MONA AD PLANT AMMONIA ASSESSMENT

Grays Biogas Ltd

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1.1	28/10/2016	DY		Final

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List of Appendices:

1 Summary

1.1 A detailed assessment of potential emissions of ammonia arising from the operation of an Anaerobic Digestion (AD) plant at Mona Industrial Estate has been undertaken using AERMOD. The model has incorporated potential sources of ammonia as emission sources, which includes the exhaust vents serving the proposed digestate drying process. The report has included an assessment of potential impacts of sensitive human and ecological receptors, with comparison to Environmental Assessment Levels (EALs) and critical levels.

2 Introduction

2.1 Background and Context of Assessment

2.1.1 An ammonia modelling assessment has been undertaken in support of an Environmental Permit Variation application being submitted for an AD Facility to be located at Mona Industrial Estate, Anglesey. The assessment has been undertaken to predict the potential impacts at surrounding human and ecological receptor locations as a result of the proposed operations. Detailed dispersion modelling has been undertaken to predict likely resulting ground level ammonia concentrations surrounding the proposed plant at sensitive receptor locations, which have been compared with the relevant assessment criteria.

2.2 Site Location

2.2.1 The site is located off the A5 road, within the Mona Industrial Estate, at approximate National Grid Reference (NGR) 242029, 375477. Reference should be made to Appendix I for a map illustrating the site location and layout plan.

2.3 Proposed Activities

2.3.1 The proposed activities include the operation of an AD plant. AD is a biological process, which breaks down organic matter within biodegradable wastes in the absence of oxygen, through the actions of a variety of micro-organisms. The result of these processes is the production of biogas, which consists predominantly of methane (CH_4) and carbon dioxide (CO_2) and a useable digestate product which has environmental benefits when used in place of fertilisers. It is proposed to utilise the biogas to power internal combustion engines for the production of electricity and heat. The electricity produced will be exported to the National Grid. The digestate will undergo a series of separation and drying processes to produce a compost product.

2.3.2 The feedstocks to be used will include the following, which are annual quantities:

- 15,000 tonnes chicken litter;
- 25,000 tonnes DAF effluent;
- 10,000 tonnes energy crops; and,
- 3,000 tonnes glycerol.

2.3.3 The site has already been awarded full planning permission. An Environmental Permit (EP) was previously issued for the operation of an AD facility at the site. However, since the EP was issued, the site layout, proposed feedstocks and quantities have been revised. As such, an application is required to vary the EP for the site. This report contains a detailed assessment of potential ammonia arising from the operation, in support of the EP variation application.

3 UK Ammonia Legislation and Regulation

3.1 Overview

3.1.1 The United Kingdom (UK) was committed to reducing airborne ammonia emissions by 17% of the 1990 base value by the year 2010. This was a target agreed during the Gothenburg Protocol (1999) which was developed by the United Nations Economic Commission for Europe (UNECE).

3.1.2 Ammonia is reported to affect plants and vegetation at relatively low atmospheric concentrations. Critical atmospheric levels have been established by UNECE, above which it is indicated that ammonia can cause damage to ecological receptors. Short and long term Environmental Assessment Levels (EALs) are also in place for ammonia for the protection of human health.

3.1.3 The atmospheric release of ammonia from the proposed AD plant will be controlled under the Environmental Permitting (England and Wales) Regulations 2010 (as amended).

3.2 Critical Level for Ammonia for Protection of Vegetation

3.2.1 A worst case critical level of 1µg.m^{-3} as an annual mean ammonia concentration has been confirmed as appropriate by Natural Resources Wales (NRW) for the nearest statutory ecological receptor (Cors Bodwrog Site of Special Scientific Interest (SSSI)). As a precautionary approach, this conservative critical level has been assigned for all ecological receptors considered within this assessment. Nitrogen deposition associated with ammonia emissions has not been assessed since the worst critical level of 1µg.m^{-3} for annual mean ammonia concentration can be considered a catch-all for critical loads, therefore, if impacts can be screened/modelled as insignificant against the worst case critical level for ammonia, impacts will be insignificant on critical loads for acid and nitrogen deposition.

3.3 Environmental Assessment Levels for Ammonia for Protection of Human Health

3.3.1 NRW have confirmed that impacts on short term EALs for ammonia should be considered, assuming that the short term EAL is a daily average EAL. The short term EAL for ammonia which is relevant to this assessment is contained in the table below. This has been obtained from the UK government website[1]. This is stated to be an hourly limit. For completeness, both 1-hour mean and 24-hour mean ammonia concentrations have been assessed against this criteria.

Table 1 Short Term EAL for Ammonia

Pollutant	Short Term EAL (Hourly Limit) ($\mu g.m^{-3}$)
Ammonia	2,500

[1] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

4 Baseline Position

4.1 Site Context

4.1.1 The proposed site is located in a rural location with other potential sources of ammonia in the vicinity, including the poultry farm to the North.

4.2 Sensitive Receptors

4.2.1 Table 2 contains a list of all identified sensitive receptors within the vicinity of the proposed plant, which would be most sensitive to ammonia. Where these are referred to in the report, they are identified as A1 to A9. These include a combination of residential receptors and statutory ecological receptors. The identified NGR for each receptor represents the nearest point to the proposed site boundary in order to ensure a 'worst case' assessment.

Table 2 Identified Ammonia Sensitive Receptor Locations

Ammonia Receptor Identifier	Ammonia Sensitive Receptor Description	National Grid Reference (m)	
		X	Y
A1	Fronleu Haulfre	242095	375823
A2	Mathafarn	242210	375539
A3	Cae Eithin	241938	375216
A4	Tyn Rhos	241138	376194
A5	Cors Bodwrog SSSI	240894	377078
A6	Corsydd Mon a Llyn/Anglesey and Llyn Fens ramsar/Corsydd Mon/Anglesey Fens Special Area of Conservation (SAC)	247587	379909
		246983	380542
		249926	378755
		247285	377783
		247540	377331
A7	Glan-traeth SAC	241732	366989
A8	Glannau Mon: Cors heli/Anglesey Coast:Saltmarsh SAC	240754	368757
A9	Y Twyni o Abermenai i Aberffraw/Abermenai to Aberffraw Dunes SAC	237890	370630

5 Modelling Methodology

5.1 Model Description

5.1.1 The potential air quality impact that may arise through emissions of ammonia during operation of the AD facility has been quantified using AERMOD, which is a steady state, next generation, dispersion model. AERMOD was developed jointly by the American Meteorological Society (AMS) and the United States (US) Environmental Protection Agency (EPA) Regulatory Model Improvement Committee. The AERMOD model is a development from the ISC(Industrial Source Complex) 3 dispersion model and incorporates improved dispersion algorithms and pre-processors to integrate the impact of meteorology and topography within the modelling output, and is approved for use within the UK by the EA and NRW. The version of AERMOD that has been used for this current assessment is Lakes Environmental ISC-AERMOD View Version 9.2. The model has been run using the most recent version of the AERMOD executable file, 15181. In order to improve modelling running times, Lakes Environmental have produced an equivalent source code to 15181, known as AERMOD parallel which enables the model to be run over multiple processors. The model was run using Lakes Environmental AERMOD MPI 15181.

5.2 Model Inputs

5.2.1 Ammonia Emissions and Sources

5.2.1.1 There are no emission limit values for ammonia. A potential source of ammonia emission at the proposed plant includes exhaust stacks associated with the air cleaning system on the drying shed. The technology provider has advised that this system will control ammonia emissions to a maximum residual ammonia concentration of 7.3mg.m^{-3}.

5.2.1.2 The following table provides a summary of ammonia emission sources and parameters assigned within the model. Reference should be made to Appendix I for a plan illustrating emission sources used as model inputs.

Table 3 Summary of Ammonia Emission Sources and Parameters Assigned in Model

Ammonia Source	Type of Emission Source	Point Source Diameter (m)	Exhaust Flow Rate Per Stack ($m^3.s^{-1}$)	Ammonia Emission Rate Per Stack ($g.s^{-1}$)	Release Height (m)	Release Temperature
Vents on Control Unit serving drying hall	Point source (5 in total)	0.8	2.46	0.017967	11	303

5.2.2 Building Downwash

5.2.2.1 The on-site structures were digitised within the model from site layout and height information provided by the site operator. As the closest buildings to the odour emission sources, these would be expected to have an influence on pollutant dispersion from point source emissions. Table 4 contains information on building dimensions assigned within the model. Reference should be made to the drawing in Appendix I for details of structure locations.

Table 4 Building and Structure Heights

Structure	Max Height (m)	Length and Width (m)	Diameter (m)
Storage Tank	14.45	-	25.31
Post Digester	14.45	-	24.93
Digester 2	12.63	-	18.98
Digester 1	12.63	-	19.08
Chicken Litter Storage Building	10.02	15.99 x 8.29	-
Drying Hall	8.58	14.65 x 28.13	-
Silage Clamp	6.1	46 x 53	-
Compost Hall	7.38	13.25 x 13.62	-
Glycerol Tank	6.4	-	4.4
DAF SCC1	7.2	-	4.06
DAF SCC2	7.2	-	4
DAF Glambia	6.4	-	3.75
Feedstock Hoppers	3	13.72 x 2.71	-
Hydronisation Tanks	5.4	-	2.5
Buffer Tank	5.4	-	3.17
PW Tank	5.4	-	3.25
CHP	4.420	13.8 x 3.4	-

5.2.2.2 The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced

by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All building structures were input into the BPIP processor.

5.2.3 Meteorological Data

5.2.3.1 Meteorological data used in this assessment was obtained from Valley meteorological station, including missing cloud cover data from Liverpool. Valley meteorological station is located approximately 11km to the West of the proposed site.

5.2.3.2 Five years of meteorological data observed between 2004 and 2008 was used within the assessment. Data was previously supplied by ADM Ltd, an established distributor of met data within the UK. The data provided by ADM Ltd was in ADMS format. This was converted to the required format required by AERMET using the ADMS UK to SAMSON converter, which is a tool within the AERMET processor. The AERMET processor within AERMOD was used to process the data to be site specific. US EPA guidance on processing met data for use within AERMOD states that land use up to 1km upwind from a site should be considered when determining surface roughness characteristics, whilst for Bowen ratio and albedo, land use types within a 10km by 10km area centred over the site should be considered[2]. The land use over the 10km by 10km area is dominated by rural and cultivated land, which make up approximately 90% of the land coverage. The remaining 10% consists of buildings and trees. AERMOD guidance states that albedo and bowen ratio should be calculated as the arithmetic and geometric mean respectively of land use types over the 10km by 10km grid, not weighted by direction or distance. In terms of surface roughness, land use surrounding the site consists of scattered trees, hedges and buildings, therefore, a surface roughness factor of 0.3 was considered appropriate.

[2] AERMOD Implementation Guide, US EPA, 2015.

5.2.3.3 The parameters use to process the meteorological data are contained within Table 4

Table 5 Parameters for Surface Roughness, Albedo and Bowen Ratio

Parameter	Directional Sector	Value
Surface Roughness	All	0.3
Albedo	All	0.239
Bowen Ratio	All	0.8608

5.2.4 Terrain Data

5.2.4.1 Topographical features can have a significant impact on pollutant dispersion, however, the gradient of the land across the site and surrounding modelling domain is predominantly <10%. Therefore, it was not considered necessary to include terrain data, in accordance with the relevant guidance[3].

5.2.5 Assessment Area

5.2.5.1 The model was used to predict resulting ammonia concentrations at discrete sensitive human and ecological receptors. The NGR for receptors used as model inputs is contained within Table 2. In addition, numerous Cartesian receptors were placed along the boundary of the closest ecological receptor (Cors Bodwrog SSSI), to ensure the point of highest impact was captured. Furthermore, a 2,000m x 2,000m uniform Cartesian receptor grid was used to represent the modelling domain with a grid spacing of 25m, centred on the site location, so that the point of maximum impact could be captured.

5.2.6 Modelled Scenarios

5.2.6.1 The scenarios modelled are contained within Table 6.

Table 6 Modelled Scenarios

[3] LAQM.TG(09), DEFRA, 2009.

Scenario	Modelled Scenarios
All years	1-hour mean, 24-hour mean and annual mean ammonia concentrations.

5.2.7 Model Uncertainty and Error

5.2.7.1 It is widely accepted that there can be a significant degree of uncertainty in predictions made by any atmospheric dispersion model, which needs to be taken into account when assessing modelled results. As the site is not yet operational, the modelling assessment has incorporated ammonia emission rates based on the maximum ammonia concentration that the control system is designed to achieve. As such, residual ammonia concentrations are likely to be a degree lower than the values used in this report. A series of conservative assumptions have been used in this assessment which are considered to provide a high level of confidence that that the ammonia model predictions present a highly conservative, worst case assessment, despite potential model uncertainty and errors. A summary of these worst case assumptions is as follows:

- Ammonia emission rates based upon worst case concentrations for control unit;
- It was assumed that the plant will be operational for 24 hours per day, 365 days per year with no shut down for maintenance;
- Worst case concentrations across five years of met data used to assess potential impacts;
- No inclusion of the effects of plume depletion as a result of wet and dry deposition, which would likely result in lower ammonia concentrations at sensitive receptors than those predicted in this report.

5.2.8 Methodology for Assessment of Potential Impacts

5.2.8.1 In order to assess potential impacts, reference has been made to the air emissions risk assessment guidance on the government website[4]. The guidance indicates that potential impacts from a process can be considered insignificant if the following screening criteria are met:

- The long term process contribution is <1% of the long term environmental standard; and/or,
- The short term process contribution is <10% of the short term environmental standard.

[4] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

6 Model Results

6.1 The tables below present the maximum modelled ammonia concentrations at sensitive receptor locations. As is indicated, the maximum modelled process contribution to the 1-hour mean and 24-hour mean EAL for ammonia will be less than 10% at all locations within the modelling domain, including the closest sensitive human receptor locations. As such, impacts on human receptors are not predicted to be significant. The modelled process contribution to the worst case critical level at sensitive ecological receptors is not predicted to exceed 1%. As such, impacts on sensitive ecological receptors are not predicted to be significant.

Table 7 Maximum Modelled Process Contribution to 24-Hour Mean Ammonia Concentrations

Maximum Modelled 24-Hour Mean Ammonia Concentrations Within Model Domain (µg.m^{-3})	Process Contribution as Percentage of EAL (%)
50.65	2.03

Table 8 Maximum Modelled Process Contribution to 1-Hour Mean Ammonia Concentrations

Maximum Modelled 1-Hour Mean Ammonia Concentrations Within Model Domain (µg.m^{-3})	Process Contribution as Percentage of EAL (%)
104.23	4.17

Table 9 Maximum Modelled Process Contribution to 24-Hour Mean Ammonia Concentrations at Sensitive Receptors

Receptor	Modelled 24-Hour Mean Ammonia Concentrations For Each Assessment Year at Sensitive Receptors (µg.m^{-3})	Process Contribution as Percentage of EAL (%)
A1	2.08	0.08
A2	3.7	0.15
A3	3.15	0.13
A4	0.54	0.02

Table 10 Maximum Modelled Process Contribution to 1-Hour Mean Ammonia Concentrations at Sensitive Receptors

Receptor	Modelled 1-Hour Mean Ammonia Concentrations For Each Assessment Year at Sensitive Receptors (µg.m^{-3})	Process Contribution as Percentage of EAL (%)
A1	15.06	0.6
A2	33.05	1.32
A3	22.89	0.92
A4	5.17	0.21

Table 11 Modelled Process Contribution to Annual Mean Ammonia Concentrations at Sensitive Ecological Receptors

Receptor	Modelled Annual Mean Ammonia Concentrations For Each Assessment Year at Sensitive Ecological Receptors ($\mu g.m^{-3}$)						Max Process Contribution as Percentage of Worst Case Critical Level
	2004	2005	2006	2007	2008	Max	
A5	0.006	0.009	0.010	0.010	0.009	**0.01**	1
A6	0.001	0.002	0.002	0.002	0.002	**0.002**	0.2
A7	0.002	0.002	0.002	0.003	0.002	**0.003**	0.3
A8	0.002	0.002	0.003	0.003	0.004	**0.004**	0.4

7 Conclusions

7.1 A detailed assessment of potential ammonia arising from the operation of an AD plant at Mona Industrial Estate has been undertaken using AERMOD. The model has incorporated potential sources of ammonia as emission sources, which includes the exhaust vents serving the digestate drying process. The modelled process contribution is not predicted to exceed 1% of the critical level for annual mean ammonia concentration at statutory ecological receptors. Furthermore, the modelled process contribution to the short term EAL for ammonia as a 1-hour mean and 24-hour mean is predicted to be less than 10% at all location surrounding the plant, including sensitive human receptors. Given the above, potential impacts from ammonia are not predicted to be significant. Given the series of conservative, worst case assumptions used in the assessment, the confidence in this prediction is considered to be high.

Appendix I

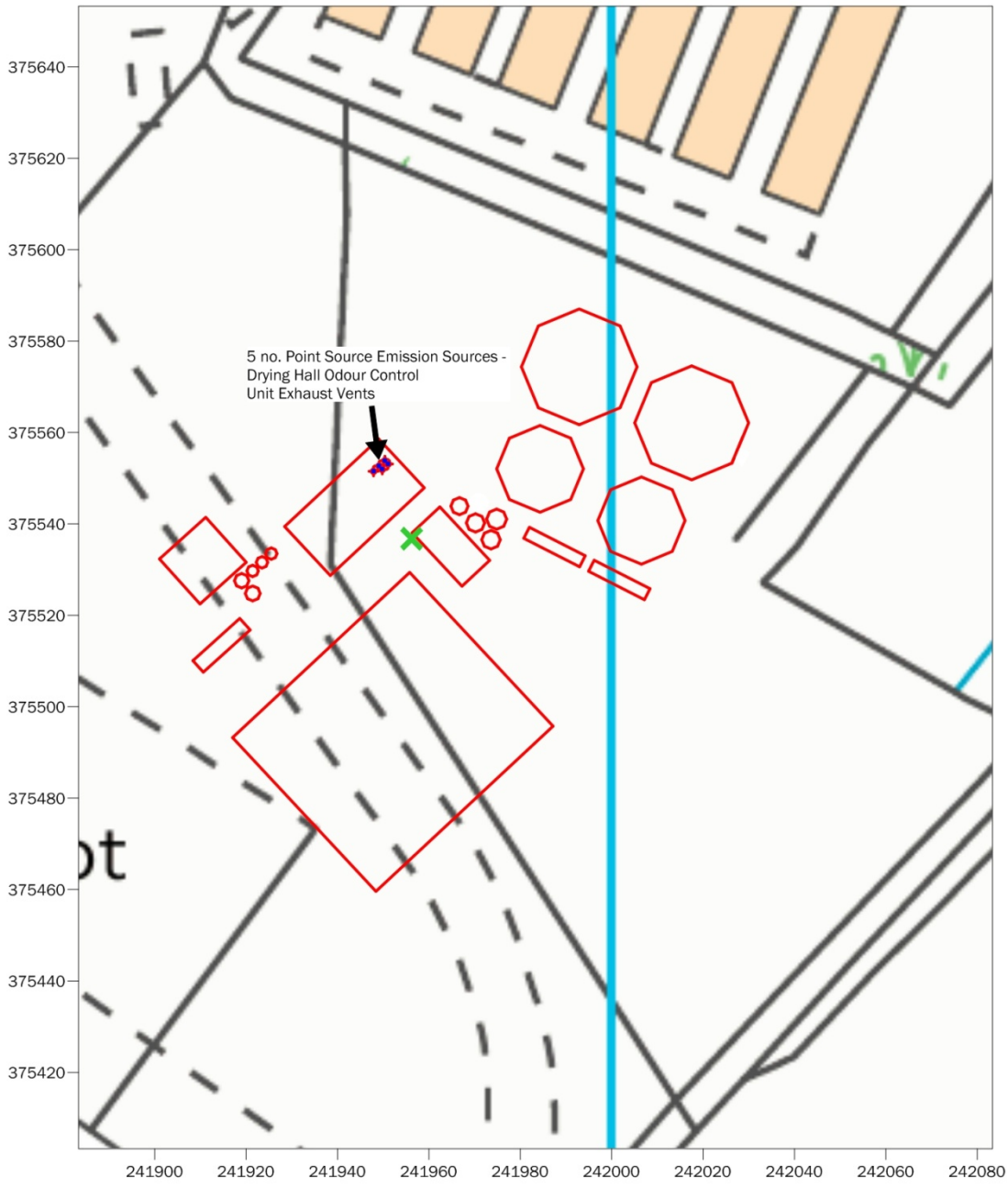
Site Location and Layout Plans

Rev.	Date	Drawn	Checked	Revision
G				
F				
E	11.04.2016	G.Spreng	J.Weyer	piping new position
D	11.04.2016	G.Spreng	J.Weyer	position PW-tank, pump
C	08.04.2016	G.Spreng	J.Weyer	Piping, ASL-tank, buffer tanks, flare updated
B	22.02.2016	HST	J.Weyer	Layout update
A	02.12.2015	V.Abels	J.Weyer	EYS, LV Station, pump leachate tank, compost hall, siclamps, CHP, gateway, weighbridge

Project:	A2529UK_MONA
State Of Planning:	draft
Drawing Title:	General Layout overview
Client:	
Plan Author:	agraferm technologies Agraferm Technologies AG Färberstraße 7 D-85276 Pfaffenhofen/Ilm www.agraferm.com

	Drawn	Checked
Date	08.10.2015	
Name	V.Abels	
Drawing No.:	A2529UK_MONA-00-01-layout	

Rev:	Sheet Size:	Scale:
E	A0	1:250



Appendix I - Buildings and Emission Sources Digitised within Model

● Point Source Emission - Drying Hall Exhaust Vents

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY

Appendix II

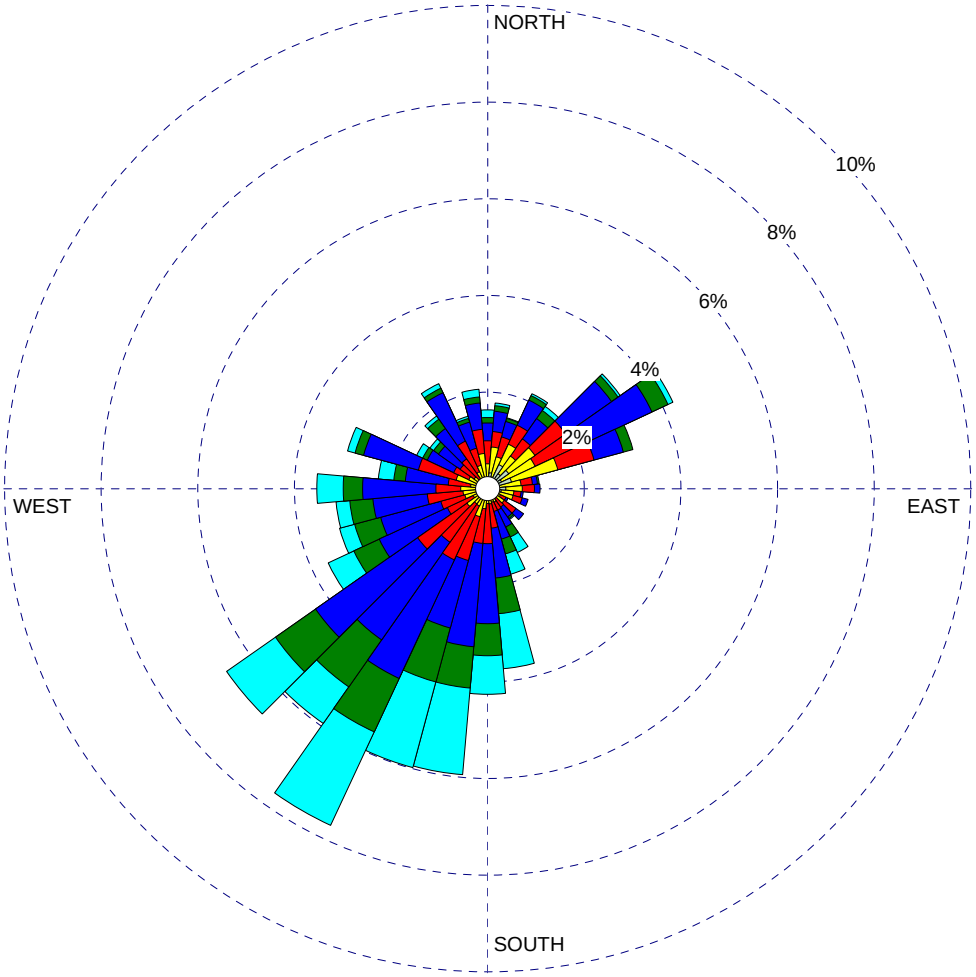
Wind Roses

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 01/01/2008 - 00:00** **End Date: 31/12/2008 - 23:00**	COMPANY NAME:	
		MODELER:	
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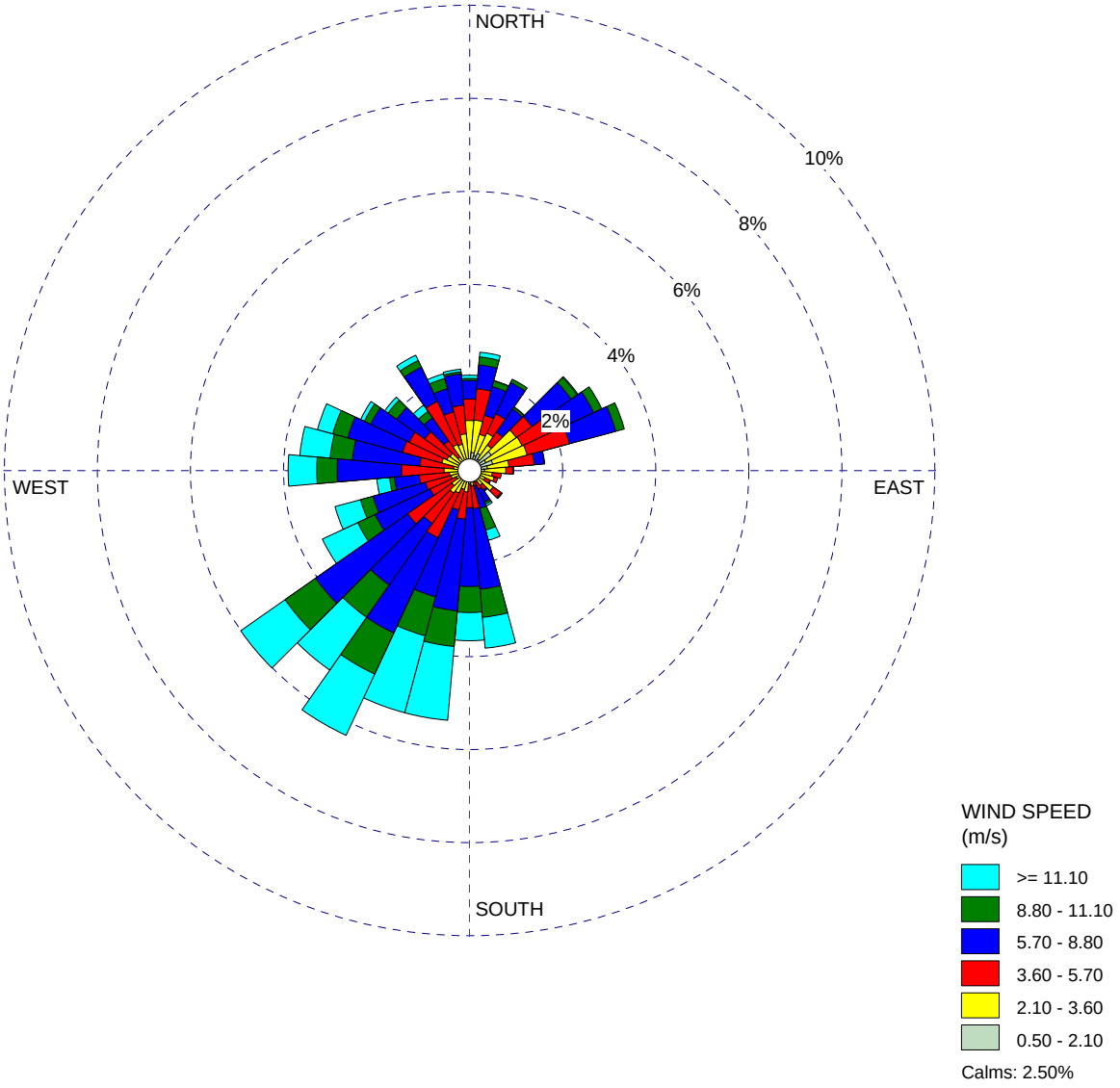
	AVG. WIND SPEED: **6.81 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



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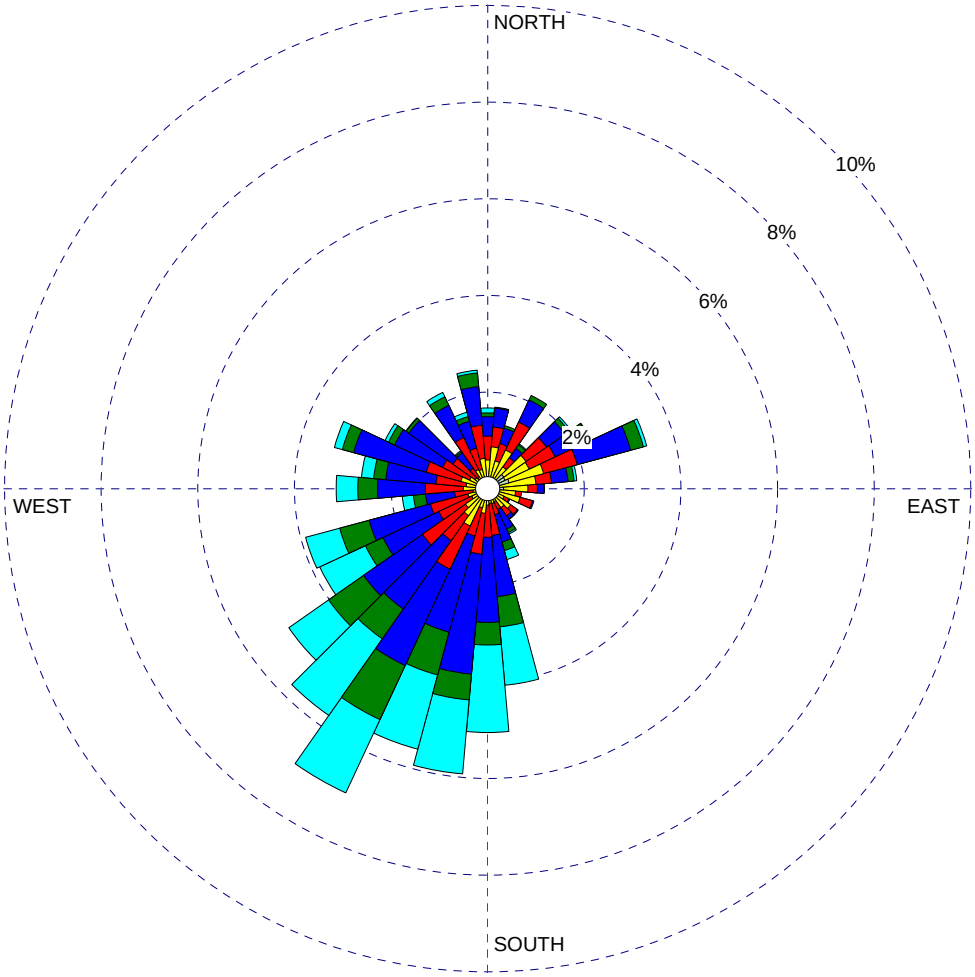
	AVG. WIND SPEED: **6.39 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 5.80%

COMMENTS:	DATA PERIOD: **Start Date: 01/01/2006 - 00:00** **End Date: 31/12/2006 - 23:00**	COMPANY NAME:	
		MODELER:	
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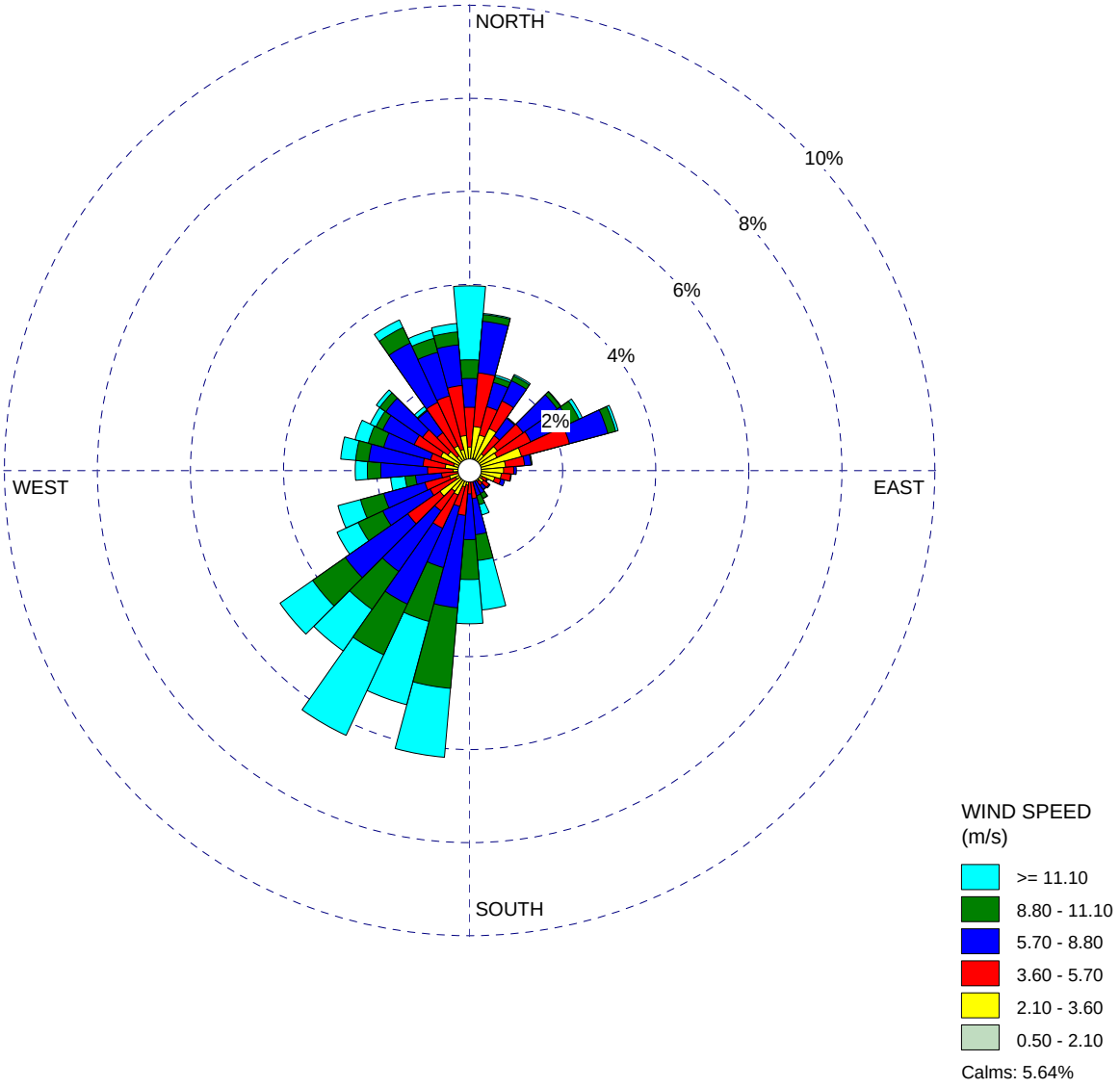
	AVG. WIND SPEED: **6.46 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



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		MODELER:	
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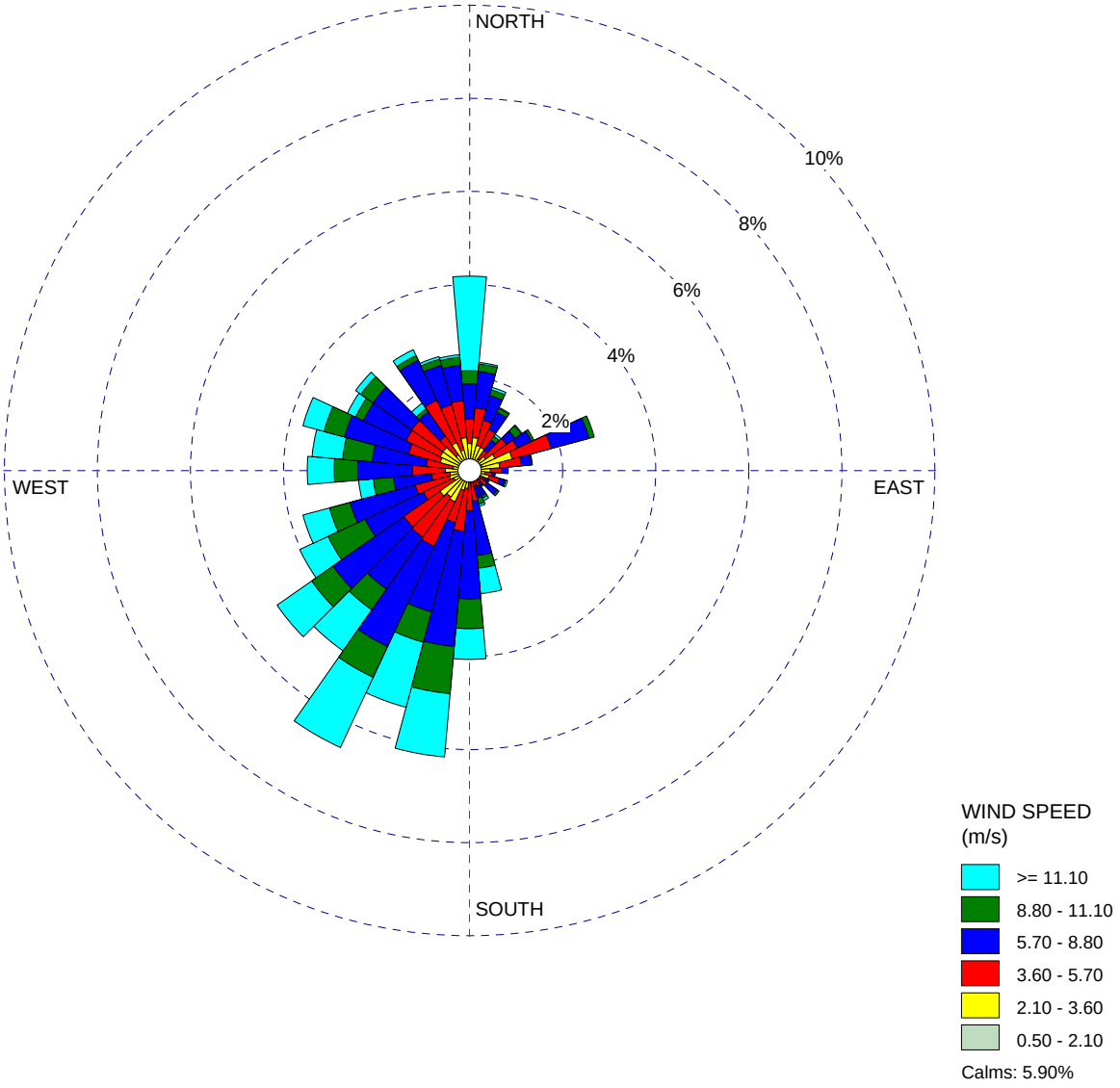
	AVG. WIND SPEED: **9.04 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
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	AVG. WIND SPEED: **9.57 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**