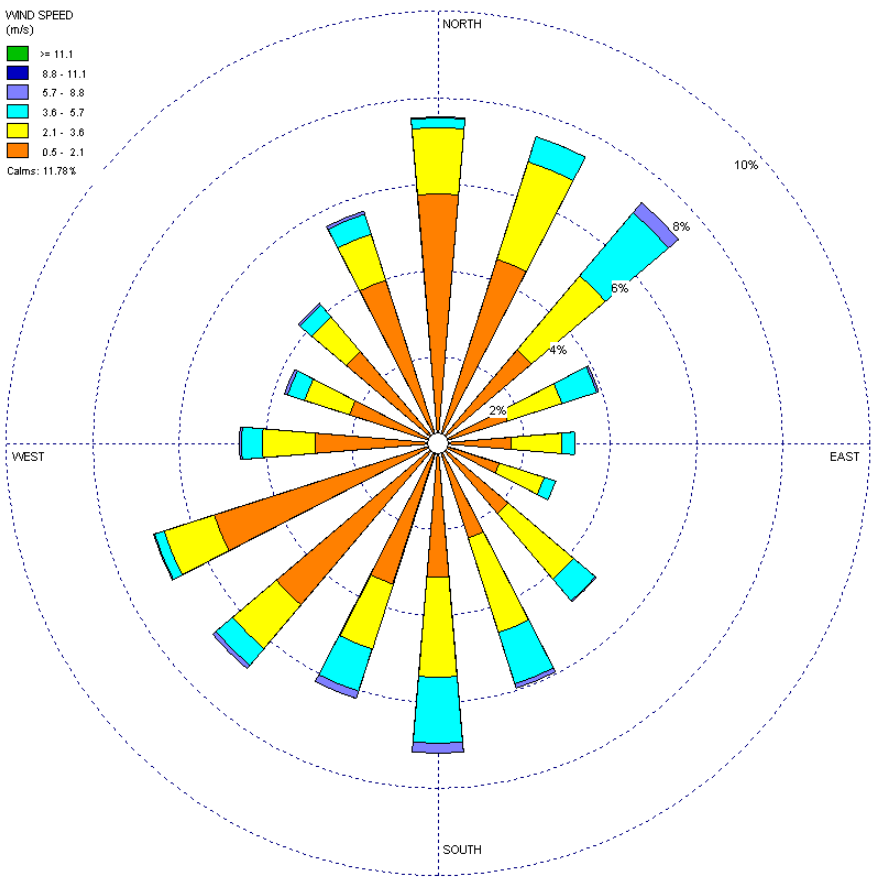


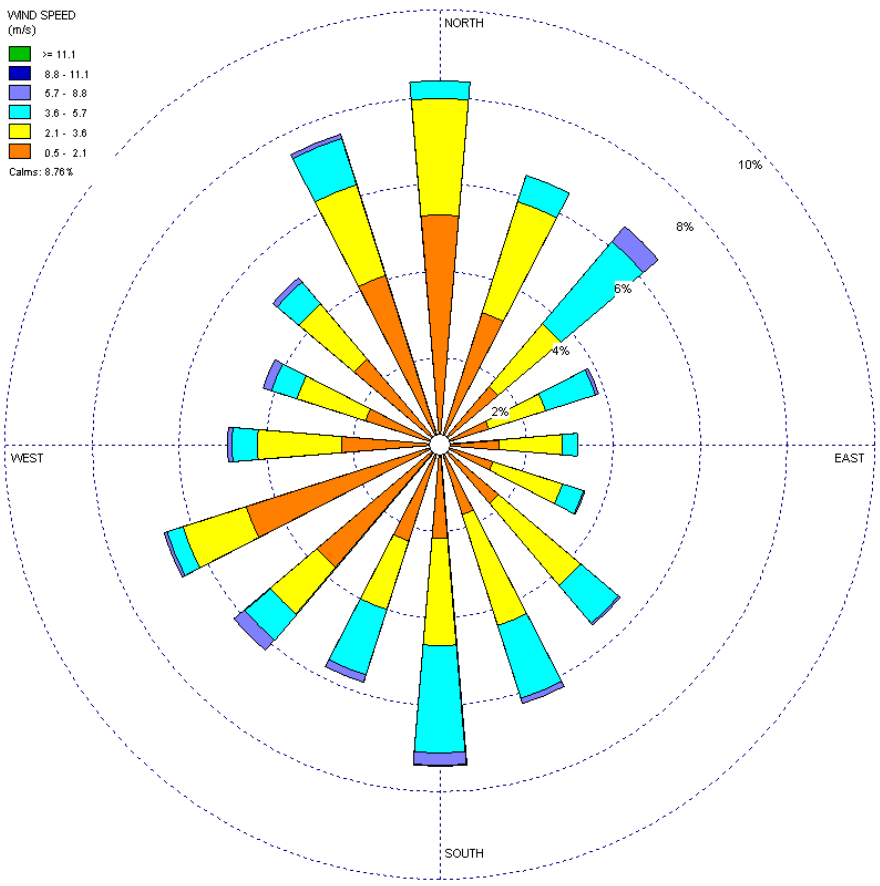
Observed 2001-2007

LMPS

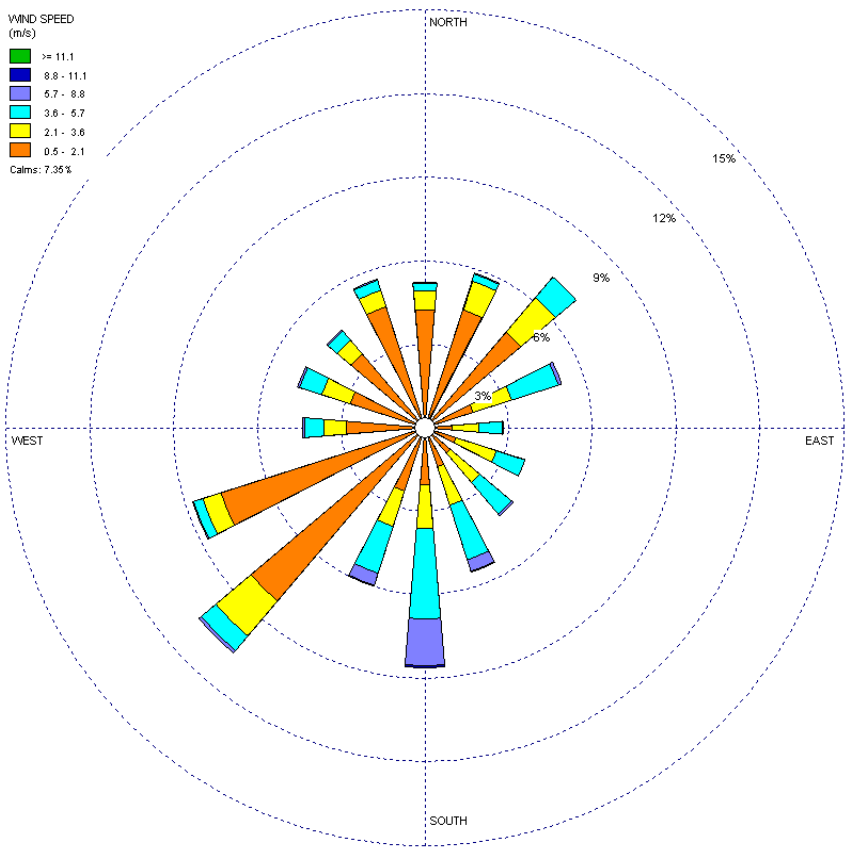


Observed 2004

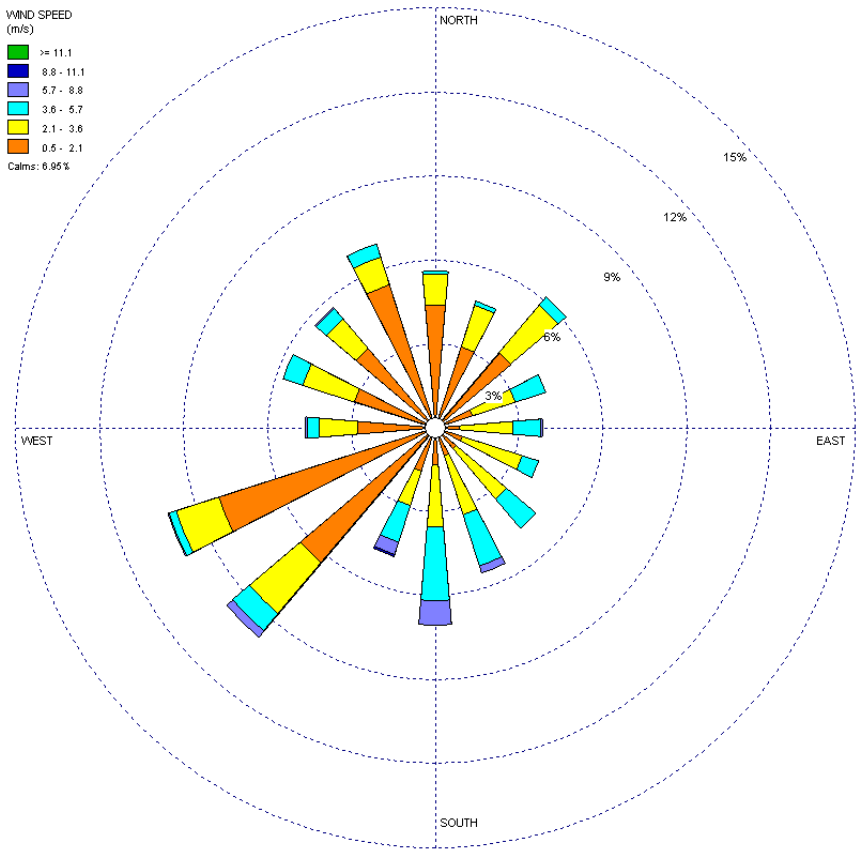
LMPS



Munmorah climatic



Munmorah climatic.



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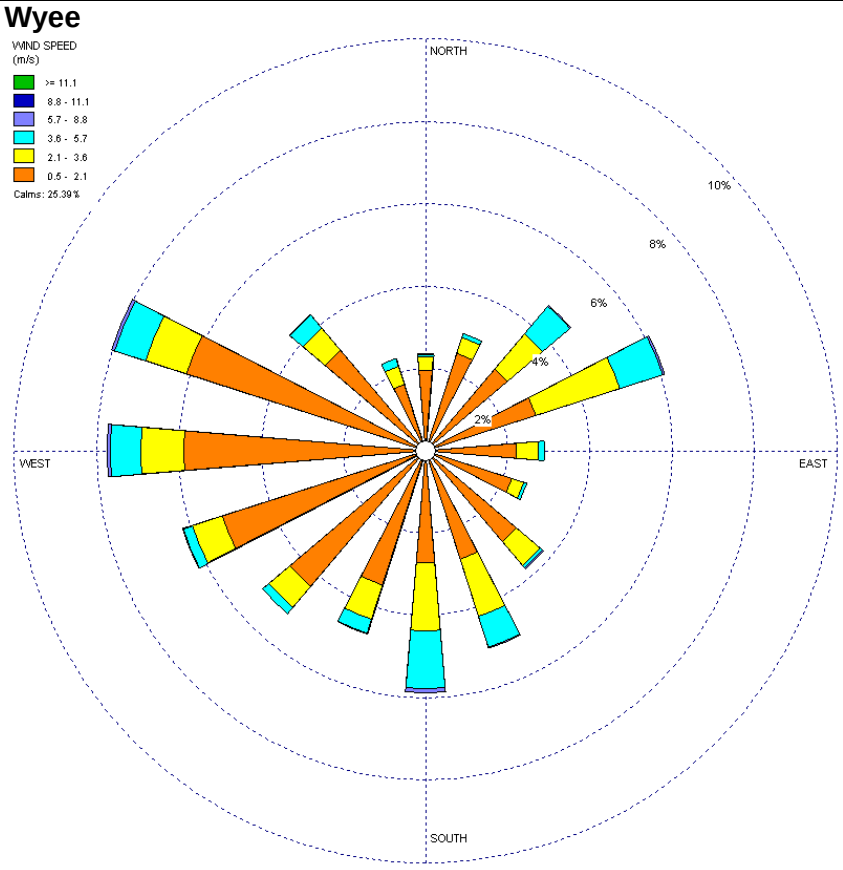

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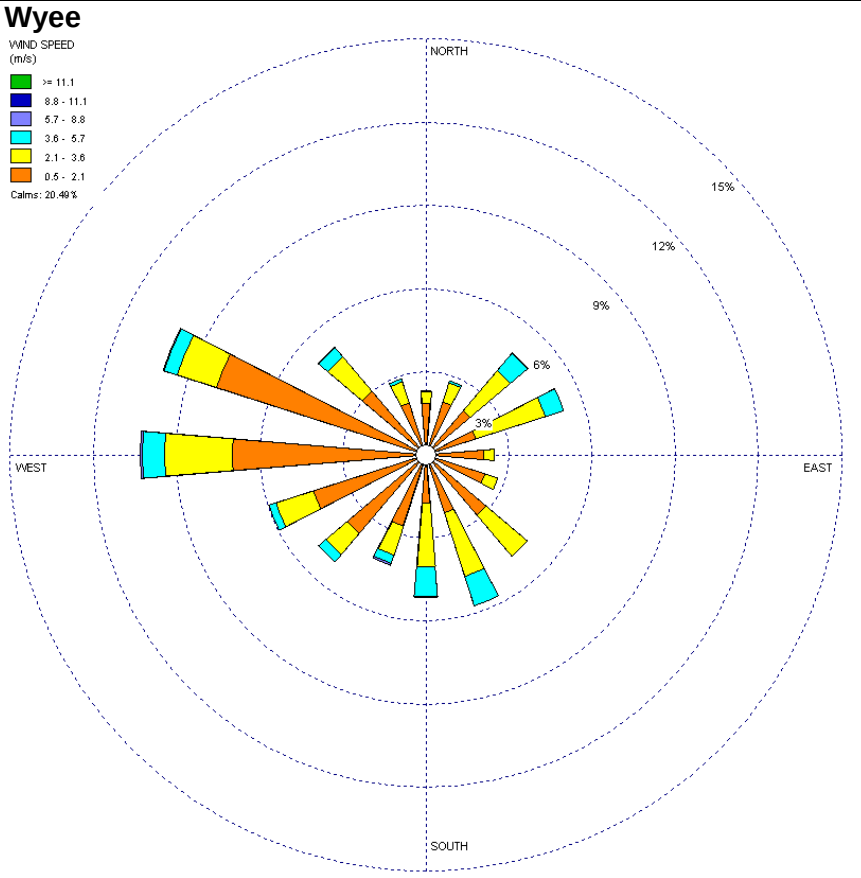


Appendix C

Pollutant contours – SO_2, NO_2 and PM_{10}

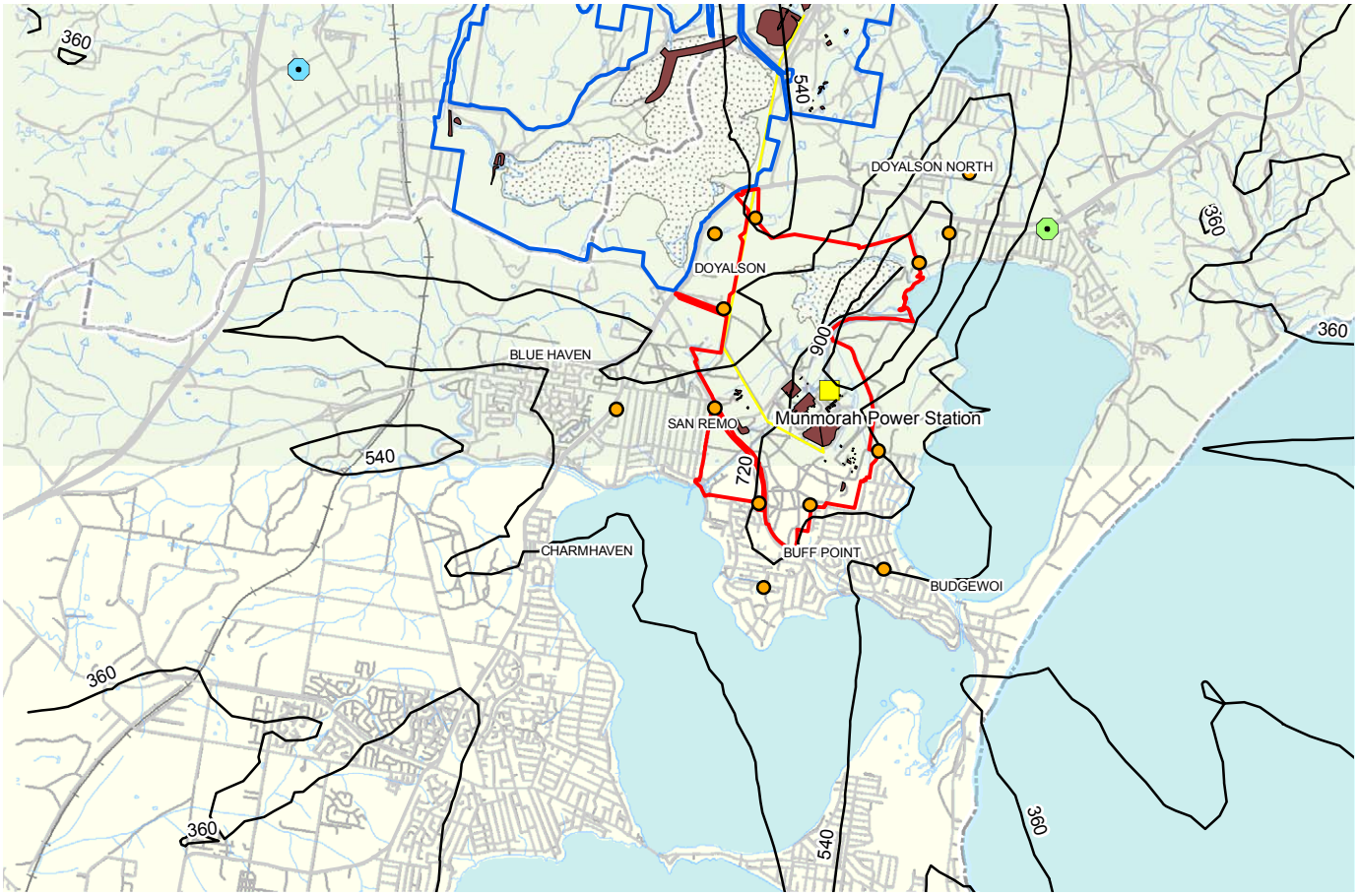
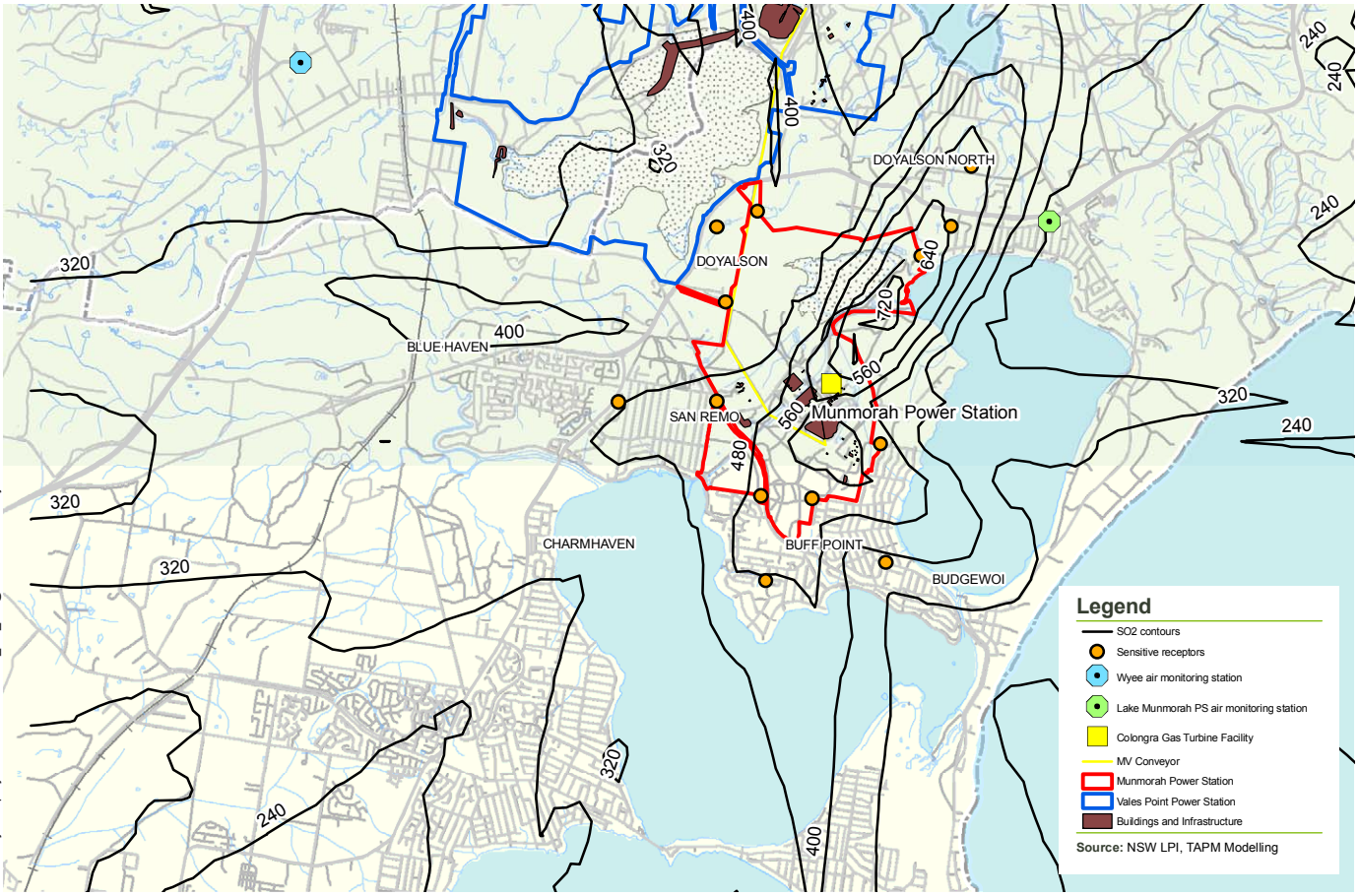


FIGURE C1a: SO2 10 minute average ground level concentration (µg/m³)



U:\GIS\Project-2\project\Munmorah\mmea_6.1_SO@ 10min and hourly.mxd\41442\11-12-09\KAD\Rev 0

FIGURE C1b: SO2 hourly average ground level concentration (µg/m³)

SCALE 1:95,000 @ A4

0 1.5 3km

Projection: MGA

Munmorah Power Station **Rehabilitation Environmental Assessment**

FIGURE C1: SO2 average ground level concentration (µg/m³)

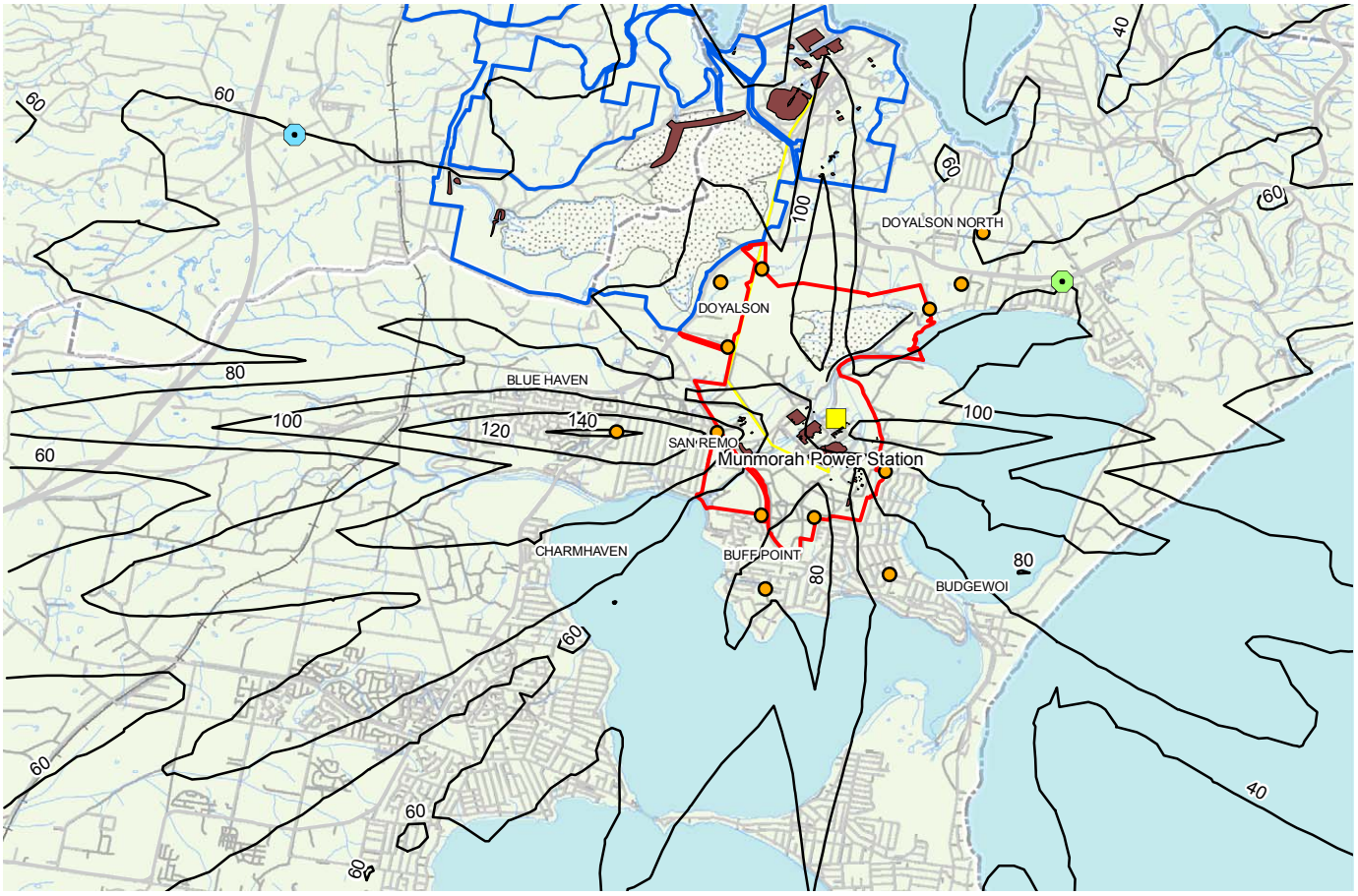


FIGURE C2a: SO2 daily average ground level concentration (µg/m³)

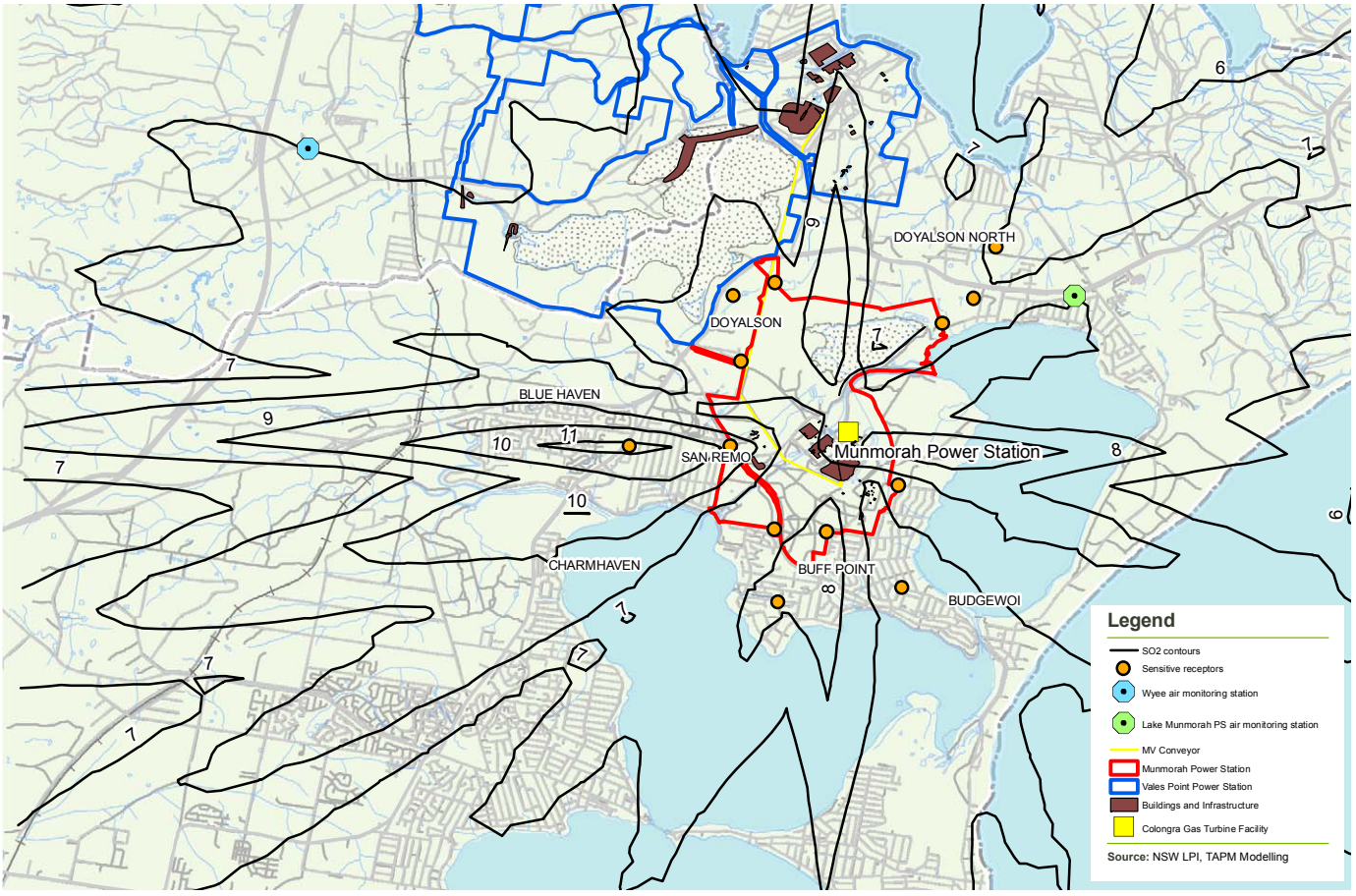


FIGURE C2b: SO2 annual average ground level concentration (µg/m³)

U:\GIS\Project-2\project\Munmorah\mmea_fig6.2_SO2 daily and annual.mxd\141442\11-12-09\KAD\Rev 0

SCALE 1:110,000 @ A4

0 1.5 3km

Munmorah Power Station **Rehabilitation Environmental Assessment**

Projection: MGA

FIGURE C2: SO2 average ground level concentration (µg/m³)

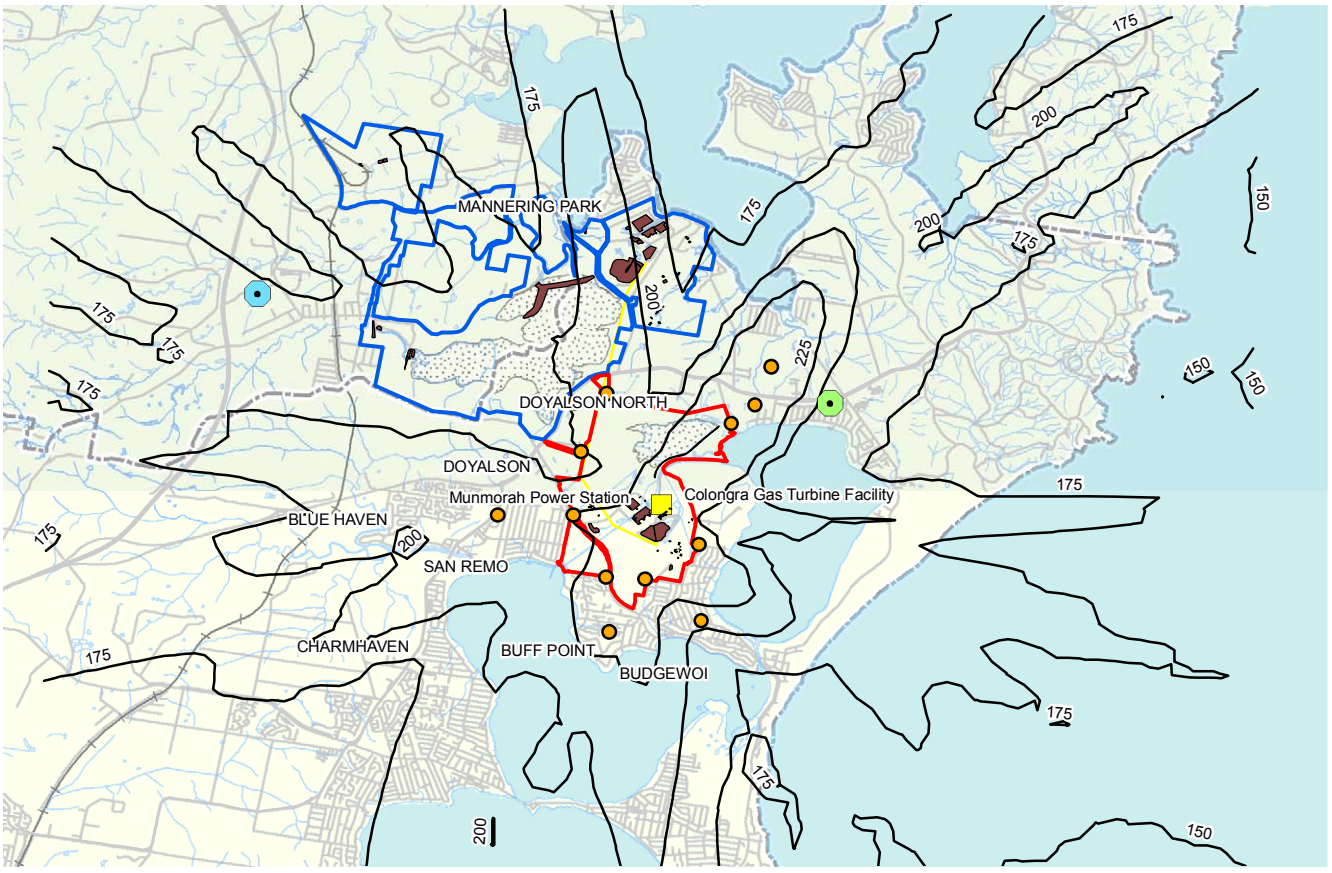


FIGURE C3a: NO2 hourly average ground level concentration (µg/m³)

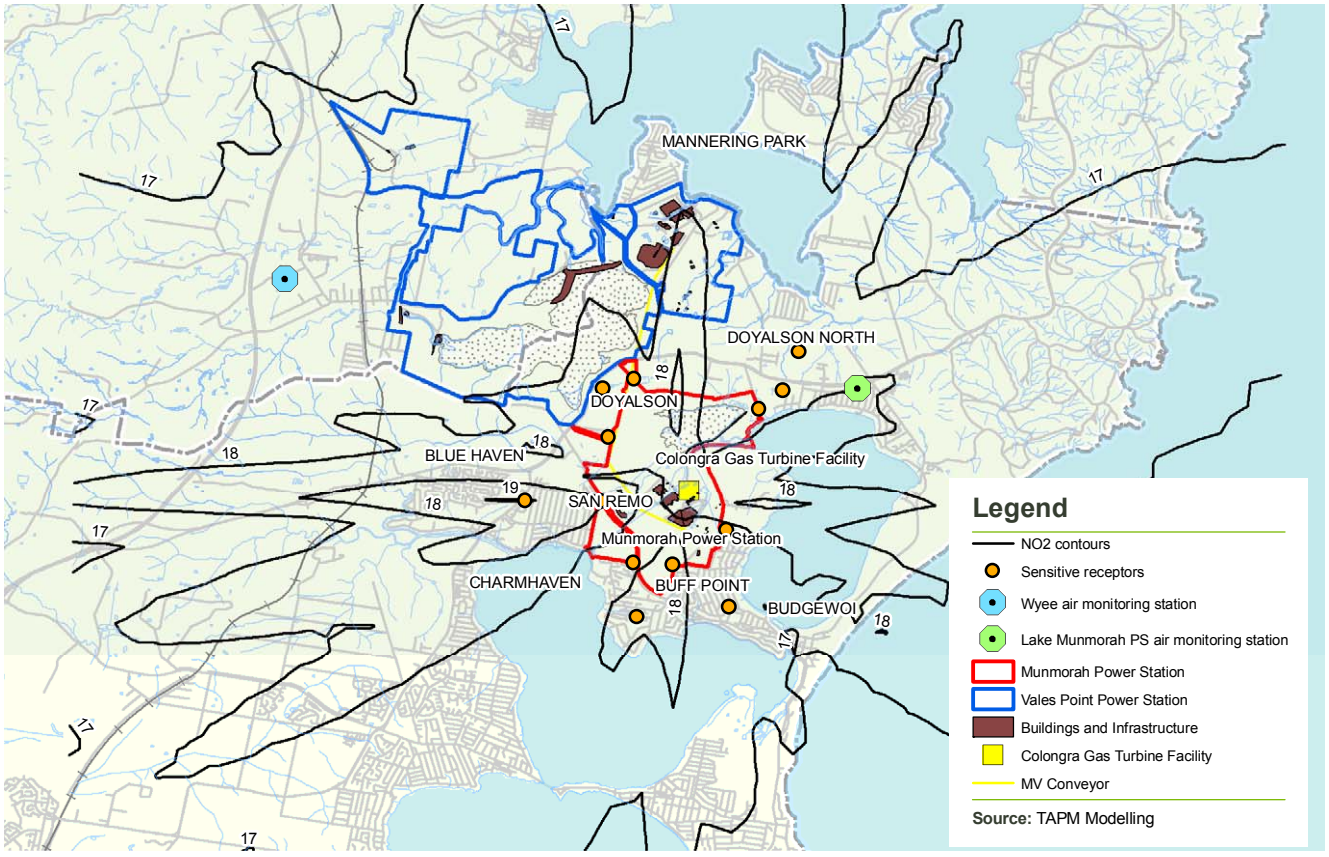


FIGURE C3b: NO2 annual average ground level concentration (µg/m³)

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SCALE 1:150,000 @ A4

0 2 4Kilometers

Projection: MGA

Munmorah Power Station **Rehabilitation Environmental Assessment**

FIGURE C3: NO2 average ground level concentration (µg/m³)

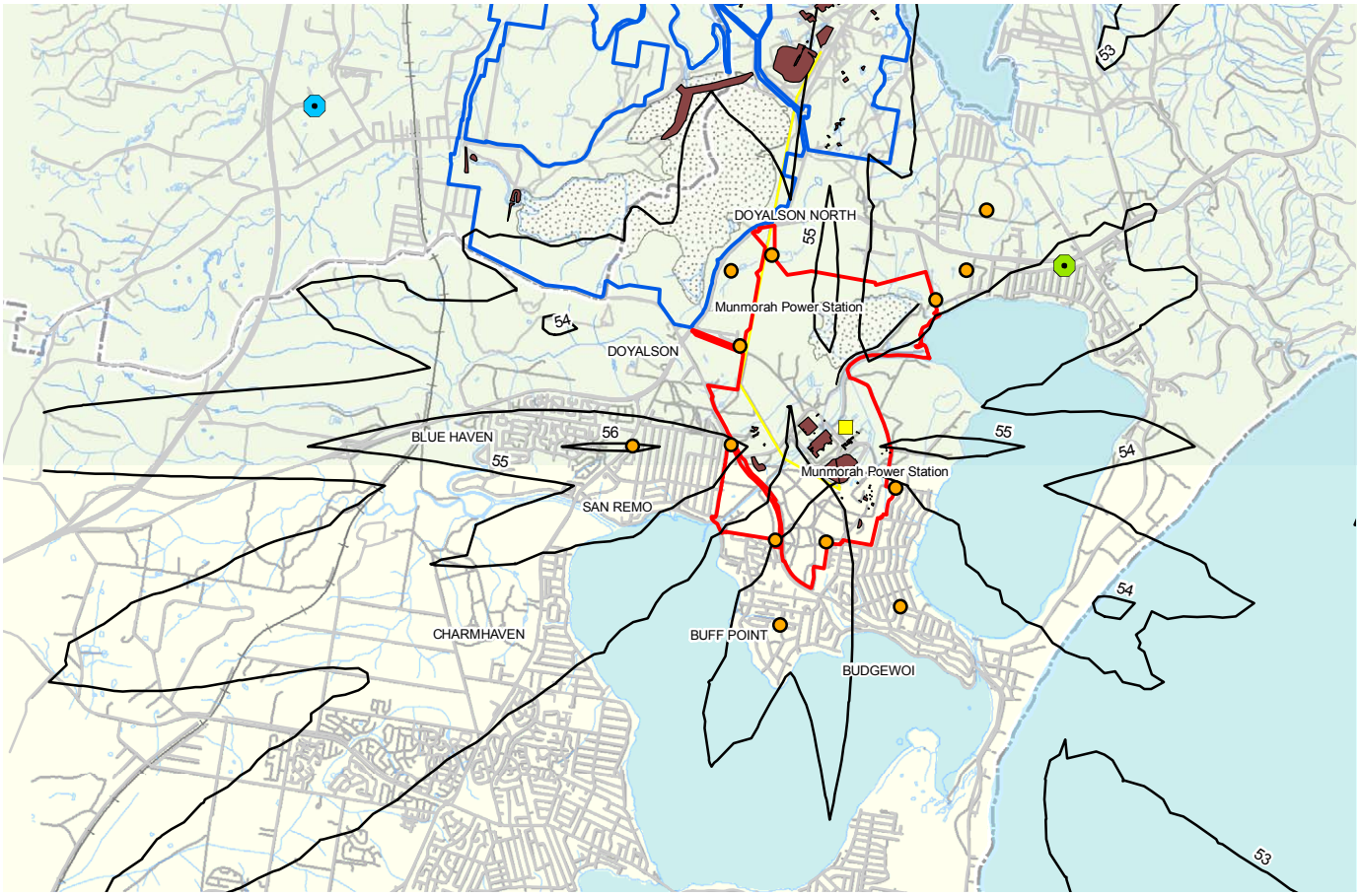


FIGURE C4a: Cumulative PM10 daily average ground level concentration (µg/m³)

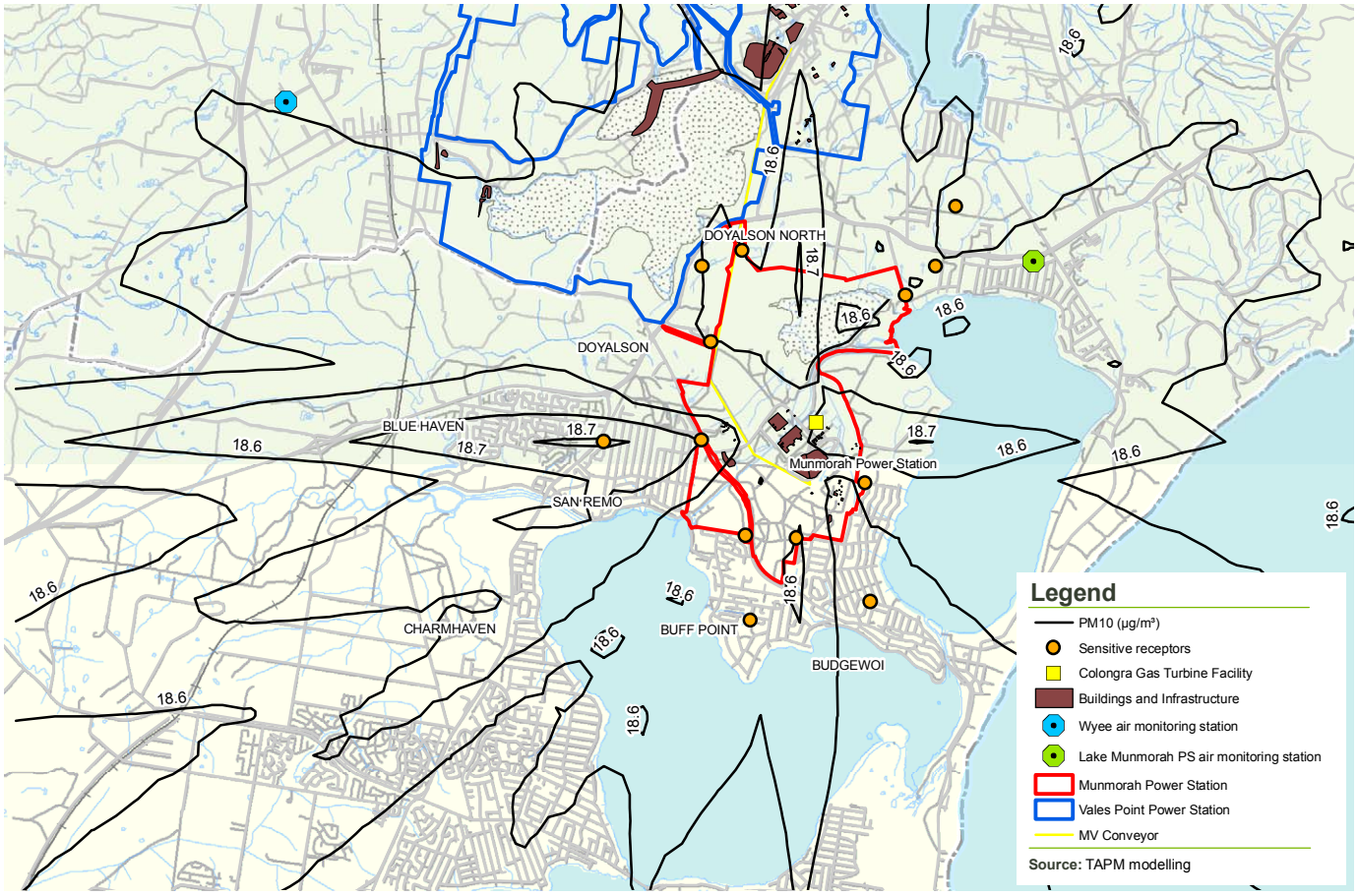


FIGURE C4b: Cumulative PM10 annual average ground level concentration (µg/m³)

U:\GIS\Project-2\project\Munmorah\mmea_fig6-8_PM10_.mxd\141442\09-12-09\KAD\Rev 1

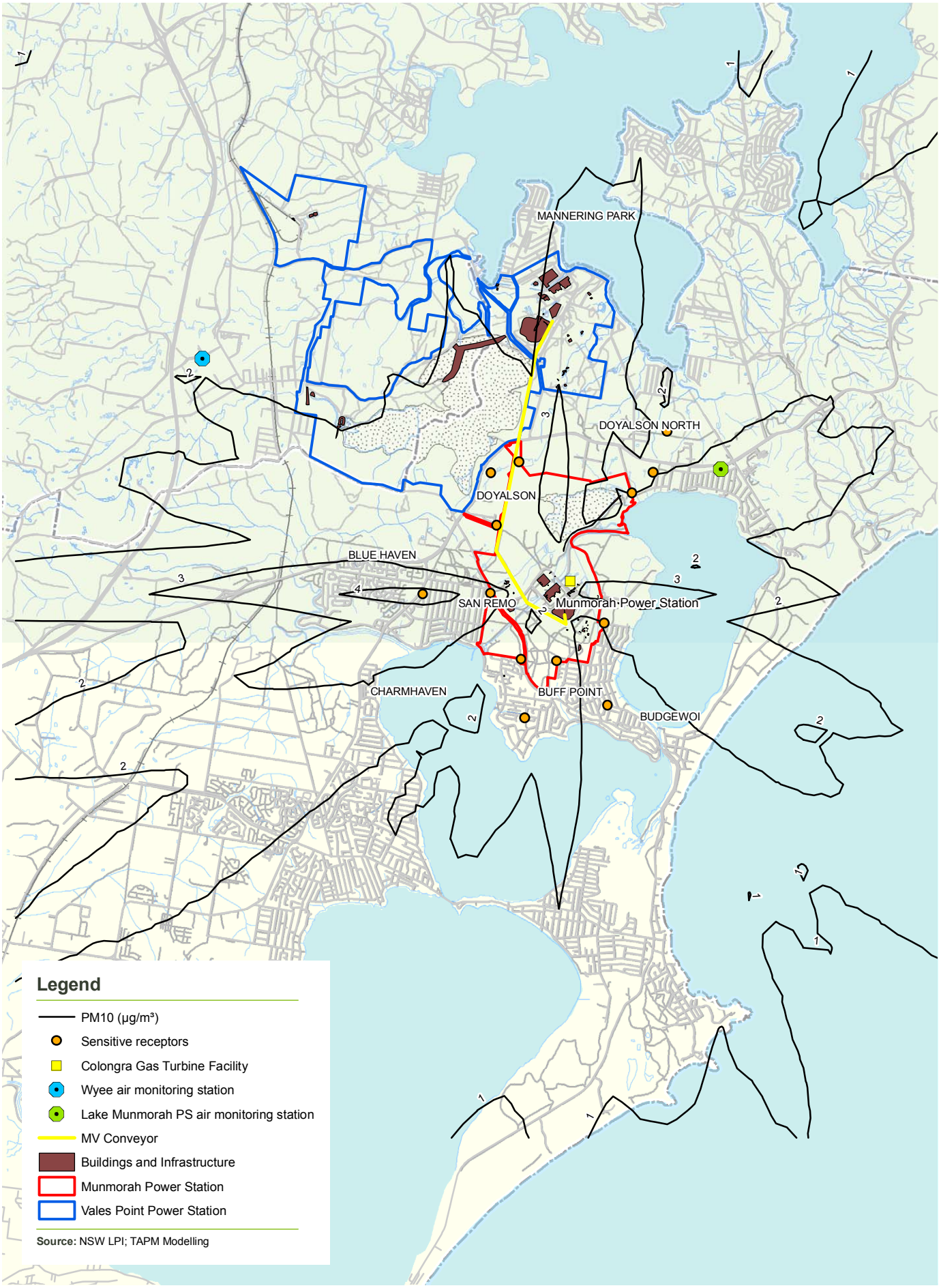
SCALE 1:95,000 @ A4

0 1.5 3km

Projection: MGA

Munmorah Power Station **Rehabilitation Environmental Assessment**

FIGURE C4: PM10 average ground level concentration (µg/m³)



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SCALE 1:95,000 @ A4

0 1.5 3 km

Munmorah Power Station **Rehabilitation Environmental Assessment**

Projection: MGA

FIGURE C5: Munmorah Power Station's incremental PM10 daily average ground level concentrations (µg/m³)