Veolia Fenn's Bank IVC facility

Ecological interpretation of AQA

Version 2.0

Prepared for Axis Ltd.

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Unit 14 The Greenhouse Greencroft Industrial Park
Annfield Plain County Durham DH9 7XN

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1 Introduction

This document provides an ecological interpretation of the Air Quality Assessment (AQA) undertaken by Fichtner Consulting Engineers for an In-Vessel Composting Facility (IVC; the 'Proposed Development'), located at Fenn's Bank, Wrexham, Wales.

The aim of the assessment is to provide further ecological interpretation of the results of the AQA, focussing on any effects on sensitive ecological receptors which cannot be screened out as insignificant, in accordance with Natural Resources Wales (NRW) and Institute of Air Quality Management (IAQM) criteria.

This analysis is based on dispersion and deposition modelling undertaken by Fichtner for Veolia, and reported in the Air Quality Assessment (AQA)[1]. It focusses on potential ecological effects at sensitive receptors where exceedances of the identified screening thresholds are predicted. In these cases, further ecological assessment has been undertaken to:

- Confirm sensitivity of qualifying and notified features;
- Assess potential effects by comparing dispersion and deposition model plots with the spatial distribution of sensitive habitats; and
- Provide an informed ecological opinion on the likelihood of significant effects or significant harm, with reference to relevant research and guidance.

Revised Version 2.0

This revision incorporates changes to the dispersion and deposition modelling undertaken by Fichtner Consulting Engineers, and reported in version 3 of their Air Quality Assessment (AQA)[2]. The AQA reports the results of a revised dispersion model, incorporating further mitigation measures in the form of an increased stack height; this was undertaken in response to a Pre-Application Consultation (PAC) with NRW. The AQA also addresses other comments made in the PAC, including on other modelling points, and on the assessment of in-combination effects.

This report provides further ecological interpretation of the revised model, and addresses comments made in the PAC regarding version 1.0.

[1] Fichtner Consulting Engineers (2025). *Shropshire In-Vessel Composting Facility. Air Quality Assessment.* Rev.2, 23/05/2025

[2] Fichtner Consulting Engineers (2026). *Shropshire In-Vessel Composting Facility. Air Quality Assessment.* Rev. 3, 26/01/2026

2 Scope and Methodology

2.1 Scope of Assessment

Geographic Scope of Assessment

The geographic scope of assessment is based on NRW guidance, as reported in the AQA. The following screening distances were applied:

- 10km from emission source for Habitat (European / Natura 2000) sites, including existing and proposed Special Areas of Conservation (SAC) and Special Protection Areas (SPA);
- 10km from emission sources for Ramsar wetland sites of international importance;
- 2km from emission source for National Nature Reserves (NNR) and Sites of Special Scientific Interest (SSSIs); and
- 2km from emission source for Local Nature Reserves (LNR), Local Wildlife Sites (LWS) and ancient woodlands.

Screening Thresholds

Statutory Agency advice

Screening thresholds used in Appendix 8.2 for statutory designated sites are based on NRW guidance, and can be summarised as follows:

- For Ramsar, Natura 2000 sites and SSSIs, predicted process contributions (PCs) below 1% of the relevant long-term (annual) Critical Level and Critical Load or 10% of the relevant short-term (24-hour) Critical Level are screened out.
- For Ramsar, European sites and SSSIs, PCs above 1%, where the predicted environmental concentration (PEC; PC plus background) is <70% of the Critical Level and Critical Load are screened out.

For Natura 2000 and Ramsar sites the 1% PC has been regarded as a *de minimis* threshold, below which effects can be considered inconsequential. The English and Welsh agencies which make up the Air Quality Technical Advisory Group (AQTAG) clarified that projects below the 1% PC do not have to be considered in an in-combination assessment[3], although this has been subject to further revision (with

[3] Environment Agency (2015). *AQTAG position. In-combination guidance and assessment*. Response to PINS, March 2015.

respect in particular to cumulative vehicle emissions) through UK and European case law.

For permitting purposes, the EA advise that a 100% PC can be used for locally designated sites and ancient woodlands; however, for planning application purposes a 1% threshold has been applied, in accordance with the advice set out below.

IAQM Guidance on Scope

The Institute of Air Quality Management (IAQM) published guidance on the assessment of air quality impacts on designated sites in June 2019 and revised in May 2020[4]. This confirmed the use of the 1% long-term / 10% short-term thresholds for industrial point source emissions, with some important clarifications:

- '*The 1% screening criterion is not a threshold of harm and exceeding this threshold does not, of itself, imply damage to a habitat*' (IAQM 2020, para. 5.5.1.8);
- The 70% PEC threshold '*was intended to be a trigger for detailed dispersion modelling. It is not intended to be a damage threshold*.' (5.5.3.2);
- The 100% threshold for locally designated sites and ancient woodlands used in permit applications purposes may be inappropriate in a planning context, failing to provide adequate protection (5.5.2.2).

IAQM guidance does not suggest a threshold for consideration of effects on locally designated sites, and there is no established practice for treatment of locally designated sites in the ecological interpretation of air quality assessments. In order to take the guidance into account, predicted impacts in excess of the 1% long-term threshold have been identified and highlighted in this report, and the sensitivity of component habitats to air quality effects considered in greater detail. However, the interpretation of impact significance reflects the lower degree of policy protection of locally designated sites.

Receptors Considered in AQA

European / Internationally Designated Sites

The following European and internationally designated sites were considered in the AQA; component SSSIs are given in parentheses:

[4] Holman et al (2020). *A guide to the assessment of air quality impacts on designated nature conservation sites* – version 1.1, Institute of Air Quality Management, London.

- Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses Special Area of Conservation (SAC);
- Midland Meres and Mosses Phase 2 Ramsar Site (Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI; Oss Mere SSSI; Llyn Bedid SSSI; Hanmer Mere SSSI; Cole Mere SSSI; Brownheath Moss SSSI).
- Brown Moss SAC;
- West Midland Mosses SAC (Clarepool Moss SSSI); and
- Midland Meres and Mosses Phase 1 Ramsar Site (Quoisley Meres SSSI; Brown Moss SSSI.

UK Statutory Designated Sites

The following UK statutory designated sites are within 2km of the Proposed Development:

- Fenn's, Whixall and Bettisfield Mosses National Nature Reserve (NNR); and
- Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI.

Local Statutory Designated Sites

No Local Nature Reserves were identified within a 2km radius of the Proposed Development.

Locally Designated Sites

No Local Wildlife Sites or other non-statutory designated sites were identified within a 2km radius of the Proposed Development.

Ancient Woodlands

Five ancient woodland sites were identified within a 2km radius of the Proposed Development (all within Wales), and are listed in Table 6 of the AQA, with modelling points as given below. They are reproduced in Figure 2. The spatial dataset (NRW Ancient Woodland Inventory 2021) distinguishes between ancient semi-natural woodlands (ASNW), plantations on ancient woodland sites (PAWS), Restored Ancient Woodland sites, and ancient woodland sites of unknown category, splitting one woodland (Fenn's Wood, on the eastern edge of Fenns' Moss) into three subsections:

- Fenn's Rough ASNW (E11);
- Fenn's Wood North PAWS (E12)

- Fenn's Wood Mid ASNW (E13);
- Fenn's Wood South PAWS (E14);
- Unnamed Wood 1 ASNW (E15);
- Unnamed Wood 2 Restored Ancient Woodland (E16);
- Unnamed Wood 3 ancient woodland of unknown category (E17).

Scope of Ecological Interpretation

The scope of the ecological interpretation is confined to those receptors, after consideration of environmental quality standards, where impacts are above the Environment Agency / IAQM screening thresholds, either alone or in combination with other plans and projects. This focusses on Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC and overlapping designations, together with Fenn's Rough ancient woodland.

2.2 Assessment Methodology

Identification of Appropriate Habitats and Environmental Quality Standards

The Air Pollution Information Service (APIS) GIS map tool[5] provides the principal source of advice for determining appropriate environmental quality standards for statutory designated sites. This was used in the AQA to identify to identify site-relevant critical loads for nitrogen and acid deposition, and the appropriate critical level for atmospheric ammonia.

APIS does not provide site-specific advice for Ramsar sites, National Nature Reserves, non-statutory designated sites, or ancient woodlands.

As most Ramsar sites are also designated as European (SAC, SPA) sites or notified as SSSIs, features considered by APIS usually encompass the Ramsar listing criteria; however, this does require checking. Similarly, the SSSI provides an appropriate analogue for assessing impacts on the National Nature Reserve.

For non-statutory designated sites it is necessary to assign an appropriate habitat for locally designated sites based on published information sourced from a local biological records centre, translated to the appropriate EUNIS habitat to determine the nitrogen critical load class.

[5] APIS GIS Map Tool. https://www.apis.ac.uk/app

For ancient woodland sites, the AQA takes a precautionary approach in assigning the most sensitive broadleaved woodland nitrogen critical load class, and in the absence of any further information on woodland type this is carried forward to the ecological interpretation.

Whilst APIS provides an authoritative source of information and advice, transposition errors can occur when translating between classification systems used for qualifying and notified features by NRW and Natural England, and those used to define critical load classes (European Nature Information System (EUNIS) for nitrogen deposition; Broad Habitat categories for acid deposition). Features used by APIS were cross-checked against NRW publications to ensure all qualifying and notified features had been considered. Field survey information from the 2023 NRW *Baseline Habitat Condition Survey* provided further information about appropriate habitats and critical load classes. Where appropriate, the most recent revision of nitrogen critical loads (Bobbink *et al*, 2022[6]) was referred to, as this provides the underpinning data for the values adopted by APIS.

Spatial Disposition of Habitats / Field survey

The location and extent of sensitive habitats within a designated site is an important factor in interpreting the results of dispersion and deposition modelling. In the case of Fenn's and Whixall Moss, a walkover survey was undertaken, with particular emphasis on those parts of the site where the AQA predicted impacts above screening thresholds. The survey also encompassed a wider are of the designated site, in order to gain a better understanding of the distribution and condition of qualifying features. Further details of methodology and results are given in Appendix 2 below; the implications of these results are discussed in the context of predicted ecological impacts in Section 5 below.

Assessment of Impact Magnitude and Effect Significance

<u>Characterisation of Impact Magnitude</u>

There are no currently accepted thresholds for assessing the magnitude of air quality effects on ecological receptors (i.e. the degree of change from baseline conditions, relative to the relevant environmental quality standard). Neither IAQM (Holman, 2020) guidance or the Chartered Institute of Ecology and Environmental Management

[6] Bobbink R, Loran C, Tomassen H, eds. (2022). *Review and revision of empirical critical loads of nitrogen for Europe*. Dessau-Rosslau: German Environment Agency.

(CIEEM, 2021)[7] Air Quality Advice Note provide any guidance on effect magnitude or ecological significance thresholds. Older EPUK (2010)[8] advice characterised effect magnitude for both human health and ecological receptors (see Table 2.1 below); later versions were confined to human health advice, and are not applicable. The 'imperceptible' level is better characterised in the context of designated sites as 'inconsequential', although this has been subject to modification in relation to in-combination impacts.

Table 2.1: EPUK (2010) Guidance on Impact Magnitude

Magnitude of Change	**Annual Mean Value Increase / Decrease (as Percentage of Assessment Level)**
Large	>10%
Medium	5 – 10%
Small	1 – 5%
Imperceptible	<1%

Guidance on effect significance

With respect to assessing **significance** of ecological effects, it is important to note that the 1% screening threshold is not an effect threshold. The magnitude of impact which might result in a significant ecological effect is likely to depend on baseline conditions and sensitivity of the receiving environment.

CIEEM (2018[9]) define a significant ecological effect as *"an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area"*. In terms of assessment of impacts on features of designated sites, a significant impact may be one which affects its favourable condition or conservation status, or which prevents or significantly delays the return to favourable condition.

Effect significance in a planning context

In terms of Welsh legislation and planning policy (arising from The Biodiversity and Resilience of Ecosystems Duty in Section 6 of Environment Act (Wales) 2016), a

[7] CIEEM (2021). *Advice on Ecological Assessment of Air Quality Impacts*. Chartered Institute of Ecology and Environmental Management. Winchester, UK
[8] Environmental Protection UK (2010). *Development Control: Planning for Air Quality*. April 2010.
[9] CIEEM (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition*. Chartered Institute of Ecology and Environmental Management, Winchester

significant effect could be postulated as one which affects the resilience of ecosystems, as expressed by attributes such as their structure and functioning, connectivity and diversity.

Effect significance in a permitting context

With respect to assessing whether it is possible to conclude no adverse effect on site integrity (European site) and to conclude no damage (SSSIs) in a permitting context in England and Wales, Environment Agency (EA) guidance[10] distinguished between circumstances when:

- the background concentration is less than the appropriate environmental criterion but a small process contribution leads to an exceedance; or
- the background concentration is currently exceeding the appropriate environmental criterion and the new process contribution will cause an additional **small** increase; and
- the background concentration is less than the appropriate environmental criterion, but the process contribution is significant (*i.e. of higher magnitude*) and leads to an exceedance; or
- the background concentration is more than the appropriate environmental criterion, and the process contribution is **large.**

In the first two circumstances, the EA recommended that a decision is based on local circumstances, based on factors set out in guidance (such as spatial disposition of sensitive habitats relative to predicted effects); in the latter two circumstances, the EA state that it is not possible to conclude no adverse effect. The EA go on distinguish between the varying level of legal and policy protection applied to European sites relative to SSSIs. For European sites (SACs, SPAs and Ramsar sites) the key policy test is 'no likely significant effect', which is best understood as 'no possible significant effect according to best available scientific knowledge'. For SSSIs, the EA refer to 'operations likely to damage' a SSSI.

Effect significance relating to modelled species loss

Natural England Commissioned Report NECR210 provides some quantification of potential significance with respect to nitrogen deposition impacts, using a modelled

[10] Environment Agency (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation*. Operational Instruction 67_12, Issued 08/05/12

metric of the incremental increase in deposition rates likely to result in the loss of 1 species from a habitat. Although their guidance is limited to a small number of habitats, it has been adopted by Highways England for assessment of road transport air quality impacts, and could be of value when considering impacts in relation to Planning Policy Wales requirements to maintain and enhance biodiversity. A key consideration of the report is the fact that nutrient-mediated species loss for most of the studied habitats appears to follow a curvilinear response, meaning sensitivity is higher at low background nitrogen deposition rates. Effects of further incremental additions are lower in circumstances where background rates already significantly exceed the critical load. For example, for the most sensitive habitat studies (decalcified acid sand dunes), a 0.1 - 0.3kg increase in nitrogen deposition at 5kg N/ha/yr background rate is modelled to reduce diversity by one species; at 20kg N/ha/yr this increases to 1.3 - 2kg N/ha/yr (NECR210, Table 21).

Habitat Condition and site-specific information

The significance of an effect can also be related to the condition of the receiving environment. Site condition provides important context to the assessment of air quality impacts, taking into account the effect of baseline conditions, including unregulated activities and existing operational consents. For SSSIs in Wales, NRW undertook a protected sites baseline assessment (the 2020 Baseline Evaluation project)[11], and published the results in the form of a CSV spreadsheet file. This does not localise condition at the level of individual units (parts) of a designated site, but gives an indicative condition assessment of each qualifying or notified feature. Around half of the individual features across Wales were classified as 'unknown' due to insufficient evidence. The condition assessment as it relates to Fenn's Moss is set out in Table 4.2 below.

A data search was also undertaken of publications and other data relating to Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC, in order to gain a better understanding of site history, management and pressures, particularly as they related to air quality impacts. Data sources consulted included the following:

- NRW *Core Management Plan including Conservation Objectives* for the SAC (2008)[12];

[11] https://naturalresources.wales/evidence-and-data/research-and-reports/protected-sites-baseline-assessment-2020/?lang=en (accessed 11/09/2025)
[12] https://www.naturalresources.wales/media/672011/fenns-and-whixhall-wes-english.pdf

- Natural England's *European Site Conservation Objectives: supplementary advice on restoring site features* (2017)[13];
- Ammonia measurements from passive samplers at three sites within the SAC (2018)[14];
- Longer-term ammonia measurements from a passive sampler within the SAC as part of the UK Eutrophying and Acidifying Network (UKEAP), reported in the AQA; and
- An EU *Project Repository Journal* article on the Marches Mosses BogLIFE programme[15].

In addition, access to a Centre for Ecology and Hydrology (CEH) commissioned research publication[16] summarising the 2018 ammonia monitoring programme was requested, but permission was initially refused (email 07 August 2025) due to client confidentiality issues; at the time of completion of the report the client (Natural England) had not responded to a CEH request to release the report.

[13] https://designatedsites.naturalengland.org.uk/TerrestrialAdvicePDFs/UK0012912.pdf
[14] https://www.data.gov.uk/dataset/0bd42a42-94b0-4e6e-a3e3-c8f5fe5cdc11/ammonia-measurements-from-passive-samplers-at-fenns-whixall-wem-cadney-mosses-sac-2018
[15] Duff, R. (2023), *"The Marches Mosses BogLIFE project: putting nature-based solutions into practice"*, *Project Repository Journal*, 16, pp.62-71. Available at https://www.europeandissemination.eu/article/the-marches-mosses-boglife-project-putting-nature-based-solutions-into-practice/19780. (Accessed: 06 Aug 2025)
[16] Tanna, B.; Keenan, P.O.; Stephens, A.C.M.. (2019) *Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses. Atmospheric ammonia monitoring data report for period: Jul 2018 – Dec 2018*. Edinburgh, NERC/Centre for Ecology & Hydrology, 18pp.

3 Statutory and Designated Sites

3.1 Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC

Summary

The SAC is described in the NRW *Core Management Plan* as one of the largest and most southerly raised bogs in the UK. It states that although much of the site has been subject to peat extraction, areas of partially-cut and uncut mire still remain. In areas formerly subject to peat-cutting, recent conservation management is leading to the regeneration of bog-forming vegetation.

Note that the SAC is a cross-border site, although proximal areas to the Proposed Development are all within Wales; information on site condition and management is sourced from both NRW and Natural England.

Qualifying Features

The SAC is designated for the following qualifying feature[17]:

- Active raised bogs (Annex 1 priority habitat H7110)).

A further Annex 1 habitat is listed as present, but not a primary reason for site selection:

- Degraded raised bogs still capable of natural regeneration (Annex 1 habitat H7120).

Note that APIS also includes consideration of dry heaths (H4030), but this is not a qualifying feature of the site; the SAC Standard Data Form[18] classifies it as having a 'non-significant presence representatively', with only 0.95ha present in the SAC. It does not therefore require separate consideration in terms of assessing air quality impacts.

Sensitivity to Air Quality Impacts

3.2 Midlands Meres and Mosses Phase 2 Ramsar Site

Summary

The Ramsar site comprises a total of 18 different sites extending across Shropshire, Cheshire and NE Wales, with a total area of 1588ha.[19] They are described as comprising nutrient-rich open water bodies (meres) with fringing habitats of reed swamp, fen, carr and damp pasture, and peatlands.

[17] https://sac.jncc.gov.uk/site/UK0012912
[18] https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0012912.pdf
[19] https://rsis.ramsar.org/ris/891

As a multi-site Ramsar, not every habitat will necessarily occur at each component site, and in the case of Fenns, Whixall, Bettisfield, Wem and Cadney Mosses the raised bog habitat is the important feature. In the area of the Proposed Development the boundaries of the SAC and Ramsar site are contiguous.

Ramsar Site Selection Criteria

The Ramsar site qualifies under selection criteria 1 and 2[20]:

- Criterion 1 (*contains a representative, rare, or unique example of a natural or near-natural wetland type*): The site comprises a diverse range of habitats from open water to raised bog.
- Criterion 2 (*supports vulnerable, endangered, or critically endangered species or threatened ecological communities*): Supports a number of rare species of plants associated with wetlands, including the nationally scarce cowbane *Cicuta virosa* and, elongated sedge *Carex elongata*. Also present are the nationally scarce bryophytes *Dicranum affine* and *Sphagnum pulchrum*. Also supports an assemblage of invertebrates including several rare species. There are 16 species of British Red Data Book insect listed for this site including the following endangered species: the moth *Glyphipteryx lathamella*, the caddisfly *Hagenella clathrata* and the sawfly *Trichiosoma vitellinae*.

3.3 Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI

Summary Description

The SSSI Citation states that the site covers a total area of 949.2ha; it was notified as one of the largest and most southerly raised mires in Britain, representing an example of mire development under relatively warm and dry conditions. Although much of the site had a long history of peat extraction, significant areas of partially uncut and intact mire surface remained, whilst the up to 4m thickness of residual peat provided suitable conditions for re-wetting and restoration of active peat formation.

The boundaries of the SAC and SSSI are contiguous in the area of the Proposed Development.

Notified Features

Natural Resources Wales' *Your Special Site and Its Future* document stated that 13 SSSI features were notified initially. These comprised one habitat feature (lowland raised

[20]https://jncc.gov.uk/jncc-assets/RIS/UK11080.pdf

bog); three species assemblage features (bryophyte, invertebrate and dragonfly assemblages); two vascular plant species (bog rosemary *Andromeda polifolia* and lesser bladderwort *Utricularia minor*); two Nationally Scarce bryophytes (waved fork-moss *Dicranum affine* and golden bog-moss *Sphagnum pulchrum*); one bird species (Eurasian curlew *Numenius arquata*; and four invertebrate species (a caddis-fly *Hagenella clathrata*, large heath butterfly *Coenonympha tullia*, white-faced darter dragonfly *Leucorrhinia dubia*, and northern footman moth *Eilema complana f. sericea*.

NRW state that four further features have been found on the site since notification which are considered to be of SSSI quality: *Teesdalia nudicaulis* (shepherd's-cress)-rich acid grassland; a money spider *Carorita limnaea*; and two bog craneflies - *Ideoptera linnei*, and *Limnophilia heterogyna*.

3.4 Fenn's, Whixall & Bettisfield Mosses National Nature Reserve (NNR)

Summary Description

Natural England's description of the NNR[21] states that the main habitats are lowland raised bog, wet woodland, wet peaty fields, heathland and *Teesdalia* (dry acid) grassland.

Its features of interest include 18 *Sphagnum* including the regionally rare *Sphagnum pulchrum*, along with other characteristic bog plants. Invertebrates include 29 species of dragonfly and damselfly, 670 species of moth and 32 species of butterfly. Reptiles include adder *Vipera berus* and common lizard *Zootoca vivipara*; mammals include water vole in outlet ditches. A total of 166 species of birds have been recorded, including breeding curlew, teal *Anas crecca* and shoveler *Spatula clypeata*.

The NNR boundaries follow public-owned land, and exclude some privately owned fields and woodlands on the margins of the SAC / Ramsar / SSSI. The nearest boundary to the Proposed Development is at modelling point E10 (see AQA and Figure 1).

For the purposes of the assessment, the sensitivity of NNR features can be adequately considered with reference to effects on bog and acid grassland habitat, to are not considered separately below.

[21] https://www.gov.uk/government/publications/shropshires-national-nature-reserves/shropshires-national-nature-reserves

4 Sensitivity to Air Quality Impacts

4.1 Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC

Nitrogen deposition

Raised bog habitats (EUNIS habitat Q11) are considered to be sensitive to nitrogen deposition, with a critical load range of 5 - 10kg N/ha/yr. This is considered 'reliable' in Bobbink *et al* (2022), being underpinned by a large amount of field and experimental evidence.

Acid deposition

There is substantial evidence for acid sulphate deposition causing significant degradation of bog habitats, particularly in blanket bog habitats in the South Pennines. However, in an environment of greatly reduced sulphate deposition, recovery of *Sphagnum* and other bog species has been observed, and evidence of effects of current levels of acidification (driven primarily by nitrogen deposition) is more equivocal.

APIS give a site-relevant critical load function for the SAC of 0.321 - 0.534keq/ha/yr for the site (minCLmaxN value 0.521keq/ha/yr), which is used in the AQA. This is a reasonable, precautionary value to use in the ecological interpretation.

Ammonia levels

Lower plants are an important component of bog habitats; as well as the bog-forming *Sphagnum* species, terricolous lichens such as *Cladonia portentosa* can attain significant cover levels on the bog surface. APIS recommend the lower critical level of 1.0μg/m^3 annual mean, which is appropriate.

4.2 Midlands Meres and Mosses Phase 2 Ramsar Site

The critical loads and levels applied to bog habitats in the SAC are both the most precautionary, and appropriate to apply to the Ramsar site. The habitat features and species which contribute to the Ramsar listing are all either associated with bog habitats (e.g. the mosses *Dicranum affine* and *Sphagnum pulchrum*), or with other less sensitive habitats (e.g. rich fen); most of the latter do not occur at the proximal Fenns, Whixall, Bettisfield, Wem and Cadney Mosses site.

4.3 Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI

Nitrogen Deposition

APIS provide the following site-specific advice for nitrogen sensitivity of SSSI notified features:

Table 4.1: SSSI nitrogen deposition critical loads

Notified feature	EUNIS habitat	APIS Critical Load class	Critical Load N deposition (kg N/ha/yr)	Considered sensitive to Nitrogen?
Raised bog (NVC M18a *Erica tetralix - Sphagnum papillosum* raised and blanket mire, *Sphagnum magellanicum - Andromeda polifolia* sub-community)	Q1	Raised and blanket bogs	5 - 10	Yes
Raised bog (NVC M3 *Eriophorum angustifolium* bog pool community)	Q1	Raised and blanket bogs	5 - 10	Yes
Raised bog (NVC M2 *Sphagnum cuspidatum / recurvum* bog pool community)	Q1	Raised and blanket bogs	5 - 10	Yes
Dry heath (NVC H8-12) (**see note 1**)	S42	Dry heaths	5 - 15	Yes
Acid grassland (NVC U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland) (**see note 1 below**)	N15	Coastal dune grasslands (grey dunes)	5 - 15	Yes
Acid grassland (NVC U1c *Festuca ovina - Agrostis capillaris - Rumex acetosella* grassland, *Erodium cicutarium - Teesdalia nudicaulis* sub-community)	N15 (**see note 2 below**)	Coastal dune grasslands (grey dunes) (**see note 2**)	5 - 15	Yes
Semi-natural woodland (**see note 1**)	T1	Broadleaved deciduous woodland	10 - 15	Yes
Marshy grassland (**see note 1**)	R35	Moist or wet mesotrophic to eutrophic hay meadow	15 - 25	Yes
Scrub (**see note 1**)	n/a	No comparable habitat with established CL class	n/a	Yes
Andromeda polifolia (bog rosemary) (**see notes 3**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed
Coenonympha tullia (large heath butterfly) (**see note 4**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed
Hagenella clathrata (a caddis-fly) (**see note 4**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed
Leucorrhynia dubia (white-faced darter) (**see note 4**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed
Odonata (dragonfly) assemblage (**see note 4**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed

Notified feature	EUNIS habitat	APIS Critical Load class	Critical Load N deposition (kg N/ha/yr)	Considered sensitive to Nitrogen?
Peatland invertebrate assemblage (**see note 4**)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed
Standing water (**see note 1**)	n/a	No comparable habitat with established CL class	n/a	Yes
Numenius arquata (curlew - breeding)	n/a	No CL assigned - seek site-specific advice	n/a	Not assessed

Notes

(1) The NVC U4 acid grassland community, dry heath, semi-natural woodland, marshy grassland, scrub and standing water are listed by APIS as habitat features, but are not notified features of this SSSI.

(2) EUNIS N15 habitat is Atlantic and Baltic coastal dune grassland, which is incorrect for a lowland dry acid grassland habitat like U1c. The correct EUNIS habitat is a higher level class of R1 Dry grassland: either R1M2 *Agristis - Festuca* grassland for closed swards, or R1P Oceanic to subcontinental inland sand grassland for more open swards. However, current guidance in Bobbink *et al* applies the same critical load class for the R1P habitat as coastal dune grasslands of 5-15kg N/ha/yr, with 6-10kg N/ha/yr recommended for R1M derivatives.

(3) APIS only consider one of the four plant species notified features, *Andromeda polifolia*. Along with *Andromeda* the other three, *Utricularia minor, Dicranum affine* and *Sphagnum pulchrum*, are all associated with bog pool and bog habitats, and can be assumed to have the same sensitivity as the supporting habitat.

(4) Although none of the invertebrate species and assemblage features have critical loads assigned by APIS, their conservation status can be assumed to be linked to that of the raised bog supporting habitat, and the raised bog critical load applied. This is a precautionary approach (since sensitivity to habitat changes will vary), but accords with the treatment of listed Ramsar site invertebrate features.

For the purposes of assessing air quality impacts, relevant nitrogen critical loads are therefore those associated with raised bog and open sandy acid grassland habitats (Q1 and R1P respectively). These both have a lower critical load of 5kg N/ha/yr, although the level of confidence in this value varies; the raised bog critical load is described in Bobbink *et al* as 'reliable', while sandy acid grassland is stated as 'expert judgement'. This value is also appropriate for all of the invertebrate notified features not assessed by APIS, but which are reliant on bog (or acid grassland) as supporting habitat.

Acid Deposition

APIS give a site-relevant critical load function for the raised bog notified feature of 0.321 - 0.534keq/ha/yr for the site (minCLmaxN value 0.521keq/ha/yr), which is used in the AQA. This is the same as that applied in the SAC, and is a reasonable, precautionary value to use in the ecological interpretation.

Ammonia Levels

APIS recommend the lower critical level of 1.0μg/m^3 annual mean for raised bog habitat, which is appropriate given the importance of lower plants to this habitat. The 1.0μg/m^3 value is also appropriate for the two separately notified lower plants, the mosses *Dicranum affine* and *Sphagnum pulchrum*, which can be assumed to be relatively sensitive to ammonia.

The 1.0μg/m^3 value is also assigned to open acid grassland habitat, presumably due APIS associating it with fixed dune habitats, which often have a significant bryophyte and lichen component. However, the description of NVC U1c acid grassland in *British Plant Communities* (Rodwell, 1992) states that the lower plant component is usually 'somewhat restricted in variety and cover', although some stands can have some small moss species and terricolous lichens present. It is probably therefore more appropriate to say that the choice of 1.0μg/m^3 or 3.0μg/m^3 annual mean critical level is site-specific, depending on the importance of potentially sensitive bryophytes and lichens in the sward.

4.4 Sensitivity of Ancient Woodland Sites

Sensitivity to nitrogen deposition

As there is no available information on woodland plant community type, the AQA uses the precautionary default value for EUNIS T1 Broadleaved deciduous woodland habitat of 10 - 15kg N/ha/yr.

In lowland areas such as the surroundings of the Proposed Development, most ancient woodland habitats will be on mineral soils with a reasonably high base status and relatively high nutrient supply. They are therefore likely to support a mesotrophic woodland habitat which would fall within EUNIS T1E critical load class, *Carpinus* and *Quercus* mesic deciduous forest; this has a critical load range of 10 - 15kg N/ha/yr. This would likely include the woodland sites to the north and east of the Proposed Development; these include Fenn's Rough Wood, and Unnamed Ancient Woodlands 2 and 3 on Figure 3.

For areas of woodland developed on peat soils (e.g. EUNIS T16 Broadleaved mire forest on acid peat), sensitivity is likely to be higher, and the T1 default value of 10 - 15kg N/ha/yr is appropriate. This is likely to apply to the Fenn's Wood ancient woodlands on the eastern edge of the peat basin, and may apply to the small lakeside Unnamed Ancient Woodland 1, depending on the soil / peat type and plant community present.

Sensitivity to acid deposition

APIS advise that sensitivity of woodland to acid deposition[22] is heavily influenced by soil chemistry, with acid mineral soils overlying areas of acid bedrock with low weathering rates having the highest sensitivity. This is further exacerbated in high rainfall areas, increasing leaching rates of base cations. Geologically sensitive areas include Snowdonia and the Cambrian mountains of central Wales.

As is the case with bog habitats, it can be difficult to disaggregate some of the effects of historic acid deposition from those of sulphur toxicity; in woodland habitats, the past loss of lichen species such as *Lobaria pulmonaria* has been attributed to sulphur dioxide-driven increases in acid deposition. However APIS report that current acidification from deposited N compounds may also lead to reduced base cation availability, via leaching and elevated concentrations of H^+ ions and potentially toxic ammonium (NH_4^+) ions.

The critical loads used in the AQA are based on APIS Screening Critical Loads by Location, and are appropriate for the dominant soil type over the relevant 1km OS grid square.

Sensitivity to Ammonia

NRW identify NH3-sensitive woods, which support N-sensitive lichens, and provide a downloadable shapefile of sensitive sites[23]. They state that this: '*identifies areas of Ancient Woodland and Parkland from which NRW hold recent, auditable records of N-sensitive lichens. Not all lichens are sensitive to increased ammonia: the 62 species used to identify N-sensitive Ancient Woodland and Parkland are particularly sensitive and are important in the woodland/parkland ecosystem. Any area identified as sensitive in this GIS layer should be assessed using a 1µg/m^3 NH3 Critical Level.*'

The AQA took a precautionary approach to assessing ancient woodlands, and used the lower 1µg/m^3 critical level for screening impacts. However, none of the ancient or other woodlands in the vicinity of the Proposed Development are identified as NH3-sensitive, so the higher 3µg/m^3 critical level is appropriate for assessment purposes. This is typical of woodlands set in a lowland agricultural landscape, likely to have been subject to elevated ammonia levels over a long timescale; the nearest NH3-sensitive

[22] https://www.apis.ac.uk/acid-deposition-broadleaved-mixed-and-yew-woodland (accessed 11/09/2025)
[23] https://datamap.gov.wales/layers/geonode:nrw_n_sensitive_wood

woodland is located 19.7km west of the Proposed Development at Brynkinalt on the River Ceiriog.

4.5 Baseline Condition Assessment - Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC / Ramsar / SSSI

Condition Assessment

The following table summarises the NRW SSSI feature condition assessment, extracted from the 2020 Baseline Evaluation spreadsheet:

Table 4.2: NRW Feature Condition Assessment

Feature	Indicative condition	Evidence quality
Active raised bogs	Unfavourable	High
Degraded raised bogs	Unfavourable	High
Acid grassland	Unknown	Inadequate
Dry heath	Unknown	Inadequate
Waved fork-moss *Dicranum bergeri*	Favourable	High
Moth *Sterrhopterix fusca*	Favourable	High
All other species features (plant, invertebrate and bird)	Unknown	Inadequate

The English side of the designated site is subject to unit-based Common Standards Monitoring; units all either fall into the 'Unfavourable- Recovering' or 'Unfavourable - No Change' categories.

Reasons for Unfavourable Condition

The EU BogLIFE article referenced above (Duff, 2023[24]) describes the pressures affecting site condition in the SAC, and measures taken to restore the site to favourable condition. Amongst the reasons cited for unfavourable condition include the following:

- Drainage associated with past peat cutting;
- Loss of interface between bog and surrounding land to agriculture and forestry;
- Ingress of nutrient-rich water from surrounding agricultural land resulting from canalised drain linkages; and

[24] Duff, R. (2023), *"The Marches Mosses BogLIFE project: putting nature-based solutions into practice"*, *Project Repository Journal*, 16, pp.62-71. Available at https://www.europeandissemination.eu/article/the-marches-mosses-boglife-project-putting-nature-based-solutions-into-practice/19780. (Accessed: 06 Aug 2025)

- Atmospheric nitrogen deposition, with agricultural activities within 5km of the site resulting in over half of emissions.

It is clear that the major changes in land-use in the past have the greatest responsibility for the site's current unfavourable condition. Nitrogenous pollutants are cited as a current factor, with excessive growth of birch *Betula* spp. and *Molinia* coupled with difficulties in establishing *Sphagnum* cited as consequences of elevated nutrient status.

APIS modelled background nitrogen deposition rates across the site range from 21.3-22.7kg N/ha/yr (2021 mid-year (2020-22) data), well above the 5kg N/ha/yr critical load for bog habitats, and modelled background ammonia levels across the site range from 2.9 - 3.2μg/m^3; these are all at a 1km grid square scale of resolution.

Ammonia data cited in Duff, 2023 from the EU BogLIFE monitoring project in 2018 showed average values of 2.64, 6.15 and 3.28μg/m^3 for three passive diffusion samplers located within the site[25]. All these values are well above the 1.0μg/m^3 critical level for habitats containing important lower plant communities such as bogs, and some were above the 3.0μg/m^3 level for protection of ecosystems.

Current Trends

The AQA (table 4) reports the more recent results of ammonia concentrations on Fenn's Moss, measured by a passive diffusion sampler forming part of the UKEAP National Ammonia Monitoring Network, and located in the central part of the bog at OS grid ref. 348873, 336488. This shows a declining trend in annual mean values from 2020 - 2024 of 2.67 - 1.88μg/m^3.

The declining trend may be attributed to mitigation measures to control local agricultural emissions undertaken through the Shared Nitrogen Action Plan (SNAP) and Catchment Sensitive Farming programme. However, as the AQA notes, there is also a disparity between modelled 1km grid square ammonia levels and actual measurements, with the 2022 APIS modelled value of 3.1μg/m^3 significantly higher than the 2.01μg/m^3 measured value. This may indicate both a local reduction in emissions as a consequence of SNAP / Catchment Sensitive Farming compared to the standardised model inputs, and the effect of other local factors such as fringing woodlands in reducing ammonia levels (and nitrogen deposition rates) within the core bog area where the ammonia sampler is located. Woodland buffer planting around

[25] Tang, S.; Stephens, A.; Keenan, P.O.; Binoti, T.; Duff, R. (2019). *Ammonia measurements from passive samplers at Fenn's, Whixall, Wem & Cadney Mosses SAC (2018).* NERC Environmental Information Data Centre. https://doi.org/10.5285/c6145da7-ec61-49ae-a050-f5c5acd6cf9e

nature conservation sites is a recognised method for intercepting ammonia pollution from agricultural sources[26], which are typically diffuse emissions from close to the land surface (e.g. from animal housing facilities or fertiliser spreading).

Mitigation Measures

Duff (2023) describes a number of major mitigation measures undertaken on the SAC since 2016, including:

- Bunding over 633ha of the mire surface, creating cells bounded by low (1m high) peat walls to retain rain water on the peat surface and encourage recolonisation by peat-forming species;
- Bog edge restoration, including felling and bunding of 50ha of plantations, and a trial topsoil strip and bunding of 3.2ha of pasture land; and
- Diversion of a 2.9km section of a drain carrying nutrient-rich water onto the bog onto mineral soils around the northern part of the SAC.

[26] Dragosits, U., Theobald, M.R., Place, C.J., ApSimon, H.M., & Sutton, M.A. (2009). *Spatial Planning as a Complementary Tool to Abate the Effects of Atmospheric Ammonia Deposition at the Landscape Scale*. In Sutton, M.A., Reis, S, & Baker, S.M. (eds.). *Atmospheric Ammonia. Detecting emission changes and environmental impacts*. Springer.

5 Assessment of Predicted Air Quality Impacts

5.1 Summary of Dispersion and Deposition Modelling Results

Note on Emission Scenarios

Sectio 6.2.1 of the AQA sets out the basis for modelling two emission scenarios:

- Scenario 1, based on the proposed ammonia emission limit value (ELV) of 3.5mg/Nm^3; and
- Scenario 2, based on seasonally varying ammonia emissions due to expected changes in the proportions of food waste to green waste.

In Scenario 2, ammonia emissions are lower in summer due to the higher proportion of green waste, and intermediate in spring and autumn, producing modelled annual mean concentrations which are correspondingly lower (see AQA Table 8).

In terms of the ecological assessment of impacts, as the effect of nitrogenous pollutants on vegetation is essentially cumulative over time (as opposed to episodic), the aggregation of emissions from different seasons to create an annual mean value is appropriate and sufficiently precautionary. This is also the case when considering the 5-year period of meteorological data which are used in the dispersion model. The AQA presents both 'worst case' (worst year in 5) and average values; when considering effects of excess nutrients which are cumulative over time, average values are more appropriate.

Ammonia Impacts above Screening Thresholds

The following impacts are predicted at or above screening thresholds (see AQA Table 19), using 'worst case' meteorological data:

- A process contribution (PC) of 0.021μg/m^3 (2.8% of 1.0μg/m^3 critical level) to ammonia levels in Scenario 1 / 0.013μg/m^3 (1.29% of critical level) in Scenario 2, at modelling point E1 at the nearest boundary of Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC / Ramsar Site / SSSI;
- A process contribution (PC) of 0.016μg/m^3 (1.63% of 1.0μg/m^3 critical level) to ammonia levels in Scenario 1 / 0.01μg/m^3 (1.0% of critical level) in Scenario 2, at modelling point E10 at the nearest boundary of Fenn's, Whixall and Bettisfield Mosses National Nature Reserve; and

- A PC of 0.046μg/m^3 (1.53% of 3.0μg/m^3 critical level) to ammonia levels in Scenario 1 / 0.033 μg/m^3 (1.1% of 3.0μg/m^3 critical level) in Scenario 2, at modelling point E11 (Fenn's Rough ancient woodland).

Note that AQA Table 19 uses the precautionary 1.0μg/m^3 critical level for all woodland habitats; as discussed in section 4.4 above, in accordance with NRW advice this is not necessary at assessment stage, so impacts on ancient woodland sites below 0.03μg/m^3 are not considered further.

Using 5-year average meteorological data with Scenario 2 (AQA Tables 20 & 27), the PC at point E1 is reduced to 0.0079μg/m^3 (0.79% of 1.0μg/m^3 critical level), and the PC at point E10 is reduced to 0.0062μg/m^3 (0.62% of 1.0μg/m^3 critical level).

Nitrogen Deposition Impacts

Nitrogen deposition impacts are shown in AQA Table 23, with more detail shown in AQA Table 30. When seasonal variation in emissions is taken into account under Scenario 2, and average meteorological data applied, they are predicted to remain below the 1% screening threshold at all sites, except for Fenn's Rough ancient woodland (E11), with a predicted maximum PC of 0.228kg N/ha/yr, 2.28% of the lower 10kg critical load for broadleaved woodland, and 1.52% of the more appropriate 15kg critical load for mesic woodland habitats. Note that these values are higher than the SAC both due to location of Fenn's Rough ('downwind' of emission source), as because they are based on woodland deposition velocities (see AQA Table 21).

At the nearest boundary of the SAC / Ramsar site / SSSI (E1) a PC of 0.041kg N/ha/yr is predicted with Scenario 2 and average meteorological data, 0.82% of the lowest critical load for bog / acid grassland habitats of 5kg N/ha/yr. At the nearest part of the SAC / Ramsar site / SSSI supporting bunded peatland habitat (E10), a PC of 0.032kg N/ha/yr is predicted with Scenario 2 and average meteorological data, 0.65% of the lowest critical load for bog / acid grassland habitats of 5kg N/ha/yr.

Acid Deposition Impacts

Acid deposition impacts are shown in detail in for the Scenario 2 / average meteorological data in AQA Table 33. They are predicted to remain below the 1% screening threshold at all sites, including Fenn's Rough ancient woodland (E11), with a predicted maximum PC of 0.0163keq H^+/ha/yr, 0.97% of the 1.672keq critical load for broadleaved woodland broad habitat in that grid square.

At the nearest boundary of the SAC / Ramsar site / SSSI (E1), a PC of 0.0029keq H^+/ha/yr is predicted, 0.55% of the 0.534keq critical load for bog habitats. At the nearest part of the SAC / Ramsar site / SSSI supporting bunded peatland (E10), a PC of 0.0023keq H^+/ha/yr is predicted, 0.43% of the 0.534keq critical load for bog habitats.

5.2 Predicted Impacts on Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC

Predicted Impacts of Ammonia Levels

AQA Figure 7 (Annual Mean Ammonia - ecology) is a contour plot showing the predicted spatial extent of annual mean ammonia levels, expressed as a percentage of the lowest 1.0μg/m^3 critical level. When compared to the spatial disposition of habitats confirmed in the field survey (Appendix 1 Figure 2, and Appendix 2), it can be seen that the realistic Scenario 2 is not predicted to expose qualifying features to additional ammonia levels above 1% of critical level. Note that both scenarios are based on 'worst-case' meteorological data.

Habitats within the 1% contour in Scenario 2 comprise the north-eastern area of an agricultural grassland field subject to significant agricultural improvement, and a linear strip of rank neutral grassland bounded by hedgerows and trees.

The linear strip of neutral grassland bounded by trees and hedgerows (see Appendix 2, photos 10 & 11) appears to be outside the peat basin, and supports typical habitats of a lowland agricultural landscape. It is unclear why this strip is included in the SAC boundary, but it does secure a (currently unused) northern access to a public road.

The north-eastern agricultural grassland fields appear to have been established near the edge of the peat basin (see Appendix 2, photos 4 & 5). The walkover survey noted how the land rises in height towards the eastern part of the field, likely marking the limit of the peat basin; there are farm buildings immediately adjoining the north-eastern boundary of this field (shown on OS maps as Fenn's Wood Farm). The proximity of an established farm steading and the location at the edge of the peat basin mean that any future restoration attempt through bunding and excavation of nutrient-enriched topsoil is likely to be limited to areas outside the 1% ammonia contour. When 5-year average meteorological data is considered, all of these fields are outside the 1% contour.

Immediately south of modelling point E10 (and therefore outside the 1% contour) is a ca. 1ha area of regenerating birch / willow near the north-west corner of the SAC (see Appendix 2, Photo 9), which it is understood was bunded in order to encourage bog

vegetation. This does not currently support an SAC qualifying habitat, but future clearance of young trees within the bunded and rewetted area could enable restoration of open bog habitat. It should be noted that if tree clearance does occur, the removal of biomass using methods described in Duff (2023) which involve clearance of brash and debris, would result in a significant loss of nitrogen from the system.

Ammonia levels at the nearest boundary of open bog habitats are below the 1% screening threshold, and can be considered inconsequential. Furthermore, modelled values do not take into account the scavenging effect of tall, structurally complex vegetation on atmospheric ammonia; fringing woodland on the northern boundaries of the designated site will act as a barrier, further reducing levels of ammonia from this source at the open bog surface.

Following changes to the Proposed Development to reduce ammonia concentrations, the process contribution would be below 1% of critical level at any location capable of being restored to bog habitat. This includes bunded areas which currently support young birch - willow regeneration, and improved agricultural grassland established near the north-eastern edge of the peat basin. Impacts on these habitats can therefore also be considered inconsequential.

Predicted Impacts of Nitrogen Deposition Rates

The maximum PC at the closest location supporting bunded peatland habitat is 0.032kg N/ha/yr (0.65% of bog critical load), safely below the 1% screening threshold, and can be regarded as inconsequential. This is predicted to occur at the nearest sampling point (E10), in an area of the SAC where there are no qualifying features present, apart from a small area of bunded peat supporting dense birch / willow regeneration. The higher deposition velocity to woodland vegetation does mean that deposition rates will be greater in these habitats; however, this can be regarded as having a protective function, reducing deposition rates on the open bog below that predicted by the dispersion and deposition modelling in the AQA.

Predicted Impacts of Acid Deposition Rates

The maximum PC at the closest location supporting bunded peatland habitat of 0.0023keq keq H^+/ha/yr (0.43% of bog critical load) is well below the 1% screening threshold, and can be regarded as inconsequential.

5.3 Predicted Impacts on Ramsar Site

The Ramsar site does not introduce any additional sensitivities to those considered above in relation to the SAC.

5.4 Predicted Impacts on SSSI

The SSSI requires consideration of a number of additional notified features to those designated as SAC or listed as Ramsar site features. The main additional habitat feature is dry acid grassland (NVC U1a community). However, some features listed by APIS and occurring within the SSSI, including the NVC U4 acid grassland community, dry heath, semi-natural woodland, marshy grassland, scrub and standing water are not notified features of this SSSI (see Table 4.1, note 1 above).

The field survey and literature search did not indicate dry acid grassland habitat was present in the northern part of the SSSI, in areas close to the Proposed Development.

The additional notified species features of the SSSI are all associated with bog or bog pool habitats, and do not introduce any additional sensitivities to consider in the impact assessment.

5.5 Predicted Impacts on Ancient Woodland Sites

The maximum 0.228kg N/ha/yr PC (1.52% of 15kg critical load) to nitrogen deposition at the southern end of Fenn's Rough woodland (E11; see AQA Table 30) can be characterised as a low magnitude impact in circumstances where the critical load is significantly exceeded; at woodland deposition velocities, background deposition rates in this area are estimated at 40.9kg N/ha/yr (see AQA, Table 24). In the context of a high degree of background exceedance, advice in NECR210 is relevant in assessing whether an additional increase is likely to result in an ecological effect. This states that there is no clear evidence for a dose-response relationship in woodland, due to the strong influence that tree canopy structure places on ground flora through inception of light, rainfall and nutrient nitrogen deposition. There is some evidence of changes to ground flora and damage to trees in the vicinity of intensive livestock rearing facilities, but these studies were associated with high levels of atmospheric ammonia in proximal areas of the source[27,28], well above the 0.033μg/m^3 PC to ammonia levels

[27] Pitcairn, C. E. R., Leith, I. D., Sheppard, L. J., Sutton, M. A., Fowler, D., Munro, R. C., Tang, S., and Wilson, D. (1998). The relationship between nitrogen deposition, species composition and foliar nitrogen concentrations in woodland flora in the vicinity of livestock farms. *Environmental Pollution*, **102**: 41-48.
[28] von Bobrutzki, K., Ammon, C., Berg, W. *et al.* (2012). Ammonia emissions from a broiler farm: spatial variability of airborne concentrations in the vicinity and impact on adjacent woodland. *Environ Monit Assess* **184**, 3775–3787. https://doi.org/10.1007/s10661-011-2223-3

predicted for Scenario 2 at this site (see AQA, table 19) or modelled background level of 2.89μg/m^3 in 2021 (from APIS). As an example, the von Bobrutzki (2012) study referenced below measured ammonia values of 12μg/m^3 in an area 45m from a broiler unit where there was visible damage to pine trees.

In the context of high background nitrogen deposition rates of 40.9kg, it is very unlikely that an additional 0.286kg N/ha/yr increase in nitrogen deposition rates would have a measurable ecological impact.

With respect to ammonia, the predicted environmental concentration (PEC) for ammonia in Scenario 2 remains below the relevant critical level at 2.92μg/m^3 annual mean (2.89 background + 0.03 PC), and can be considered inconsequential. In the context of continued measures to control agricultural sources in the area around the SAC, the PEC is unlikely to exceed the critical level at this site in the lifetime of the Proposed Development.

5.6 Significance of Effects

Additional Mitigating factors - Emission Trends and Headroom

The presence of positive measures in the vicinity of the designated site to control agricultural emissions, with apparent results confirmed by UKEAP monitoring on Fenn's Moss, strongly indicate a positive effect likely to continue over the lifetime of the Proposed Development. In terms of the magnitude of effect, this is far greater than the insignificant process contribution to ammonia emissions represented by the Proposed Development. The 5-year annual average ammonia level at the Fenn's Moss sampler has declined from 2.67 - 1.88μg/m^3 between 2020-2024 (AQA Table 4), an average annual change of -0.2μg/m^3, which is more than 9x the maximum PC using worst-case assumptions of 0.021μg/m^3 at the northern SAC boundary. Given the continuing mitigation measures to control agricultural ammonia emissions through the SNAP and Catchment Sensitive Farming, it is reasonable to expect further net reductions would occur through the lifetime of the Proposed Development.

Likely Significant Effect on SAC and Ramsar Site

Following consideration of the PAC from NRW, and after further consultation with Wrexham Council, a 'shadow' Habitats Regulations Assessment (HRA) will be prepared to assess the impacts of the Proposed Development on the SAC and Ramsar Site.

In terms of the Habitats Regulations, a PC in excess of 1% of the relevant environmental quality standard is normally regarded as a likely significant effect, requiring Appropriate

Assessment to determine if it is likely to represent an effect on site integrity. This is the case for ammonia levels at the nearest edge of the SAC (modelling point E1). However, as the predicted increase in ammonia levels will not exceed the 1% screening threshold at any qualifying features, or any features capable of restoration to qualifying features, there is no likelihood of any effect on site integrity as consequence of emissions to air by the Proposed Development.

In addition, when the inconsequential magnitude of effect is considered in the context of wider trends in ammonia levels, it is apparent that the Proposed Development will not delay a return to favourable condition of the SAC and Ramsar site. The targets for air quality in the SAC set out in Natural England's *Supplementary Advice for Conservation Objectives* and NRW's *Core Management Plan and Conservation Objectives* are to maintain nitrogenous pollutants at or below critical loads. The Proposed Development will not impede the achievement of this target.

Likelihood of damage to SSSI

No additional impacts are predicted on SSSI notified features, so it can be safely concluded that the Proposed Development does not constitute an operation likely to damage the special interest of the SSSI, or delay its return to favourable condition.

Significance of effects on Fenn's Rough ancient woodland

It should be noted that for environmental permitting purposes, the PC is well below the screening threshold for locally designated sites and ancient woodlands. IAQM advice for planning recommends using the 1% threshold, but interpreting the significance of results in terms of the level of policy protection afforded to the site.

In the case of this site, the relevant Wrexham Local Plan policy is NE3 (Trees, woodlands and hedgerows), which states *'Development will only be permitted where it does not cause unacceptable harm to trees, woodlands and hedgerows of significant public amenity, natural or cultural heritage value or those that provide important ecosystem services*.' Based on advice in NECR210 discussed above, and with reference to the magnitude of impact in the context of background levels, it can be concluded that emissions from the Proposed Development will not cause unacceptable harm to Fenn's Rough or other ancient woodlands in the vicinity.

5.7 In-Combination Effects

Following consultation responses set out in the PAC, a further search has been undertaken for new and proposed projects which could contribute to in-combination air quality effects.

The only development identified is the Whitchurch Biogas Ltd Anaerobic Digestion (AD) Plant (14/01398/MAW) located on the A525 approximately 5 km east of the Facility. This has been operational since approximately 2016 so any contribution it makes to ammonia concentrations and acid and nitrogen deposition will be in the background data used to inform the assessment and an in-combination assessment is not required for this development. As such, no potentially significant new or planned sources of ammonia or nitrogen deposition have been identified within 5 km of the Facility, so an in-combination assessment is not required.

It should be further noted, in considering the source attribution of emissions contributing to baseline pollutant levels and deposition rates, the AQA and this assessment have taken account of existing unregulated activities and operational consents.

6 Conclusions

Assessment of Impacts on Statutory Designated Sites

The Proposed Development is located 0.4km north-east (broadly 'downwind') of Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC, Ramsar site and SSSI. Dispersion and deposition modelling undertaken in the Air Quality Assessment predicted a small magnitude exceedance of screening thresholds for annual mean ammonia levels in the northernmost area of Fenn's Moss, within the boundaries of the designated sites.

A walkover survey and literature search confirmed that the areas affected by an >1% increase in ammonia levels do not currently support SAC, Ramsar site or SSSI qualifying or notified features. A small ca.1ha area has been bunded for rewetting and eventual bog restoration, but this currently supports dense regrowth of birch and willow. Following consultation with NRW, mitigation measures (increased stack height) have reduced the predicted process contribution below 1% at this location, and process contributions at all qualifying features, or areas capable of restoration to support qualifying features, can now be regarded as inconsequential.

The presence of trees and woodland around the margins of the northern part of the designated site means that ammonia emissions from the Proposed Development and agricultural sources in the surrounding area are likely to be intercepted, leading to lower than predicted impacts on sensitive habitats. Support for this inference is provided by reference to the lower values of monitored ammonia on the open bog relative to modelled levels at 1km grid square scale reported by APIS.

Measures aimed at reducing the major local source of ammonia from surrounding agricultural land through the SNAP and Catchment Sensitive Farming initiatives appear to be resulting in a trend of reducing ammonia levels on the designated site, with a realistic prospect of achieving the target of meeting the appropriate critical level. In this context, the small magnitude contribution from the Proposed Development is not likely to delay the return to favourable condition of site features, or impede air quality targets linked to the SAC / Ramsar site's Conservation Objectives. It is therefore suggested that the Competent Authority (Wrexham Borough Council) can safely conclude that there would be no likely significant effect on the SAC or Ramsar site as a consequence of the Proposed Development. It is also not likely to damage the special interest features of the SSSI. It therefore conforms to Wrexham Local Plan Policy NE1 for protection of internationally and nationally designated conservation sites.

Assessment of Impacts on Ancient Woodlands

A small magnitude exceedance of screening thresholds for nitrogen deposition and ammonia (in a planning context only) is predicted at Fenn's Rough ancient woodland, in circumstances where background deposition rates significantly exceed critical loads. This woodland is not identified by NRW as important for lower plant communities, and the 3μg/m^3 ammonia critical level is therefore appropriate; no exceedance of the critical level for ammonia is predicted.

This impact has been assessed in relation to the likely sensitivity of the woodland habitat to small increments in nitrogen deposition rates, with reference to Natural England commissioned research, and published research on ammonia-based nitrogen inputs on woodland habitats. It can be concluded that the magnitude of predicted impact in the context of high background deposition rates would not be likely to cause unacceptable harm to the ancient woodland resource, and therefore complies with Wrexham Local Plan Policy NE3.

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Appendix 1: Figures

Fig.1: Statutory Designated Sites and Ancient Woodlands (within 2km of emission source)

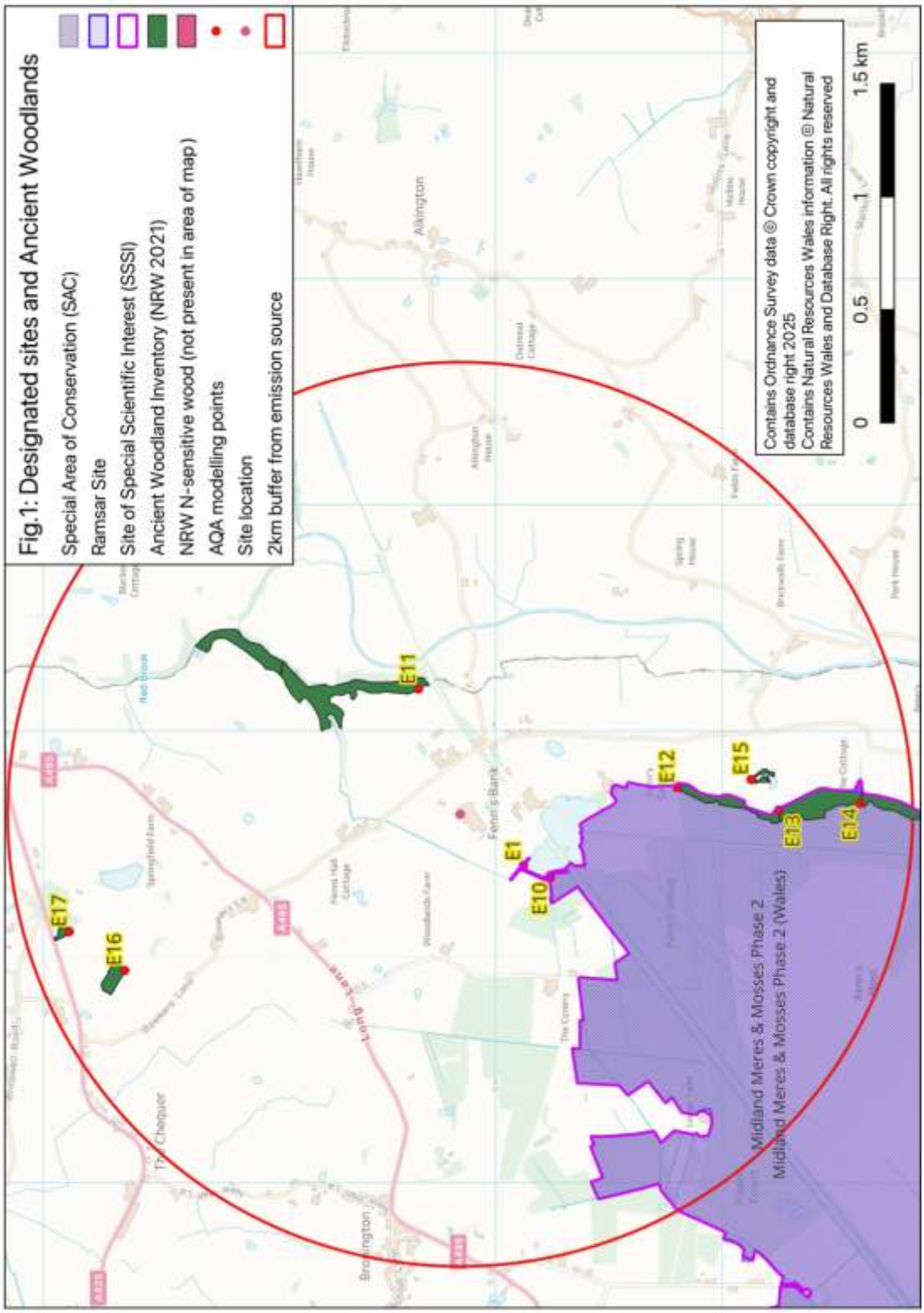
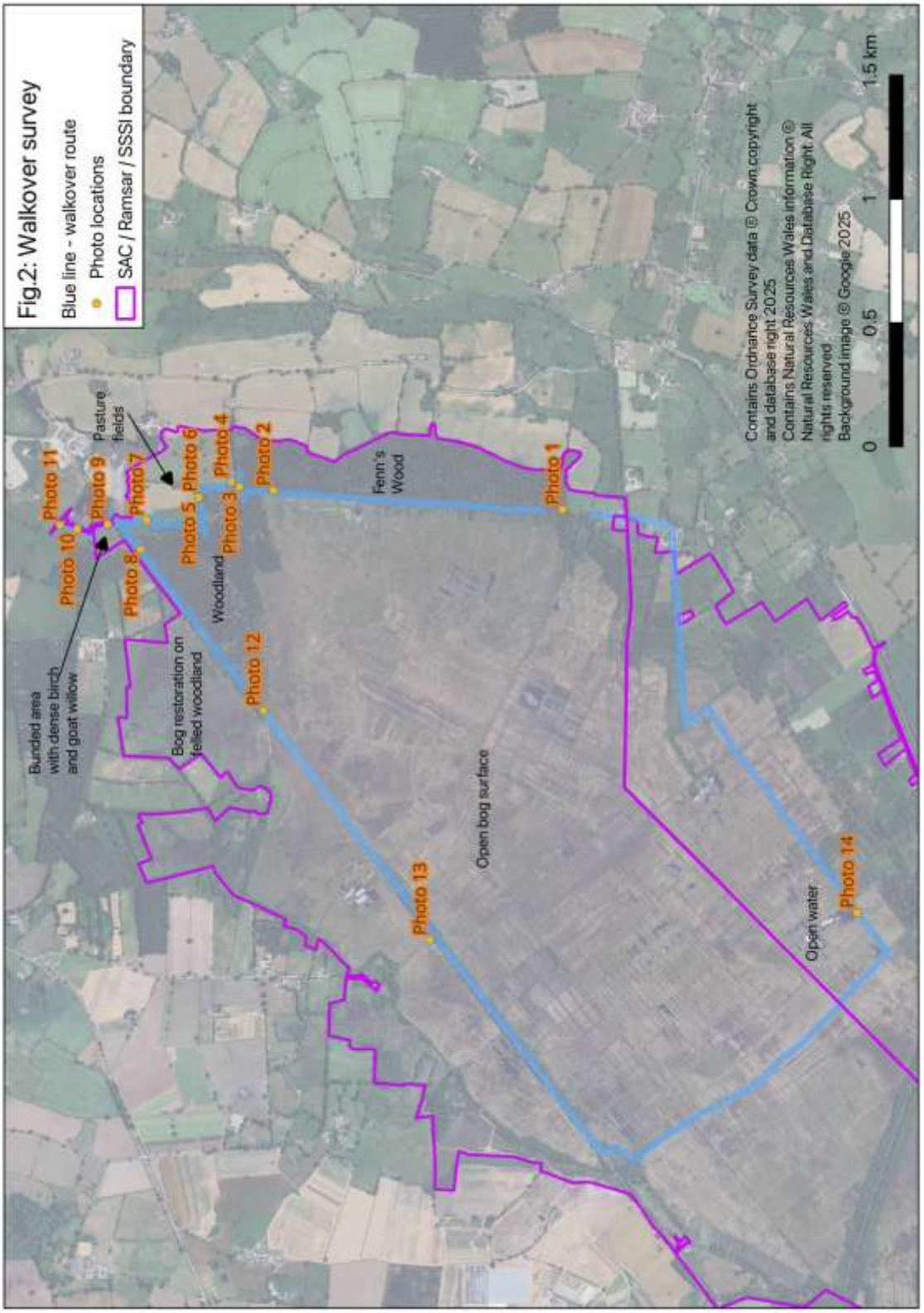


Fig. 2: Walkover Survey



Appendix 2: Walkover survey

A2.1 Introduction

A walkover survey was undertaken around the northern part of the Fenn's and Whixall Moss, using public footpaths, together with other permissive routes established within the National Nature Reserve.

The primary purpose of the survey was to confirm the habitats present within the northern part of the designated sites, particularly those areas where the AQA predicted a process contribution to ammonia levels in excess of the 1% screening threshold. This would in turn allow a better understanding of habitat sensitivity, and of factors which may mitigate or exacerbate any impacts of the Proposed Development. Other areas of the site were visited for contextual purposes, to include restored bog habitat.

A2.2 Methodology

The walkover was undertaken on 12 August 2025, between 16:35 and 19:42. A circular route of ca. 9.1km was walked, starting and ending at the Shed Yard car park at OS grid ref. 350380, 336810.

The route initially headed north, within the eastern part of the SAC. taking in accessible habitats within the Scenario 1 (emission limit values) 1% ammonia PC contour, and the Scenario 2 (seasonally varying) 1% contour. The route extended as far as modelling points E10 and E1 at the northern extremities of the designated site, before heading back south on the dismantled rail line close to the western designated site boundary.

The route then extended south along the dismantled rail line, outside the worst-case 1% ammonia contour, in order to encompass the core bog habitats within Fenn's Moss. The route then headed south-east across the national boundary onto Whixall Moss, before returning across the eastern edge of the site to the starting point.

Notes were made of habitats present at key points along the walkover route, with particular reference to those within the 1% ammonia contours. Representative geo-referenced photographs were taken at each stopping point. The relevant National Vegetation Classification (NVC) plant community, and European Nature Information System (EUNIS) habitat / nitrogen critical load class was identified where possible.

Constraints

The survey was limited to public rights of way and other permissive routes (i.e. marked trails within the National Nature Reserve); in particular, access is explicitly prohibited

to Fenn's Wood in the eastern and northern parts of the SAC. These could be adequately viewed for the purposes of the survey from adjoining public footpaths.

The timing of the survey was within the optimum seasonal period for visibility of flora, but too late to record the vernal component of woodland field-layer flora. Weather conditions were dry and warm during the survey, imposing no constraints.

Figure 2 (Appendix 1 above) shows the survey route and photograph locations.

A2.3 Habitats

Fenn's Wood (east edge of site)

The southern and eastern edges of Fenn's Wood are classed as ancient semi-natural woodland; the southern edge can be viewed from the public right of way (the 'Long Mile') which runs along the western boundary of the woodland.



Photo 1: Fenn's Wood south end, view 88^0 from 350436, 386870

The canopy in this area includes abundant Scots pine *Pinus sylvestris* with downy birch *Betula pubescens* and rowan *Sorbus aucuparia* forming an understorey. Bracken *Pteridium aquilinum* is abundant in the field layer, with bramble *Rubus fruticosus* dominating areas where shading from the pine canopy is less intense.

This area is slightly elevated above the peat basin, and supports an essentially terrestrial woodland habitat. The canopy has been modified by planting, but the bracken - bramble field layer is indicative of NVC plant community W10 (oak - bracken - bramble woodland), equivalent to EUNIS level 5 class T1E11 Mixed Atlantic *Quercus* forests with *Hyacinthoides non-scripta*. This in turn falls within the EUNIS level 3

category and nitrogen critical load class T1E *Carpinus* and *Quercus* mixed deciduous forest.



Photo 2: Fenn's Wood northern part, view 99^0 from 350513, 338036

Further north the pine canopy gives way to mature Norway spruce *Picea abies*, with bracken remaining abundant in the field layer. In one area a ride is dominated by purple moor-grass *Molinia caerulea*, typical of more acidic soil conditions and indicating this is part of the peat basin. Canopy modification makes identification of the woodland plant community difficult, and the plantation has likely led to significant drying of underlying peat and invasion of terrestrial species such as bracken. If restored to a more natural canopy, it would most likely develop as a NVC W4 downy birch - *Molinia* woodland (EUNIS level 3 class T16, Broadleaved mire forest on acid peat), which is part of the EUNIS level 2 T1 Deciduous broadleaved forest nitrogen critical load class.

The northern edge of Fenn's Wood has a dense, mature Norway spruce canopy, with a dense bracken field layer. Photo 3 overleaf is taken just within the Scenario 1 1% ammonia contour. At this point it is not possible to identify the appropriate plant community, although with respect to location and topography it can be assumed that the area is within the eastern boundary of the peat basin.



Photo 3: North end of Fenn's Wood, view 149^0 from 350526, 338174

Grassland at NE corner of SAC

The north-eastern corner of the SAC consists of two fields, which are crossed by the 1% Scenario 2 ammonia contour. The easternmost field is a cattle grazed pasture with occasional mature oak trees, accessible by means of a public footpath.



Photo 4: Cattle-grazed pasture, view 13^0 from 350547, 338206

The field was quite lightly grazed by cattle at the time of survey, with many grasses having flowered. The sward included abundant Yorkshire fog *Holcus lanatus* with creeping bent *Agrostis stolonifera*, common bent *Agrostis capillaris*, patches of soft rush *Juncus effusus* and very occasional hard rush *Juncus inflexus*. A small area of disturbed ground allowed confirmation that the grassland was overlying peat, but was very dry at the time of survey and likely heavily modified by agricultural use. The land rises noticeably at the eastern edge of the field, indicating the likely north-eastern

extent of the peat basin. In terms of plant community, this appears to be an example of EUNIS level 3 habitat R21 Mesic permanent pasture of lowlands and mountains; as it appeared herb-poor with significant agricultural improvement, it fits broadly within the NVC MG6 ryegrass - crested dog's-tail community, equivalent to EUNIS level 5 habitat R2111 ryegrass pastures.



Photo 5: Pasture, view 338^{0} from 350484, 338338

The western field was ungrazed at the time of survey. Viewed from the adjoining right of way, the main part of the field supported abundant common bent and Yorkshire fog, with cock's-foot *Dactylis glomerata* and ryegrass *Lolium perenne*. Soft rush was very scattered, indicating relatively dry conditions (although apparently established within the peat basin). A trampled area adjoining a field gate held abundant ryegrass and creeping bent, with docks *Rumex spp.* and stinging nettle *Urtica dioica*. This clearly had affinities for EUNIS R2111 ryegrass pastures, with significant agricultural improvement.

North end of woodland

The woodland in the northern part of the SAC lies partly within the 1% Scenario 1 ammonia contour. The photograph below is taken from the northern edge of the woodland to the south-west of the two fields. The canopy is composed of alder *Alnus glutinosa* and birch *Betula spp.* with dense bracken and brambles in less shaded areas.

In terms of plant communities, despite being located on the peat basin, it's flora is typical of an NVC W10 / EUNIS T1E mesotrophic woodland community.



Photo 6: Northern woodland, view 198^0 from 350488, 338334

The far northern tip of the woodland supports a very dense canopy with abundant wild cherry *Prunus avium*, with a dense understory and field layer of rowan, hawthorn *Crataegus monogyna* and hazel *Corylus avellana*. The field layer includes dense bramble, stinging nettles and bracken, with ivy *Hedera helix* abundant in the ground layer and as a climber.



Photo 7: Northern woodland, view 270^0 from 350392, 338548

This also falls within the EUNIS level 3 T1E *Carpinus* and *Quercus* mixed deciduous forest community, with indicators of mesotrophic to eutrophic nutrient status such as brambles and stinging nettle in the field layer.

The western edge of this woodland block adjoins a disused rail line. The photograph below shows a typical species composition in the area within the 1% Scenario 1 ammonia contour. The canopy mostly comprises silver birch *Betula pendula* and oak

Quercus sp. with a bracken-dominated field layer. In terms of woodland habitat, this is more representative of woodland developed over dry peat, with fewer signs of elevated nutrient levels compared to other parts of this and other woodlands. In terms of habitat, it can be viewed as a drier modification of EUNIS level 3 class T16, (Broadleaved mire forest on acid peat), which is part of the EUNIS level 2 T1 Deciduous broadleaved forest nitrogen critical load class.



Photo 8: Northern woodland, view 160^0 from 350274, 338571

Regenerating woodland



Photo 9: Young regenerating woodland, view 232^0 from 350375, 338704

An area of regenerating woodland of just over 1ha is located near the northern apex of the SAC. It comprises dense birch and grey sallow *Salix cinerea* on low lying ground which has been bunded to encourage rewetting. It is not possible to determine the plant community or EUNIS habitat at this stage of development.

Northernmost extents of designated site

The SAC / Ramsar extends northwards between air quality modelling points E10 and E1. This is a narrow (<8m) strip of land consisting of an overgrown grassy trackway supporting rank false oat-grass *Arrhenatherum elatius* grassland with bramble, nettle, creeping thistle *Cirsium arvense* and hogweed *Heracleum sphondylium*. The trackway is lined with shrubs and trees including alder, oak and elder *Sambucus nigra*.



Photo 10: Rank neutral grassland with shrubs, view 27^0 from 350358, 338827

In terms of plant community and habitat, this is an example of NVC MG1 *Arrhenatherum elatius* grassland / EUNIS level 5 habitat R2211 Atlantic *Arrhenatherum* grasslands, a mesotrophic grassland community.



Photo 11: Rank grassland with trees, view 330^0 from 350373, 338897

Tall herbs and brambles become more frequent at the northernmost extremities of the SAC, as shown in the photograph above looking north-west from near modelling point E1.

Raised bog habitats

To the north-west of the dismantled rail line, an area of formerly forested land (shown on OS maps as Maelor Forest) has been felled and bunded, apparently for re-wetting and encouragement of bog regeneration. The main open area of Fenn's Moss is located on the south-east of the rail line, and extends south from the edge of the woodlands at the location of Photo 12 below:



Photo 12: Northern edge of open bog, view 138^0 from 349623, 338076

Bog habitats to the north-west of the rail line appear to be dominated by *Molinia*, which is associated with slightly drier and more nutrient-rich habitats - this is illustrated in Photo 13 overleaf. *Molinia* appears to be abundant across all parts of the route; however higher quality, wetter bog habitats are associated with the main central area of Fenn's Moss, and adjoining areas of Whixall Moss across the English border. There are areas of wet bog with common cotton-grass *Eriophorum angustifolium*, and a large pool (see Photo 14).



Photo 13: Restored bog NW of rail line, view 19^0 from 348700, 337405



Photo 14: Pool on Whixall Moss, view 335^0 from 348808, 335680