Ecological Air Quality Assessment

Copeland Local Plan

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1.0 INTRODUCTION

1.1.1 Redmore Environmental Ltd was commissioned by Copeland Borough Council to undertake an Ecological Air Quality Assessment in relation to the Copeland Local Plan.

1.1.2 Copeland Borough Council are currently in the process of preparing a new Local Plan, for which a Habitats Regulations Assessment (HRA) is required. Work undertaken to date has highlighted the requirement for an Ecological Air Quality Assessment to consider potential impacts at the following designations as a result of traffic changes on the associated road links:

- Duddon Mosses Special Area of Conservation (SAC) - A595 Foxfield, Broughton-in-Furness;
- Subberthwaite, Blawith and Torver Low Commons SAC - A5092 Grizebeck Brow, Grizebeck 'Hill Farm'; and,
- Lake District High Fells SAC - A66 between A592 and A5091.

1.1.3 Dispersion modelling was undertaken in order to quantify potential changes in pollution levels at the identified ecological designations as result of the Local Plan. The results are summarised in the following report.

2.0 METHODOLOGY

2.1 Introduction

2.1.1 The assessment included the following stages:

- Identification of discrete receptor locations within the ecological designations;
- Dispersion modelling of oxides of nitrogen (NO_x) and ammonia (NH_3) emissions from the relevant road sources;
- Post processing of model outputs to produce predictions of pollution levels for the relevant scenarios; and,
- Comparison of modelling results with the relevant criteria.

2.1.2 Reference was made to the following documents throughout the assessment:

- Natural England (NE) 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations'[1]; and,
- Institute of Air Quality Management (IAQM) 'A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites'[2].

2.1.3 The following Sections outline the methodology and inputs used for the assessment.

2.2 Modelling Scenarios

2.2.1 Potential impacts have been defined by predicting NO_x and NH_3 concentrations, as well as nitrogen and acid deposition rates, using dispersion modelling for the following scenarios:

- Base 2038 - Reference Case Scenario (RCS). Includes developments which have planning permission and live applications with the potential to gain permission soon. Other developments that are likely to gain planning permission and be constructed by 2038 have been included;

[1] Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations, NE, 2018.

[2] A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites v1.1, IAQM, 2020.

- Local Plan scenario 2038 - Local Plan Scenario (LPS). As well as the development in Base scenario, it includes the preferred residential and employment options; and,
- Local Plan High Growth Scenario 2038 (LPHGS) - includes additional residential and employment options over and above the preferred options.

2.2.2 Pollution levels were predicted using 2021 and 2038 backgrounds and vehicle emission rates to provide an indication of potential conditions with and without anticipated changes in air quality over the plan period.

2.3 Modelled Receptors

2.3.1 Discrete receptor locations were included in the model to quantify changes in pollution levels throughout the identified designations. These were selected based on site proximity to the roadside. Transects were included at each location in order to provide analysis of pollution reduction with distance from source. The following format was utilised for receptor identification:

- EX-0 - 0m from the roadside;
- EX-50 - 50m from the roadside;
- EX-100 - 100m from the roadside;
- EX-150 - 150m from the roadside; and,
- EX-200 - 200m from the roadside.

2.3.2 Receptor positions are summarised in Table 1. It should be noted that the designations are not directly adjacent to the roadside in all locations. As such, not all distances were included for all transects.

Table 1 Modelled Discrete Receptor Locations

Receptor		NGR (m)	
		X	Y
E1-150	Duddon Mosses SAC	321864	485712
E1-200	Duddon Mosses SAC	321907	485688
E2-150	Duddon Mosses SAC	322647	486321
E2-200	Duddon Mosses SAC	322629	486274

Receptor		NGR (m)	
		X	Y
E3-100	Duddon Mosses SAC	323052	485876
E3-150	Duddon Mosses SAC	323002	485876
E3-200	Duddon Mosses SAC	322952	485877
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	325870	484994
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	325875	485043
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	325880	485093
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	325885	485143
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	325890	485193
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	326328	484876
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	326347	484922
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	326367	484968
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	326387	485014
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	326406	485060
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	326831	484783
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	326855	484827
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	326879	484871
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	326903	484915
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	326927	484959
E7-150	Lake District High Fells SAC	333473	526623
E7-200	Lake District High Fells SAC	333446	526665
E8-100	Lake District High Fells SAC	334202	526957
E8-150	Lake District High Fells SAC	334186	527005
E8-200	Lake District High Fells SAC	334170	527053

2.3.3 Reference should be made to Figure 1 and Figure 2 for maps of the receptor locations.

2.4 Environmental Quality Standards

2.4.1 A critical load is defined by the UK Air Pollution Information System (APIS)[3] as:

> "A quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. The exceedance of a critical load is defined as the atmospheric deposition of the pollutant above the critical load."

2.4.2 A critical level is defined as:

> "Threshold for direct effects of pollutant concentrations according to current knowledge. Exceedance of a critical level is defined as the atmospheric concentration of the pollutant above the critical level."

2.4.3 A critical load refers to deposition of a pollutant, while a critical level refers to pollutant concentrations in the atmosphere (which usually have direct effects on vegetation or human health).

2.4.4 When pollutant loads (or concentrations) exceed the critical load or level it is considered that there is a risk of harmful effects. The excess over the critical load or level is termed the exceedence. A larger exceedence is often considered to represent a greater risk of damage.

2.4.5 Maps of critical loads and levels and their exceedences have been used to show the potential extent of pollution damage and aid in developing strategies for reducing pollution. Decreasing deposition below the critical load is seen as means for preventing the risk of damage. However, even a decrease in the exceedence may infer that less damage will occur.

2.4.6 Table 2 presents the critical levels for the protection of vegetation for pollutants considered within this assessment.

[3] UK Air Pollution Information System, www.apis.ac.uk.

Table 2 Critical Levels for the Protection of Vegetation

Pollutant	Critical Level	
	Concentration (µg/m³)	Averaging Period
NO_x	30	Annual mean
NH_3	1(a)	Annual mean
	3(b)	Annual mean

NOTE: (a) Specified for the protection of lichens and bryophytes.
(b) Specified for the protection of higher plants.

2.4.7 Review of the APIS website[4] indicated that lichens and bryophytes are present within the three designations of interest. As such, a critical level of 1µg/m³ was used throughout the assessment.

2.4.8 Nitrogen deposition critical loads for the habitats present at the discrete receptor positions were obtained from the APIS website[5] based on the Site of Special Scientific Interest (SSSI) unit information available from MAGIC[6] where relevant. These are presented in Table 3.

Table 3 Critical Loads for Nitrogen Deposition

Designation	Site Interest Feature	Relevant Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Duddon Mosses SAC	Active raised bogs (H7110)	Raised and blanket bogs	5	10
Subberthwaite, Blawith and Torver Low Commons SAC	Transition mires and quaking bogs (H7140)	Valley mires, poor fens and transition mires	10	15
Lake District High Fells SAC	European dry heaths (H4030)	Dry heaths	10	20

4 UK Air Pollution Information System, www.apis.ac.uk.

5 UK Air Pollution Information System, www.apis.ac.uk.

6 magic.defra.gov.uk/MagicMap.aspx.

2.4.9 Acid deposition critical loads for the habitats present at the discrete receptor positions were also obtained from the APIS website[7]. These are summarised in Table 4.

Table 4 Critical Loads for Acid Deposition

Designation	Site Interest Feature	Acidity Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Duddon Mosses SAC	Active raised bogs (H7110)	Bogs	0.321	0.371	0.692
Subberthwaite, Blawith and Torver Low Commons SAC	Transition mires and quaking bogs (H7140)	Bogs	0.321	0.518	0.839
Lake District High Fells SAC	European dry heaths (H4030)	Dwarf shrub heath	0.499	0.42	0.919

2.5 Baseline Pollution Levels

2.5.1 Baseline annual mean nitrogen dioxide (NO_2) and NO_x concentrations were obtained from the Department for Environment, Food and Rural Affairs (DEFRA) website[8] for each discrete receptor location. Baseline annual mean NH_3 concentrations and nitrogen deposition rates were obtained from the APIS website[9]. The relevant values are summarised in Table 5 for 2021.

Table 5 Baseline Pollution Levels - 2021

Receptor	Annual Mean Concentration (µg/m³)			Annual Deposition Rate		
	NO_x	NO_2	NH_3	Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
					Nitrogen	Sulphur
E1-150	5.21	4.19	1.21	16.2	1.2	0.2
E1-200	5.21	4.19	1.21	16.2	1.2	0.2
E2-150	5.20	4.18	1.21	16.2	1.2	0.2
E2-200	5.20	4.18	1.21	16.2	1.2	0.2

7 UK Air Pollution Information System, www.apis.ac.uk.

8 https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018.

9 UK Air Pollution Information System, www.apis.ac.uk.

Receptor	Annual Mean Concentration (µg/m³)			Annual Deposition Rate		
	NO_x	NO_2	NH_3	Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
					Nitrogen	Sulphur
E3-100	5.49	4.40	1.21	16.2	1.2	0.2
E3-150	5.49	4.40	1.21	16.2	1.2	0.2
E3-200	4.88	3.93	1.21	16.2	1.2	0.2
E4-0	7.98	6.27	0.93	16.9	1.2	0.2
E4-50	5.58	4.47	0.93	16.9	1.2	0.2
E4-100	5.58	4.47	0.93	16.9	1.2	0.2
E4-150	5.58	4.47	0.93	16.9	1.2	0.2
E4-200	5.58	4.47	0.93	16.9	1.2	0.2
E5-0	5.66	4.53	0.93	16.9	1.2	0.2
E5-50	5.66	4.53	0.93	16.9	1.2	0.2
E5-100	5.66	4.53	0.93	16.9	1.2	0.2
E5-150	5.46	4.37	0.93	16.9	1.2	0.2
E5-200	5.46	4.37	0.93	16.9	1.2	0.2
E6-0	5.66	4.53	0.93	16.9	1.2	0.2
E6-50	5.66	4.53	0.93	16.9	1.2	0.2
E6-100	5.66	4.53	0.93	16.9	1.2	0.2
E6-150	5.66	4.53	0.93	16.9	1.2	0.2
E6-200	5.66	4.53	0.93	16.9	1.2	0.2
E7-150	5.30	4.26	0.85	24.0	1.7	0.3
E7-200	5.30	4.26	0.85	24.0	1.7	0.3
E8-100	5.09	4.09	0.85	24.0	1.7	0.3
E8-150	4.72	3.81	0.85	24.0	1.7	0.3
E8-200	4.72	3.81	0.85	24.0	1.7	0.3

2.5.2 The baseline levels for 2038 are summarised in Table 6. It should be noted that the DEFRA background maps have only been produced up to 2030. As such, this dataset was

utilised in lieu of alternative information. Additionally, APIS does not provide future predictions of pollution levels. As such, these have not been adjusted to ensure a worst-case representation of conditions during 2038.

Table 6 Baseline Pollution Levels - 2038

Receptor	Annual Mean Concentration (µg/m³)			Annual Deposition Rate		
	NO_x	NO_2	NH_3	Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
					Nitrogen	Sulphur
E1-150	4.13	3.34	1.21	16.2	1.2	0.2
E1-200	4.13	3.34	1.21	16.2	1.2	0.2
E2-150	4.12	3.33	1.21	16.2	1.2	0.2
E2-200	4.12	3.33	1.21	16.2	1.2	0.2
E3-100	4.34	3.51	1.21	16.2	1.2	0.2
E3-150	4.34	3.51	1.21	16.2	1.2	0.2
E3-200	3.97	3.22	1.21	16.2	1.2	0.2
E4-0	6.92	5.48	0.93	16.9	1.2	0.2
E4-50	4.59	3.70	0.93	16.9	1.2	0.2
E4-100	4.59	3.70	0.93	16.9	1.2	0.2
E4-150	4.59	3.70	0.93	16.9	1.2	0.2
E4-200	4.59	3.70	0.93	16.9	1.2	0.2
E5-0	4.63	3.73	0.93	16.9	1.2	0.2
E5-50	4.63	3.73	0.93	16.9	1.2	0.2
E5-100	4.63	3.73	0.93	16.9	1.2	0.2
E5-150	4.53	3.65	0.93	16.9	1.2	0.2
E5-200	4.53	3.65	0.93	16.9	1.2	0.2
E6-0	4.63	3.73	0.93	16.9	1.2	0.2
E6-50	4.63	3.73	0.93	16.9	1.2	0.2
E6-100	4.63	3.73	0.93	16.9	1.2	0.2
E6-150	4.63	3.73	0.93	16.9	1.2	0.2

Receptor	Annual Mean Concentration (µg/m³)			Annual Deposition Rate		
	NO_x	NO_2	NH_3	Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
					Nitrogen	Sulphur
E6-200	4.63	3.73	0.93	16.9	1.2	0.2
E7-150	4.02	3.26	0.85	24.0	1.7	0.3
E7-200	4.02	3.26	0.85	24.0	1.7	0.3
E8-100	3.92	3.18	0.85	24.0	1.7	0.3
E8-150	3.73	3.03	0.85	24.0	1.7	0.3
E8-200	3.73	3.03	0.85	24.0	1.7	0.3

2.6 Traffic Flow Data

2.6.1 Traffic data for use in the assessment, including 24-hour Annual Average Daily Traffic (AADT) flows and fleet composition as Heavy Duty Vehicle (HDV) proportion, was provided by David Archer Associates. Road widths and vehicle speeds were estimated from aerial photography and UK highway design standards. A summary of the data is provided in Table 7.

Table 7 Traffic Data

Link		24-hour AADT Flow			HDV Prop. of Fleet (%)	Mean Vehicle Speed (km/h)	Road Width (m)
		RCS	LPS	LPHGS			
L1	A595	7,890	8,064	8,349	14.1	80	7.3
L2	A5092	9,400	9,502	9,788	12.5	80	7.3
L3	A66	17,756	17,634	18,038	8.2	80	7.3

2.6.2 Reference should be made to Figure 1 and Figure 2 for maps of the road link locations.

2.7 Emission Factors

2.7.1 Emission factors for each link were calculated using the relevant traffic flows and the Emissions Factor Toolkit (version 11.0). This has been produced by DEFRA and incorporates COPERT 5.3 vehicle emission factors and fleet information.

2.7.2 Emission factors of NH_3 for each link were calculated using the relevant traffic flows and the Calculator for Road Emissions of Ammonia (CREAM) workbook released by Air Quality Consultants Ltd (AQC) in 2020. Reference should be made to the accompanying report[10] for details of the calculation methodology. It should be noted that CREAM only includes predictions up to 2035. As such, this dataset was utilised in lieu of alternative information.

2.8 Meteorological Data

2.8.1 Meteorological data used in the assessment was taken from Shap meteorological station over the period 1st January 2020 to 31st December 2020 (inclusive). This observation site is located at NGR: 355739, 512068.

2.8.2 All meteorological records used in the assessment were provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 3 for a wind rose of utilised meteorological data.

2.9 Roughness Length

2.9.1 The roughness length (z_0) is a modelling parameter applied to allow consideration of surface height roughness elements. A z_0 of 0.2m was used to describe the modelling extents and meteorological site. This is considered appropriate for the morphology of both areas and is suggested within ADMS-Roads as being suitable for 'agricultural areas (min)'.

2.10 Monin-Obukhov Length

2.10.1 The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 1m was used to describe the modelling extents and meteorological site. This value is considered appropriate for the nature of both areas and is suggested within ADMS-Roads as being suitable for 'rural areas'.

[10] Ammonia Emissions from Roads for Assessing Impacts on Nitrogen-sensitive Habitats, AQC, 2020.

2.11 NO_x to NO_2 Conversion

2.11.1 Predicted annual mean NO_x concentrations were converted to NO_2 concentrations using the spreadsheet (version 8.1) provided by DEFRA. This is the method detailed within DEFRA guidance[11].

2.12 Nitrogen Deposition

2.12.1 Nitrogen deposition rates were calculated using the conversion factors provided within the IAQM document 'A guide to the assessment of air quality impacts on designated nature conservation sites'[12]. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used for the determination of nitrogen deposition are presented within Table 8.

Table 8 Conversion Factors to Determine Dry Deposition Flux for Nitrogen Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to kg/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	95.9
NH_3	0.020	0.030	260

2.12.2 The relevant deposition velocity for each ecological receptor was selected from Table 8 based on the vegetation type at the specific location.

2.13 Acid Deposition

2.13.1 Predicted ground level NO_2 and NH_3 concentrations were converted to kilo-equivalent ion depositions (keq/ha/yr) for comparison with the critical load for acid deposition at each of the identified ecological receptors. The conversion to units of equivalents, a measure of the potential acidifying effect of a species, was undertaken using the standard conversion factors shown in Table 9.

[11] Local Air Quality Management Technical Guidance (TG16), DEFRA, 2021.

[12] A guide to the assessment of air quality impacts on designated nature conservation sites v1.1., IAQM, 2020.

Table 9 Conversion Factors to Determine Dry Deposition Flux for Acid Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to keq/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	6.84
NH_3	0.020	0.030	18.5

3.0 RESULTS

3.1 2038 Predictions

3.1.1 Predicted pollution levels using 2038 emission factors and background values are summarised in the following Sections. It should be noted that results are presented inclusive of the relevant baseline values shown in Table 6.

Oxides of Nitrogen

3.1.2 Annual mean NO_x concentrations were predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 10.

Table 10 Predicted Annual Mean NO_x Concentrations

Receptor		Predicted Annual Mean NO_x Concentration (µg/m³)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	4.66	4.67	4.69
E1-200	Duddon Mosses SAC	4.54	4.55	4.56
E2-150	Duddon Mosses SAC	4.66	4.68	4.70
E2-200	Duddon Mosses SAC	4.59	4.60	4.61
E3-100	Duddon Mosses SAC	4.92	4.94	4.96
E3-150	Duddon Mosses SAC	4.80	4.81	4.83
E3-200	Duddon Mosses SAC	4.36	4.36	4.38
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	11.19	11.24	11.36
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	6.45	6.47	6.52
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	5.90	5.92	5.96
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	5.64	5.65	5.68
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	5.49	5.50	5.52
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	8.97	9.02	9.15
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	6.51	6.53	6.58

Receptor		Predicted Annual Mean NO_x Concentration (µg/m³)		
		RCS	LPS	LPHGS
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	5.93	5.95	5.99
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	5.55	5.56	5.59
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	5.38	5.39	5.41
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	8.69	8.73	8.85
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	6.45	6.47	6.52
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	5.88	5.89	5.93
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	5.61	5.62	5.65
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	5.45	5.46	5.49
E7-150	Lake District High Fells SAC	5.42	5.41	5.44
E7-200	Lake District High Fells SAC	5.12	5.11	5.13
E8-100	Lake District High Fells SAC	6.03	6.02	6.07
E8-150	Lake District High Fells SAC	5.31	5.30	5.33
E8-200	Lake District High Fells SAC	4.98	4.98	5.00

3.1.3 As indicated in Table 10, predicted annual mean NO_x concentrations were below the relevant critical level of 30µg/m³ at all receptors for all scenarios.

Ammonia

3.1.4 Annual mean NH_3 concentrations were predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 11.

Table 11 Predicted Annual Mean NH_3 Concentrations

Receptor		Predicted Annual Mean NH_3 Concentration (µg/m³)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	1.44	1.45	1.46
E1-200	Duddon Mosses SAC	1.39	1.39	1.40

Receptor		Predicted Annual Mean NH_3 Concentration (µg/m³)		
		RCS	LPS	LPHGS
E2-150	Duddon Mosses SAC	1.45	1.46	1.47
E2-200	Duddon Mosses SAC	1.42	1.42	1.43
E3-100	Duddon Mosses SAC	1.47	1.47	1.48
E3-150	Duddon Mosses SAC	1.41	1.42	1.43
E3-200	Duddon Mosses SAC	1.38	1.39	1.39
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.78	2.80	2.85
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.73	1.74	1.77
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.50	1.50	1.52
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.38	1.39	1.40
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.32	1.32	1.34
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.81	2.83	2.89
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.74	1.75	1.78
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.49	1.50	1.52
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.37	1.38	1.39
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.30	1.30	1.31
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.69	2.71	2.76
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.72	1.73	1.75
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.47	1.48	1.49
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.35	1.36	1.37
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.29	1.29	1.30
E7-150	Lake District High Fells SAC	1.41	1.41	1.42
E7-200	Lake District High Fells SAC	1.29	1.29	1.30
E8-100	Lake District High Fells SAC	1.70	1.70	1.71
E8-150	Lake District High Fells SAC	1.49	1.48	1.50
E8-200	Lake District High Fells SAC	1.36	1.35	1.36

3.1.5 As indicated in Table 11, predicted annual mean NH_3 concentrations were above the relevant critical level of 1µg/m^3 at all receptors for all scenarios.

3.1.6 It is noted that NH_3 emissions from road vehicles are predicted to increase between 2021 and 2038. This is due to controls on exhaust NO_x emissions and the anticipated shift in fleet towards vehicles requiring abatement with associated potential for NH_3 slip.

3.1.7 No improvement in background NH_3 concentrations has been assumed up to 2038. This is likely to overestimate total pollution levels as government policies, including those outlined in the 'Clean Air Strategy 2019'[13], are designed to reduce NH_3 emissions. Measures aimed at the agricultural sector, which caused 88% of UK NH_3 emissions during 2016, are predicted to reduce overall emissions by 9% against a 2016 baseline by 2020 and 23% by 2030[14]. As such, the future year predictions should be viewed with caution.

Nitrogen Deposition

3.1.8 Annual nitrogen deposition was predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 12.

Table 12 Predicted Annual Nitrogen Deposition

Receptor		Predicted Annual Nitrogen Deposition (kgN/ha/yr)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	17.46	17.49	17.54
E1-200	Duddon Mosses SAC	17.17	17.19	17.23
E2-150	Duddon Mosses SAC	17.51	17.53	17.58
E2-200	Duddon Mosses SAC	17.32	17.34	17.39
E3-100	Duddon Mosses SAC	17.59	17.62	17.67
E3-150	Duddon Mosses SAC	17.30	17.32	17.36
E3-200	Duddon Mosses SAC	17.13	17.15	17.18

[13] Clean Air Strategy 2019, DEFRA, 2019.

[14] Clean Air Strategy 2019, DEFRA, 2019.

Receptor		Predicted Annual Nitrogen Deposition (kgN/ha/yr)		
		RCS	LPS	LPHGS
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	26.85	26.96	27.26
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	21.23	21.28	21.41
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.96	20.00	20.09
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.35	19.38	19.45
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	19.00	19.02	19.08
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	27.02	27.13	27.43
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	21.28	21.32	21.46
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.94	19.97	20.06
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.28	19.31	19.38
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	18.88	18.91	18.96
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	26.36	26.47	26.75
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	21.14	21.18	21.31
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.82	19.85	19.93
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.19	19.21	19.28
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	18.82	18.84	18.90
E7-150	Lake District High Fells SAC	27.04	27.01	27.08
E7-200	Lake District High Fells SAC	26.38	26.36	26.42
E8-100	Lake District High Fells SAC	28.60	28.57	28.67
E8-150	Lake District High Fells SAC	27.43	27.41	27.48
E8-200	Lake District High Fells SAC	26.73	26.71	26.77

3.1.9 As indicated in Table 12, predicted annual nitrogen deposition was above the lower critical load at all receptors for all scenarios. This is partly due to the baseline exceedences, as shown in Table 6.

Acid Deposition

3.1.10 Annual acid deposition (nitrogen element in isolation) was predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 13.

Table 13 Predicted Annual Acid Deposition

Receptor		Predicted Annual Acid Deposition (keq/ha/yr)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	1.29	1.29	1.30
E1-200	Duddon Mosses SAC	1.27	1.27	1.27
E2-150	Duddon Mosses SAC	1.29	1.29	1.30
E2-200	Duddon Mosses SAC	1.28	1.28	1.28
E3-100	Duddon Mosses SAC	1.30	1.30	1.30
E3-150	Duddon Mosses SAC	1.28	1.28	1.28
E3-200	Duddon Mosses SAC	1.27	1.27	1.27
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.91	1.92	1.94
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.51	1.51	1.52
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.42	1.42	1.43
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.37	1.38	1.38
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.35	1.35	1.36
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.92	1.93	1.95
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.51	1.51	1.52
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.42	1.42	1.43
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.37	1.37	1.38
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.34	1.34	1.35
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.87	1.88	1.90
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.50	1.50	1.51
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.41	1.41	1.42

Receptor		Predicted Annual Acid Deposition (keq/ha/yr)		
		RCS	LPS	LPHGS
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.36	1.36	1.37
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.34	1.34	1.34
E7-150	Lake District High Fells SAC	1.92	1.91	1.92
E7-200	Lake District High Fells SAC	1.87	1.87	1.87
E8-100	Lake District High Fells SAC	2.03	2.02	2.03
E8-150	Lake District High Fells SAC	1.94	1.94	1.95
E8-200	Lake District High Fells SAC	1.89	1.89	1.90

3.2 2021 Predictions

3.2.1 Predicted pollution levels using 2021 emission factors and background values are summarised in the following Sections. It should be noted that results are presented inclusive of the relevant baseline values shown in Table 5.

Oxides of Nitrogen

3.2.2 Annual mean NO_x concentrations were predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 14.

Table 14 Predicted Annual Mean NO_x Concentrations

Receptor		Predicted Annual Mean NO_x Concentration (µg/m³)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	6.90	6.94	7.00
E1-200	Duddon Mosses SAC	6.52	6.54	6.59
E2-150	Duddon Mosses SAC	6.94	6.98	7.04
E2-200	Duddon Mosses SAC	6.70	6.73	6.79
E3-100	Duddon Mosses SAC	7.35	7.39	7.46
E3-150	Duddon Mosses SAC	6.96	6.99	7.05

Receptor		Predicted Annual Mean NO_x Concentration (µg/m³)		
		RCS	LPS	LPHGS
E3-200	Duddon Mosses SAC	6.12	6.15	6.19
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	21.06	21.20	21.58
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	11.32	11.38	11.55
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	9.70	9.74	9.87
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	8.91	8.94	9.04
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	8.43	8.46	8.55
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	19.18	19.32	19.71
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	11.44	11.50	11.67
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	9.73	9.77	9.89
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	8.68	8.71	8.81
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	8.15	8.18	8.26
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	18.03	18.15	18.51
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	11.24	11.30	11.46
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	9.57	9.61	9.73
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	8.77	8.80	8.89
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	8.28	8.31	8.39
E7-150	Lake District High Fells SAC	9.73	9.70	9.80
E7-200	Lake District High Fells SAC	8.79	8.76	8.84
E8-100	Lake District High Fells SAC	11.73	11.68	11.83
E8-150	Lake District High Fells SAC	9.73	9.69	9.81
E8-200	Lake District High Fells SAC	8.72	8.69	8.78

3.2.3 As indicated in Table 14, predicted annual mean NO_x concentrations were below the relevant critical level of 30µg/m³ at all receptors for all scenarios.

Ammonia

3.2.4 Annual mean NH_3 concentrations were predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 15.

Table 15 Predicted Annual Mean NH_3 Concentrations

Receptor		Predicted Annual Mean NH_3 Concentration (µg/m³)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	1.41	1.41	1.42
E1-200	Duddon Mosses SAC	1.36	1.36	1.37
E2-150	Duddon Mosses SAC	1.42	1.42	1.43
E2-200	Duddon Mosses SAC	1.39	1.39	1.40
E3-100	Duddon Mosses SAC	1.43	1.43	1.44
E3-150	Duddon Mosses SAC	1.38	1.38	1.39
E3-200	Duddon Mosses SAC	1.36	1.36	1.37
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.43	2.43	2.49
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.59	1.59	1.61
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.40	1.40	1.42
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.31	1.31	1.33
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.26	1.26	1.27
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.48	2.48	2.54
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.59	1.59	1.62
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.40	1.40	1.42
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.30	1.30	1.31
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.24	1.24	1.25
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	2.35	2.35	2.40
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.57	1.57	1.60
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.38	1.38	1.40
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.29	1.29	1.30

Receptor		Predicted Annual Mean NH_3 Concentration (µg/m³)		
		RCS	LPS	LPHGS
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.23	1.23	1.24
E7-150	Lake District High Fells SAC	1.31	1.31	1.32
E7-200	Lake District High Fells SAC	1.21	1.21	1.22
E8-100	Lake District High Fells SAC	1.54	1.54	1.55
E8-150	Lake District High Fells SAC	1.37	1.37	1.38
E8-200	Lake District High Fells SAC	1.27	1.26	1.27

3.2.5 As indicated in Table 15, predicted annual mean NH_3 concentrations were above the relevant critical level of 1µg/m³ at all receptors for all scenarios.

Nitrogen Deposition

3.2.6 Annual nitrogen deposition was predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 16.

Table 16 Predicted Annual Nitrogen Deposition

Receptor		Predicted Annual Nitrogen Deposition (kgN/ha/yr)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	17.38	17.24	17.30
E1-200	Duddon Mosses SAC	17.11	17.00	17.05
E2-150	Duddon Mosses SAC	17.41	17.27	17.33
E2-200	Duddon Mosses SAC	17.24	17.12	17.17
E3-100	Duddon Mosses SAC	17.50	17.35	17.41
E3-150	Duddon Mosses SAC	17.23	17.11	17.16
E3-200	Duddon Mosses SAC	17.07	16.96	17.01
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	25.74	24.70	25.01
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	20.79	20.32	20.46

Receptor		Predicted Annual Nitrogen Deposition (kgN/ha/yr)		
		RCS	LPS	LPHGS
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.69	19.36	19.46
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.16	18.89	18.97
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	18.83	18.60	18.67
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	26.04	24.96	25.28
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	20.82	20.35	20.48
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.66	19.33	19.43
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.08	18.82	18.90
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	18.73	18.51	18.57
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	25.26	24.27	24.56
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	20.68	20.23	20.36
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	19.55	19.23	19.33
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	19.01	18.75	18.83
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	18.68	18.46	18.53
E7-150	Lake District High Fells SAC	26.77	26.39	26.44
E7-200	Lake District High Fells SAC	26.18	25.88	25.92
E8-100	Lake District High Fells SAC	28.14	27.58	27.66
E8-150	Lake District High Fells SAC	27.12	26.70	26.76
E8-200	Lake District High Fells SAC	26.49	26.15	26.20

3.2.7 As indicated in Table 16, predicted annual nitrogen deposition was above the lower critical load at all receptors for all scenarios.

Acid Deposition

3.2.8 Annual acid deposition (nitrogen element in isolation) was predicted at the sensitive receptor locations for the RCS, LPS and LPHGS scenarios. These are summarised in Table 17.

Table 17 Predicted Annual Acid Deposition

Receptor		Predicted Annual Acid Deposition (keq/ha/yr)		
		RCS	LPS	LPHGS
E1-150	Duddon Mosses SAC	1.28	1.27	1.28
E1-200	Duddon Mosses SAC	1.26	1.26	1.26
E2-150	Duddon Mosses SAC	1.29	1.28	1.28
E2-200	Duddon Mosses SAC	1.27	1.27	1.27
E3-100	Duddon Mosses SAC	1.29	1.28	1.29
E3-150	Duddon Mosses SAC	1.27	1.26	1.27
E3-200	Duddon Mosses SAC	1.26	1.25	1.26
E4-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.83	1.75	1.78
E4-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.48	1.44	1.45
E4-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.40	1.37	1.38
E4-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.36	1.34	1.35
E4-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.34	1.32	1.33
E5-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.85	1.77	1.80
E5-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.48	1.45	1.46
E5-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.40	1.37	1.38
E5-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.36	1.34	1.34
E5-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.33	1.31	1.32
E6-0	Subberthwaite, Blawith and Torver Low Commons SAC	1.80	1.72	1.75
E6-50	Subberthwaite, Blawith and Torver Low Commons SAC	1.47	1.44	1.45
E6-100	Subberthwaite, Blawith and Torver Low Commons SAC	1.39	1.37	1.37
E6-150	Subberthwaite, Blawith and Torver Low Commons SAC	1.35	1.33	1.34
E6-200	Subberthwaite, Blawith and Torver Low Commons SAC	1.33	1.31	1.32
E7-150	Lake District High Fells SAC	1.90	1.87	1.87
E7-200	Lake District High Fells SAC	1.85	1.83	1.84
E8-100	Lake District High Fells SAC	1.99	1.95	1.96

Receptor		Predicted Annual Acid Deposition (keq/ha/yr)		
		RCS	LPS	LPHGS
E8-150	Lake District High Fells SAC	1.92	1.89	1.90
E8-200	Lake District High Fells SAC	1.88	1.85	1.86

4.0 SUMMARY

4.1.1 Redmore Environmental Ltd was commissioned by Copeland Borough Council to undertake an Ecological Air Quality Assessment in relation to the Copeland Local Plan.

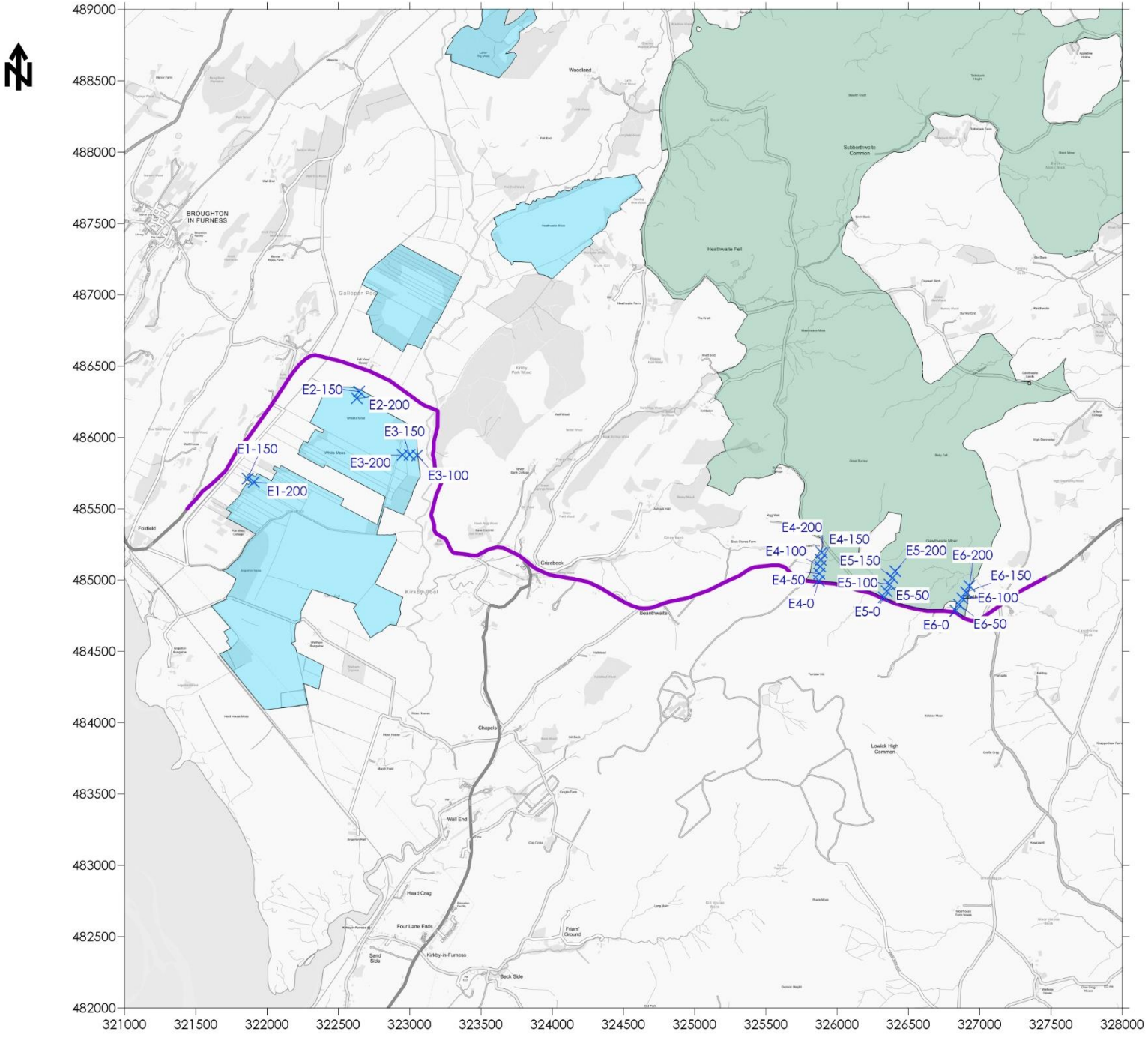
4.1.2 The Copeland Local Plan has the potential to cause impacts at ecological designations as a result of road traffic exhaust emissions from increased traffic generation. Dispersion modelling was therefore undertaken to quantify NO_x, NH_3 concentrations and annual nitrogen and acid deposition levels for three potential scenarios.

4.1.3 The results of the dispersion modelling assessment indicated that predicted annual mean NO_x concentrations were below the relevant critical level at all receptors for all scenarios considered. Annual mean NH_3 concentrations and annual nitrogen deposition exceeded the relevant critical level and loads at all locations. This was partly due to the high baseline values throughout the assessment extents.

5.0 ABBREVIATIONS

AADT	Annual Average Daily Traffic
APIS	Air Pollution Information System
AQC	Air Quality Consultants Ltd
CREAM	Calculator for Road Emissions of Ammonia
DEFRA	Department for Environment, Food and Rural Affairs
HDV	Heavy Duty Vehicle
HRA	Habitats Regulations Assessment
IAQM	Institute of Air Quality Management
LPHGS	Local Plan High Growth Scenario
LPS	Local Plan Scenario
NE	Natural England
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
RCS	Reference Case Scenario
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
z_0	Roughness length

Figures



Legend

- Subberthwaite, Blawith and Torver Low Commons SAC
- Duddon Mosses SAC
- Discrete Receptor
- Modelled Road Link

Title
Figure 1 - A595 and A5092 Modelling Area

Project
Ecological Air Quality Assessment
Copeland Local Plan

Project Reference
5168

Client
Copeland Borough Council

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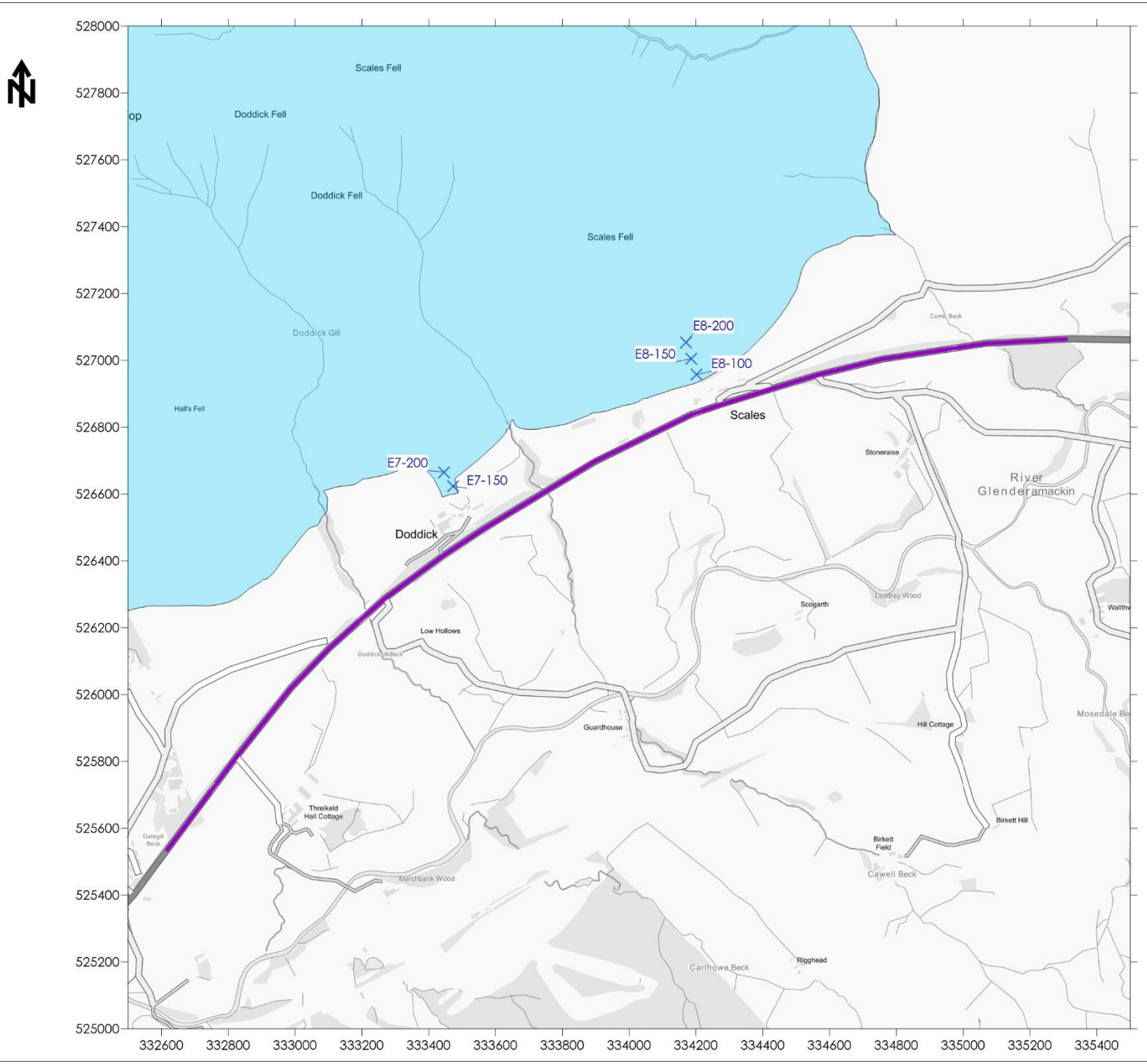

Legend

Lake District High Fells SAC

Discrete Receptor

Modelled Road Link

Title
Figure 2 - A66 Modelling Area

Project
Ecological Air Quality Assessment
Copeland Local Plan

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5168

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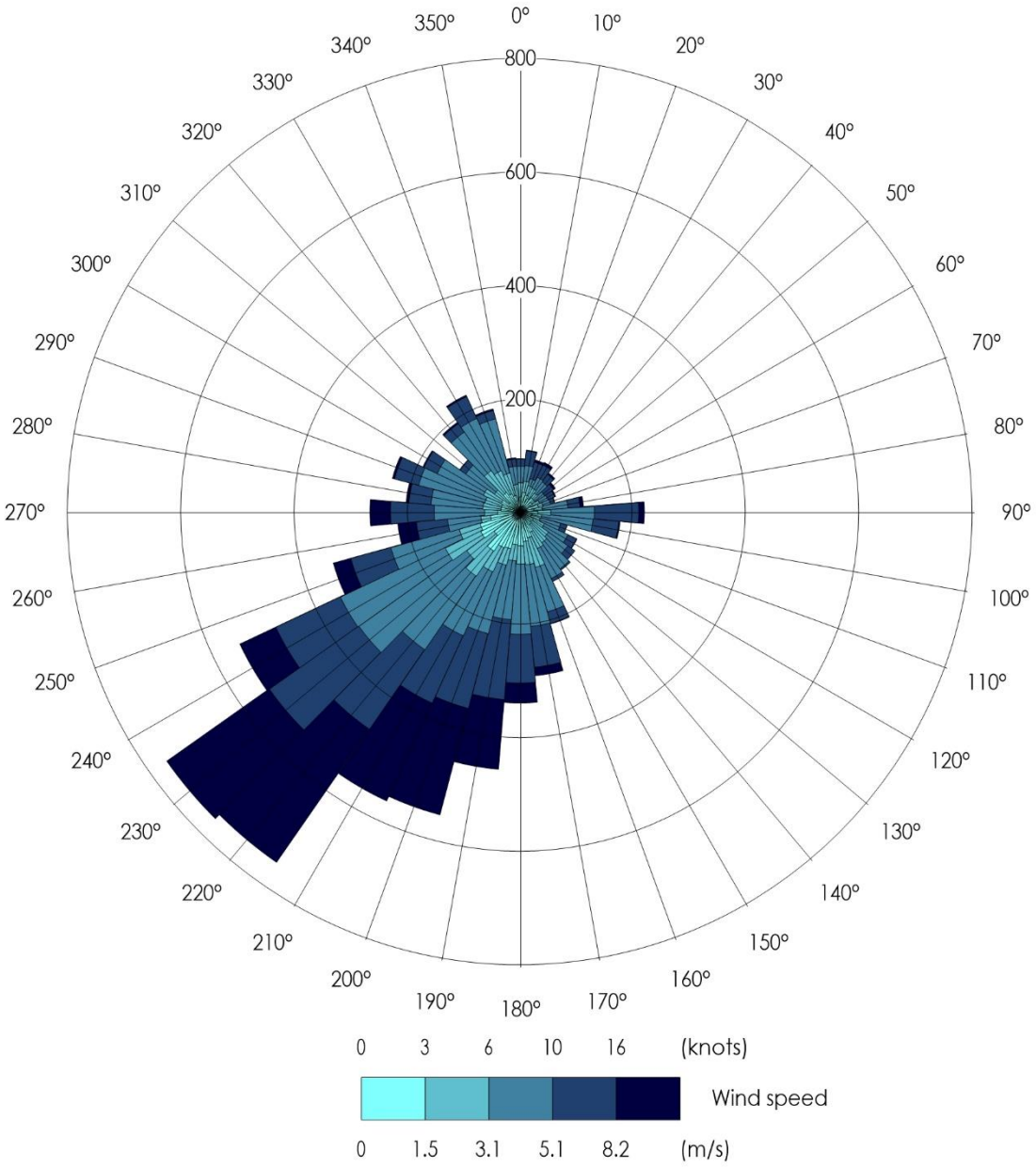

Legend

Title
Figure 3 - Wind Rose of 2020 Shap Meteorological Data

Project
Ecological Air Quality Assessment
Copeland Local Plan

Project Reference
5168

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