# Appendix A12.5: Ecology Air Quality Assessment

## 1.1 Introduction

1.1.1 This appendix presents the methodology and results of the assessment of potential effects of air quality changes at sites of biodiversity importance resulting from the operation of the proposed scheme (Chapter 6: Proposed Scheme). The assessment considers statutory and non-statutory designated sites, ancient woodland (AW) and veteran trees within 200m of the Affected Road Network (ARN) for the proposed scheme where it is predicted that nitrogen (N) deposition would increase beyond threshold levels set out in the Design Manual for Roads and Bridges (DMRB) LA 105: Air Quality (Highways England et al., 2019).

1.1.2 This appendix is structured as follows:

- The methodology is described in Section 1.2;
- Results of screening (as part of the Air Quality assessment) are reported in Section 1.3;
- The possible effects of increased N deposition, informed by a literature review of scientific evidence, are explored in Section 1.4; and
- The detailed assessment is presented in Section 1.5.
- Results of ecological site investigations to support the assessment are provided in Annex 1.

## 1.2 Methodology

1.2.1 The ecological assessment of the effects of N deposition resulting from the proposed scheme accords with the requirement of the DMRB standard LA 105: Air Quality (Highways England et al., 2019) and LA 108 Biodiversity (Highways England et al., 2020).

1.2.2 The assessment methodology also refers to the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine Version 1.3 (CIEEM, 2018). The professional judgement of a competent expert for biodiversity has been applied to the assessment of impact level and significance as per DMRB LA 108 and CIEEM (2018).

1.2.3 The assessment comprises the following elements:

- desk study to identify biodiversity resources for consideration;
- screening assessment to identify sites for assessment of the effects of N deposition (including ammonia $NH_3$);
- site investigation to inform assessment of N deposition; and
- assessment of ecological significance of N deposition.

**Desk Study**

1.2.4 DMRB LA 105 (Highways England et al., 2019) requires an assessment on biodiversity resources of international, national and local conservation importance within 200m of the

ARN. The ARN is defined in Chapter 8 (Air Quality) following the application of the scoping criteria within DMRB LA 105 and is illustrated in Figure 12.16

1.2.5 An assessment of air quality impacts from construction traffic was scoped out because the estimated additional construction related traffic (as annual average daily traffic) was below the DMRB LA 105 screening thresholds, therefore the increase in nitrogen dioxide ($NO_2$) was negligible and air quality effects were considered to be not significant.

1.2.6 Biodiversity resources within the 200m study area of the operational ARN were identified as part of the desk study for the proposed scheme (Chapter 12: Biodiversity), with veteran trees further identified through site surveys (Appendix A10.8: Arboriculture Assessment).

1.2.7 The following biodiversity resources were considered:

- Ramsar sites;
- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC);
- Sites of Special Scientific Interest (SSSI);
- Ancient Woodland Inventory (NatureScot, 2023);
- veteran trees (Woodland Trust, Not Dated); and
- ancient trees (Woodland Trust, Not Dated).

1.2.8 The following resources were identified within 200m of the proposed scheme's ARN:

- River Tay SAC (NatureScot, Not Dated) (NatureScot site code 8366, EU site code UK0030312);
- AW; and
- veteran trees.

1.2.9 Hereafter, the resources included in the assessment are referred to as 'sites'. The locations of all sites considered in the screening assessment are shown in Figure 12.16 of this report, as well as Figure 8.2 (Air Quality Assessment: Designated Habitat).

1.2.10 For AW, the NatureScot Ancient Woodland Inventory (AWI) (NatureScot, 2023) was refined following desk study and site surveys to create a verified AWI layer for use in the assessment. The approach to determining this dataset is outlined in Appendix A12.6 (Woodland Strategy). The different categories of ancient woodland are described in Table A12.5-1. These have been defined, where possible, for the sites.

**Table A12.5-1 Ancient woodland descriptions (NatureScot, 2023)**

| Type of Ancient Woodland | Description |
|---|---|
| Ancient woodland of semi-natural origin | Interpreted as semi-natural woodland from maps of 1750 (1a) or 1860 (2a) and continuously wooded to the present day. If planted with non-native species during the 20th century they are referred to as Plantations on Ancient Woodland Sites (PAWS). |
| Long-established woodland of plantation origin (LEPO) | Interpreted as plantation from maps of 1750 (1b1) or 1860 (2b) and continuously wooded since. Many of these sites have developed semi-natural characteristics, especially the oldest ones, which may be as rich as AW. |
| Other woodland on 'Roy' woodland sites. | Shown as unwooded on the 1st edition maps but as woodland on the Roy maps. Such sites have, at most, had only a short break in continuity of woodland cover and may still retain features of AW. |

1.2.11 Further information on the current status and condition of AW was gained from aerial imagery and site visits (see Appendix A12.3: Detailed Survey Methods and Baseline Data and A12.6: Woodland Strategy).

1.2.12 Forestry plans were referred to for information on woodland management proposals within the proposed scheme and wider area. The Craigvinean Land Management Plan (Forestry and Land Scotland, 2020), which provides details of current and future forestry management for FLS land, covers four management coupes: Hermitage and Ladywell, Dalmarnock and Inverwood, Dalguise, and Creag Dhubh and Elrick More. A large part of the study area is covered by this land management plan, specifically within the Hermitage and Ladywell and Dalmarnock and Inverwood coupes. An updated felling plan was provided by FLS for woodlands within the Birnam Pass area which falls within the Hermitage and Ladywell and Dalmarnock and Inverwood coupes (FLS, 2024). The remainder of woodland within the proposed scheme falls under the Murthly and Strathbraan Estate Long Term Forest Plan (Scottish Woodlands, 2024).

1.2.13 The assessment of ecological effects of increased nitrogen deposition takes into account the site history (where known), current status and management practices. For example, ancient woodlands of semi-natural origin that are classified as Plantations on Ancient Woodland Sites (PAWS) may have been planted with conifers for many decades and undergone such significant disturbance that they no longer function as natural woodland ecosystems. It is questionable whether a coniferous woodland critical load should be applied to PAWS, as these presumably were once broadleaved deciduous woodland. Furthermore, there has been discussion over the most appropriate critical load for managed conifer plantation, with 12kg/ha/yr being suggested by Hall et al. (2015). The critical loads for managed conifer plantations are set to protect the soil on the basis that there is little ground vegetation present under most managed conifer plantations in the UK (Forestry Research, Undated). Furthermore, it is likely that management practices will have more impact on the vegetation than pollution inputs. However, in the absence of definitive guidance on how to assess managed plantations, particularly those on ancient woodland sites, this assessment adopts a precautionary 3kg N/ha/yr for all coniferous woodlands, in accordance with Bobbink et al. (2022).

1.2.14 For veteran and ancient trees, data gathered during the arboricultural survey was consulted where available (Appendix A10.8: Arboricultural Assessment). This included information on the tree species and presence of fungi and lichens.

**Screening**

1.2.15 The approach to quality modelling for ecological receptors is described in Chapter 8: Air Quality.

1.2.16 Screening incorporated the steps in the flow diagram, Figure 2.98, in DMRB LA 105 as follows:

- calculate the Do-Minimum (DM) and Do-Something (DS) Scheme N deposition;
- is the total N deposition with the proposed scheme less than the applicable lower critical load (LCL)? (The applicable LCL is for the habitat for which the site is designated and /or that is most sensitive to N). If yes, then the site is screened out as not significant. If no, then screening proceeds to the next step;
- is the change in N deposition with and without the proposed scheme less than 1% of the LCL? If yes, then the site is screened out as not significant. If no, then screening proceeds to the next step;
- identify whether the site air quality attribute is either restore or maintain[1];
- if 'restore' – use the lowest change in N deposition regardless of background N deposition which would bring about a change of a loss of one species corresponding to the LCL[2]; and
- is the change in N deposition associated with the proposed scheme likely to lead to the loss of one species? If no, then the site is screened out as not significant. If yes, then the next step is to undertake a site investigation (detailed in Section 1.2).

1.2.17 The lowest change in N deposition which would bring about a change of a loss of one species is derived from Table 21 in Caporn et al. (2016). This table provides data for a limited range of habitats, none of which correspond with the sites in this assessment. Therefore, as instructed in DMRB LA 105, a figure of 0.4kg N/ha/yr is used to indicate the lowest change in N deposition likely to lead to the loss of one species in any of the habitats in Table 21, excluding nutrient impoverished sand dunes.

1.2.18 The critical load ranges for specific habitats were obtained from the Air Pollution Information System (APIS, Not Dated) and from recent review of critical loads for N (Bobbink et al., 2022). Site relevant critical loads are available on APIS for SSSIs and for internationally important sites such as SACs. The AW sites and veteran/ancient trees in this assessment do not have site relevant critical loads and were assigned as either broadleaved deciduous woodland (10-20kg N/ha/yr) or coniferous woodland (3-15kg N/ha/yr).

[1] Air quality attributes are not routinely published for sites other than those designated at a European level and therefore, in line with DMRB LA 105, all sites except the River Tay SAC were assumed to have a 'restore' attribute.
[2] The lowest change in N deposition is derived from Table 21 in Caporn et al. (2016).

1.2.19 The locations of transects for modelling were agreed with the Air Quality team (Chapter 8: Air Quality). The transect locations modelled in this assessment are shown on Figure 8.6 (Air Quality Assessment: Operational Ecological Assessment Results) and Figure 12.16 (Ecology Air Quality). Each transect was formed of lines of model receptor points at 10m intervals extending into the habitat, as required by DMRB LA 105.

1.2.20 Sites were screened in for further assessment where the N deposition in the DM and DS scenarios was greater than 1% of the relevant LCL for the site and greater than 0.4kg N/ha/yr.

**Site Investigation**

1.2.21 UK Habitat Classification (UKHab) surveys were undertaken in August-September 2020, June-October 2021, May-June 2022, and August and October 2024. All habitats in and within a 50m buffer of the scheme footprint were mapped. All habitats were described and mapped according to the UK Habitat Classification (UKHab Ltd, 2023), and condition assessments were undertaken. Condition assessment was undertaken directly in the field where possible, and during post-survey analysis using detailed survey notes, photos and professional judgement where necessary. The minimum mapping unit (MMU) used was 400m$^2$ due to the large extent of habitat to be surveyed (please refer to Appendix A12.3: Detailed Survey Methods and Baseline Data). The UKHab survey data have been used to identify biodiversity resources potentially sensitive to N deposition that could be affected as a result of the proposed scheme.

1.2.22 The results of the site investigations were used, along with desk study data, to inform the assessment of significance of effects from N deposition on sites.

**Assessment**

Determination of importance

1.2.23 The importance of the sites has been determined using Table 3.9 in LA 108 Biodiversity (Highways England et al., 2020).

1.2.24 The following geographic levels of importance have been assigned:

- international importance – River Tay SAC; and
- national importance – SSSI and irreplaceable habitats, including AW, veteran trees and ancient trees.

Characterisation of impacts

1.2.25 Table 3.11 of DMRB LA 108 describes the different levels of impact (from no change to major) and the key criteria are in relation to the permanence/reversibility of the impact and whether or not there is considered to be an effect on integrity or on the key characteristics of the ecological resource (as determined by assessment of duration, reversibility, extent, magnitude, frequency and/or timing of the impact).

1.2.26 According to DMRB LA 108, and in line with CIEEM guidance (CIEEM, 2018), level of impact is determined by assessment of the following characteristics: positive or negative (e.g., adverse/beneficial); duration (e.g., permanent/temporary); reversibility (e.g., irreversible/reversible); extent; magnitude; frequency; and timing.

*Positive or negative impacts*

1.2.27 Positive impacts are characterised by a decrease in N deposition. It is possible that modelling might predict that some sites will experience a DS N deposition that is lower than DM and therefore a potential beneficial effect. However, these resources are not screened in for ecological assessment and so are not considered here.

1.2.28 In accordance with DMRB LA 105, only sites with the potential to be negatively impacted as a result of the increase in N deposition from the proposed scheme have been screened in for further ecological assessment. Negative impacts are characterised by an increase in N deposition.

*Duration and reversibility*

1.2.29 The duration of impact was estimated by calculated by modelling road traffic nitrogen oxides ($NO_x$) emissions for the proposed year of opening (2036) and design year (2051); 15 years after the scheduled opening). For the nearest road traffic links for each transect, the emission results were interpolated between the opening and design years for the proposed scheme scenarios to obtain emissions in the intervening years. Where the future years with proposed scheme emissions fall to become equal to the opening year without the scheme emissions, this interval was taken as the duration.

1.2.30 The transition to electric, particularly of cars and vans, influences duration and reversibility, because emissions of $NO_x$ and $NH_3$ from road transport will continue to reduce in the future. The effect of the DS scenario is therefore to delay rather than reverse the future predicted decreases in the road contribution. Given that the effects of increases in N deposition are not always detectable in terms of changes in vegetation composition and habitat structure and require long-term exposure to generate change (Caporn et al., 2016), it is possible that even a long-term increase in N deposition may not result in a permanent effect on the integrity of a site. Many ecosystem changes due to long-term levels of N deposition are theoretically reversible but may require intervention through habitat management to remove biomass, nutrient loading and competition from dominant species from the system (Dise et al., 2011). Recovery from long-term N deposition is ill-understood (Clark et al., 2013) and it is unclear to what extent recovery from long-term deposition is possible.

1.2.31 In view of the aforementioned, and given that critical loads for N deposition are based on an assumed exposure over a period of 20 – 30 years, for this assessment it is considered that impacts of duration of 15 years or more are permanent and irreversible because it is not known how much longer beyond 15 years the impact is likely to persist. Impacts of less than 15 years are considered temporary and could result in effects that are reversible. However, it is recognised that the magnitude of N deposition could influence the reversibility of an effect, although this will also be influenced by factors such as background N deposition loading (Caporn et al, 2016), baseline site condition and management and external pressures (Bobbink et al, 2010; Dise et al., 2011). Where information is limited or there is any uncertainty in terms of impact level, a precautionary approach has been adopted and it is assumed that the impact is irreversible. The individual site assessments explain the rationale for determination of reversibility.

*Extent*

1.2.32 For sites screened in for ecological assessment, the extent of impact has been estimated from the results predicted at modelled points (at 10m intervals) along a transect, which extend up to 200m from the ARN. For each transect, the first point at which N deposition falls below 0.4kg/N/ha/yr was identified and used as the maximum distance at which there may be ecological effects of N deposition. This approach is considered suitably precautionary as the magnitude of N deposition within the affected area is not constant across the whole area because deposition decreases with distance from the emission source and any effects due to increased N deposition are most likely to be evident closer to the road.

*Magnitude*

1.2.33 The output of the air quality modelling helps to quantify the magnitude of impact. Although the thresholds of 1% of the lower critical load and 0.4 kg/N/ha/yr are used to screen designated sites and habitats for further ecological consideration by a competent expert in biodiversity (in line with DMRB LA 105), the predicted quantities of N deposited on the sites under consideration vary, as does the baseline N deposition.

1.2.34 A Natural England commissioned report NECR210 (Caporn et al, 2016) on the effects of increments of N deposition on semi-natural habitats reported that the habitats studied showed strong curvi-linear responses to increased deposition at varying background nitrogen loads, indicating a more rapid species loss at lower levels of deposition. Where levels of N deposition are at or above the upper end of a habitat’s critical load, any additional increments of long-term nitrogen are associated with further declines in species-richness, affecting site structure and composition. However, the incremental effect of long-term N deposition reduces as deposition levels increase above the upper end of the critical load for a habitat. Less polluted sites were therefore more sensitive to increases in N deposition, whereas sites already receiving high levels of N deposition had already experienced a loss in species diversity. The magnitude of N deposition at affected sites is therefore considered in relation to the baseline, DM and DS values.

1.2.35 This key relationship between extent and magnitude of impact, and the influence of baseline habitat condition on this impact is critical at a site-specific level in considering how the site’s integrity may be affected. The narrative around these considerations, based on the air quality modelling data and site baseline, and the professional judgement of a competent expert in biodiversity, is set out in the conclusions section of this document. This will consider whether the structure and function of the affected area is maintained, whether connectivity between the affected area and the wider designated site or habitat is maintained, and whether the quality of the habitat within the affected area and the wider designated site or habitat is comparable to baseline conditions (Balla et al., 2013).

*Frequency*

1.2.36 Given that N deposition is ongoing throughout the operational phase, and is measured in units of kg per hectare per year, frequency is categorised as 'annual' for all sites.

*Timing*

1.2.37 As described in paragraph 1.2.36, N deposition continues throughout the operational phase of the proposed scheme. Therefore, timing is described as 'ongoing' for all sites.

Determination of impact level and significance

*Impact Level*

1.2.38 Impact level is defined in Table 3.11 of DMRB LA 108 (reproduced in Table A12.5-2). In order to make assessments of effects on integrity or key characteristics of a resource, it is critical to define what they mean.

1.2.39 Integrity is defined as *"the coherence of a site's ecological structure and function across its whole area"* (European Commission, 2019). In assessing the potential for effects on integrity, it is helpful to understand the processes and interactions on which the biodiversity features of the site depend. Ecological interactions are multiple and complex and therefore the assessment of effect on integrity relies heavily on professional judgement. The potential for an effect on site integrity is dependent on extent of impact, the magnitude of the predicted increase in N deposition and the duration of impact, as higher increases in N deposition for an extended period are more likely to result in changes in vegetation composition that may constitute an effect on integrity.

1.2.40 Although the assessment is based on the modelled results for transects in different sites, as defined by polygons mapped on the AWI, the sites are part of a forested landscape and therefore effects on integrity are considered on this larger scale, rather than at the scale of the individual site and its modelled transect.

1.2.41 For veteran trees, integrity is considered with respect to the individual tree itself and not to the assemblages that it supports, such as lower plants or invertebrates. The key characteristics of a veteran tree are considered to include its age, size, structure and presence of dead and decaying wood, all of which are physical characteristics which are not likely to be affected by N deposition. Further detail on the assessment of veteran trees is given below.

**Table A12.5-2: Impact level reproduced from Table 3.11 of DMRB LA 108**

| Level of Impact (Change) | | Typical Description |
|---|---|---|
| **Major** | Adverse | ▪ Permanent/irreversible damage to a biodiversity resource; and |
| | | ▪ the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| | Beneficial | ▪ Permanent addition of, improvement to, or restoration of a biodiversity resource; and |

| Level of Impact (Change) | | Typical Description |
|---|---|---|
| | | ▪ the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| **Moderate** | Adverse | ▪ Temporary/reversible damage to a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| | Beneficial | ▪ Temporary addition of, improvement to, or restoration of a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource |
| **Minor** | Adverse | ▪ Permanent/irreversible damage to a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| | Beneficial | ▪ Permanent addition of, improvement to, or restoration of a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| **Negligible** | Adverse | ▪ Temporary/reversible damage to a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| | Beneficial | ▪ Temporary addition of, improvement to, or restoration of a biodiversity resource; and |
| | | ▪ The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource. |
| **No change** | | ▪ No observable impact, either positive or negative |

*Significance*

1.2.42 A matrix for determining the significance of effects is presented in Table 3.13 of DMRB LA 108 and reproduced in Table A12.5-3. In accordance with approach adopted in the EIA for the proposed scheme, effects that are moderate, large or very large are considered significant.

**Table A12.5-3: Matrix for determining significance of effect reproduced from Table 3.13 of DMRB LA 108.**

| | | **Level of Impact** | | | | |
|---|---|---|---|---|---|---|
| | | **No Change** | **Negligible** | **Minor** | **Moderate** | **Major** |
| **Resource Importance** | **International or European Importance** | Neutral | Slight | **Moderate** or large | **Large** or **very large** | **Very large** |
| | **UK or National Importance** | Neutral | Slight | Slight or **moderate** | **Moderate** or **large** | **Large** or **very large** |
| | **Regional Importance** | Neutral | Neutral or slight | Slight | **Moderate** | **Moderate** or **large** |
| | **County or equivalent authority Importance** | Neutral | Neutral or slight | Neutral or slight | Slight | Slight or **moderate** |
| | **Local Importance** | Neutral | Neutral | Neutral or slight | Neutral or slight | Slight |

*Precautionary approach*

1.2.43 The precautionary approach has been adopted throughout the assessment, with precautionary measures built into the N deposition model described in Chapter 8 (Air Quality), and the adoption of the 'restore' threshold in this assessment, which a conservative 0.4kg N/ha/yr threshold for screening sites in for assessment (in accordance with DMRB LA 105).

1.2.44 Where there is a choice of more than one significance category (Table 3.13 of DMRB LA 108), the presumption is to assume the lower level category, on account of all the precautionary measures already adopted and listed here. However, on occasions where it is considered appropriate to select the higher level category, rationale is given. Where the choices are 'neutral or slight' the selection makes no difference to the outcome of the assessment of 'not significant'. Similarly, where the choice is between 'moderate or large' or 'large or very large' the resulting assessment will be 'significant'.

<u>Limitations</u>

1.2.45 UKHab surveys were undertaken up to 50m from the proposed scheme (see paragraphs 1.2.21-1.2.22 and Appendix A12.3: Detailed Survey Methods and Baseline Data), therefore there are transects, and parts of transects, that fall outwith the scope of these habitat surveys. However, with detailed review of desk-based information, including aerial imagery, woodland management plans and other data sources (see paragraph 1.2.8) the lack of survey data is not considered to be a limitation to the assessment. Similarly, not all trees were subject to detailed arboricultural surveys (ATI_1 and ATI_5, were not surveyed). However, as the air quality assessment considers the ancient/veteran tree as a biodiversity resource in its own right, rather than based on the specific lichen/fungi/mosses it supports, the absence of arboricultural data on these two trees is not considered to be a limitation to the assessment.

## 1.3 Results of Screening

1.3.1 The results of screening are presented in Table 8.13 of Chapter 8: Air Quality. The predicted ($NO_2$ and $NH_3$) total deposition rate exceeds 1% of the lower critical load and the 0.4kg N/ha/year threshold at 27 sites:

- Ancient trees: ATI_1;
- Veteran trees: ATI_5, BT_1, BT_2 , BT_3, BT_4, BT_5, BT_6; and
- Woodland listed on the AWI: ECO_A , ECO_C, ECO_D, ECO_E, ECO_H, ECO_I, ECO_J, ECO_K, ECO_M, ECO_N, ECO_P, ECO_R, ECO_U, ECO_X, ECO_Y, ECO_Z, ECO_AB, ECO_AC and ECO AH.

1.3.2 All other receptors were screened out for potential impacts. A summary of the sites and the modelling outputs is provided in Table 8.13 in Chapter 8 (Air Quality) (also see Figure 12.16).

1.3.3 River Tay SAC was scoped out of the assessment because it is not considered sensitive to N deposition. The site relevant critical load for the SAC given on APIS is 2-10kg N/ha/yr (APIS, Not Dated). However, this is for 'Permanent oligotrophic lakes, ponds and pools (including soft water lakes)' and it is noted that: *"This critical load only applies if the interest feature is associated with soft water oligotrophic or dystrophic lakes at the site. If the feature is not depending on these lake types, there is no comparable critical load available".* The habitat-specific information on APIS acknowledges that N deposition could have ecological impacts on rivers and streams, but that N inputs from catchment land-use, not deposition from the atmosphere, are likely to be much more significant (Strong et al. 1997, Smith & Stewart 1989, Foy et al. 1982). As a result, no critical load estimate is provided for rivers and streams and the site relevant critical load given for River Tay SAC is not applicable because it does not support soft water oligotrophic or dystrophic lakes .

## 1.4 Potential ecological effects of nitrogen deposition

**Introduction**

1.4.1 This section presents the current knowledge of the potential effects of N deposition on the habitats present within the sites screened in for assessment. Scientific research on the effects of N deposition on terrestrial ecosystems has been ongoing in Europe for decades and underpins the determination of critical loads for different habitats. There are a number of published papers and reports that review the current scientific understanding , both in general e.g., Bobbink et al. (2010), Clark et al. (2013) and UKREATE (2007) and with particular reference to roads, e.g., Bignal et al. (2004) and Natural England (2016). Reports published by the Institute of Air Quality Management (IAQM) (2020) and CIEEM (2021) provide guidance on the ecological assessment of air quality impacts.

1.4.2 N deposition affects terrestrial biodiversity and vegetation through four primary mechanisms:

- eutrophication (nutrient enrichment);
- acidification of soil;

- exacerbation of secondary stresses such as frost, drought tolerance and herbivory; and
- direct toxicity at high concentrations close to emissions sources (particularly bryophytes and lichens).

1.4.3 The effects of N deposition are mediated through complex interactions between biotic and abiotic factors. Clark et al. (2013) explains that the magnitude and nature of effects on ecosystems are extremely variable and depend on interactions between other factors such as climate, disturbance and vegetation composition. This means that attributing observable vegetation change to N deposition alone is extremely difficult. In line with DMRB LA 105, the focus of this assessment is the potential for change in vegetation composition and therefore does not specifically address the mechanisms listed above, although these may themselves be the cause of changes in vegetation composition.

**Potential effects of nitrogen deposition on veteran and ancient trees**

1.4.4 There is no critical load as such for veteran trees. In this assessment they have been assigned the critical loads for broadleaved and coniferous woodland depending on the species of the tree and surrounding habitat. There is little scientific literature on the specific impacts of N deposition on veteran trees however there is evidence that oak foliage, compared with other tree species, loses resistance to pests following N deposition (Jones et al., 2008).

1.4.5 Veteran and ancient trees often support lower plant communities that are susceptible to changes in N deposition e.g., lungworts (*Lobaria* spp.) and beard lichens (*Usnea* spp.). Lichens on trees provide shelter, food and vital micro-habitats for invertebrates. Lichens also contribute to wider ecosystem services, including carbon cycling and water retention.

**Potential effects of nitrogen deposition on woodland**

1.4.6 All of the sites under consideration in this assessment are AW and either assigned critical loads associated with broadleaved woodland or coniferous woodland. The critical load takes into account the sensitive lower plant communities often present in woodland and potential changes in soil chemistry from N deposition.

1.4.7 N deposition is not believed to have a direct, major effect on tree growth in the UK, but it has a variety of indirect effects. Nitrogen can affect woodlands through eutrophication and acidification which can make the habitat vulnerable to a range of indirect injurious effects. The different components of woodland ecosystems have different sensitivities to nitrogen and respond in different ways. Tree species form the canopy layer, with an under storey of woody shrubs and a ground layer of forbs and grasses, often with lower plants such as mosses and lichens carpeting the forest floor. Below ground there are mycorrhizal fungi associated with plant roots which are especially sensitive to N deposition (but the effects won’t be seen unless specialist surveys are undertaken). In addition, the trees may support epiphytic communities of bryophytes and algae. The structural complexity of woodlands means that they provide a diverse habitat for wildlife, especially insects, birds and small mammals. N deposition can compromise this biodiversity value through changes in cover (protection), food type, quantity and quality, changes in the overall environment for predators, and timing of food source availability via effects on phenology (bud burst, bud set, flowering).

1.4.8 Woodlands tend to intercept large amounts of dry and wet N deposition compared to less "rough" surfaces (e.g. grasslands; Bobbink et al., 2010). This is particularly the case for woodland edges, which experience the highest N deposition, especially where there is a local source of gaseous nitrogen, e.g., roads and/or intensive agricultural areas. Therefore, there is often a gradient of N deposition declining from the woodland edge (Spangenberg and Kölling, 2004).

1.4.9 It is widely recognised that the effect of N deposition on woodland vegetation communities is poorly understood and that there are knowledge gaps in the literature (Jones et al., 2018; Caporn et al., 2016). This is due to many factors complicating the study of woodlands. The canopy can have a strong influence and can intercept rainfall, pollution and light before it reaches the ground flora. Variables such as woodland management and browsing pressure are also considerable factors (Caporn et al., 2016). A study looking at N deposition on woodlands compared the same sites three decades apart and found little to no change in species richness but noted minor compositional changes with nitrogen-loving species such as cleavers (*Galium aparine*) and common nettle (*Urtica dioica*) responding positively to nitrogen. It was also noted that woodland plants occupy a middle to upper zone on the Ellenberg nitrogen value scale and therefore may be better adapted to increases in available nitrogen than other plant communities (Caporn, 2016; Kirby et al., 2005).

1.4.10 Attributing possible effects seen in the field to N deposition is not always possible as some of the effects are not easily distinguished from the effects of management (Jones et al., 2018), especially where this involves changing light levels e.g., thinning or over-grazing. Inappropriate or insufficient management and wind throw can simulate the effects of increased nitrogen and may result in very similar outcomes to eutrophication, e.g., an increase in grass growth.

1.4.11 Furthermore, not all indicators of exceedance of the critical load as listed on APIS are easily recorded in the field, such as: changes in soil processes; nutrient imbalance; altered composition of mycorrhiza; changes in soil nutrient levels; and increases in tree foliar and litter N concentrations and P/N ratio. The indicators of nitrogen enrichment most likely to be noticeable on field survey are changes in ground vegetation composition towards dominance by nitrophilic species (De Vries et al., 2007) and an increased likelihood of algal growth (Achermann & Bobbink, 2003).

**Responses to increased nitrogen deposition above the critical load**

1.4.12 Given the existing route of the A9 through the woodlands under consideration in this assessment, sites in the study area of the proposed scheme are already subject to N deposition as a result of vehicle emissions. The existing N deposition at the modelled sites is between 13.51 and 14.12 kg N/ha/yr (Table 8.10 of Chapter 8: Air Quality), which is within the CL range of broadleaved deciduous woodland (10-20kg N/ha/yr) and of coniferous woodland (3-15kg N/ha/yr).

1.4.13 Although the higher critical load is not currently exceeded for the woodland habitat types, it is possible there have been some changes in nutrient cycling, vegetation composition and ecosystem function as a result of nitrogen deposition over the years. The habitats closest to the existing road are particularly likely to already be showing symptoms of N deposition and increased graminoid and nitrophilous species cover may already be apparent in affected areas (De Vries et al., 2007). This shifted baseline could make further changes in vegetation from incremental additions of nitrogen difficult to recognise in the field. Therefore, it is important to understand the evidence (if any) of further changes that could be the result of additional nitrogen above the critical load.

1.4.14 At levels of N deposition at and above the upper end of the critical load, additional long-term increments of nitrogen are generally associated with further declines in species richness. However, the incremental effect of long-term N deposition reduces as deposition levels increase above the upper end of the critical load for a habitat. Caporn et al. (2016) found that less polluted sites were therefore more sensitive to increases in N deposition, whereas sites already receiving high levels of N deposition had already experienced a loss in species diversity. In addition, some species, especially graminoids (grasses, sedges, rushes) increase their cover in high N deposition scenarios and this can result in further losses of species that are sensitive to enrichment (Caporn et al., 2016).

1.4.15 Some of the N deposition studies on vegetation change in woodlands have contradictory outcomes around which species are found to respond to N deposition (Pitcairn et al., 1998 and Kirby et al., 2005). This lack of a clear relationship between species richness and N deposition makes assuming a dose-response relationship difficult (Caporn et al., 2016).

## 1.5 Assessment

**Introduction**

1.5.1 The baseline descriptions and impact assessments for sites screened in for operational stage N deposition assessment are presented in Table A12.5-4 (ancient and veteran trees) and Table A12.5-5 (AW sites).

**Veteran and Ancient Trees**

1.5.2 Veteran and ancient trees are of National importance because they are considered irreplaceable if damaged or destroyed. Table A12.5-4 shows the magnitudes of increase in N deposition. For all trees, both the existing N deposition and the modelled base year exceed the LCL. The predicted DS N deposition is less than the base year (2023) N deposition except for BT_3 and BT_4. The magnitude of increase (DS-DM is less than 1 kg N/ha/yr apart from BT_4 and BT_5.  It is of note that BT_4, which is a  grand fir (*Abies grandis*) is the only coniferous species (LCL of 3kg N/ha/yr) but is a non-native species and therefore the large increase in N deposition predicted for this receptor is not considered to be of ecological significance.  The duration of increase for all is estimated at >15 years and therefore assumed to be permanent. Despite the permanent elevation of N deposition, the increase in N deposition as a result of the proposed scheme is not predicted to result in death or damage of veteran and ancient trees because the key characteristics such as age, size, structure and presence of dead and decaying wood are not themselves sensitive to increased N deposition. Even a permanent (15 or more years) increase in N deposition is not anticipated to alter the key characteristics or integrity of the trees. Therefore, a permanent change in N deposition results in a minor impact level. Given that there is not likely to be a change in the key characteristics of the trees, the significance of effect of all trees has been assessed as slight adverse and not significant.

**Table A12.5-4: Assessment of veteran and ancient trees**

| Tree ID | Classification | Existing N deposition kgN/ha/yr[3] | N deposition kg N/ha/yr | | | Magnitude of impact (DS-DM) kg N/ha/yr | Lower Critical load kg N/ha/yr | DS-DM (% of LCL) |
|---|---|---|---|---|---|---|---|---|
| | | | Base (2023) | DM (2036) | DS (2036) | | | |
| ATI_1 | Ancient unknown species (not surveyed) within same AWI polygon as ECO_Y | 13.92 | 16.9 | 15.5 | 16.4 | 0.9 | 10 | 9.2 |
| ATI_5 | Veteran unknown species (not surveyed) | 13.81 | 14.5 | 14.2 | 14.6 | 0.4 | 10 | 4.3 |
| BT_ 1 | Veteran beech (*Fagus sylvatica*) | 13.51 | 18.0 | 16.0 | 16.8 | 0.8 | 10 | 7.7 |
| BT_2 | Veteran pedunculate oak (*Quercus robur*) | 13.51 | 18.7 | 16.4 | 17.3 | 0.9 | 10 | 9.1 |
| BT_3 | Veteran pedunculate oak | 13.81 | 14.9 | 14.3 | 15.2 | 0.9 | 10 | 8.6 |
| BT_4 | Veteran grand fir (*Abies grandis*) | 13.81 | 25.0 | 20.4 | 26.3 | 5.9 | 3 | 196.5 |
| BT_5 | Veteran pedunculate oak | 13.81 | 21.1 | 18.0 | 20.2 | 2.2 | 10 | 22.2 |

[3] Background N deposition rates for the grid square associated with the transect boundary (from APIS)

| Tree ID | Classification | Existing N deposition kgN/ha/yr[3] | N deposition kg N/ha/yr | | | Magnitude of impact (DS-DM) kg N/ha/yr | Lower Critical load kg N/ha/yr | DS-DM (% of LCL) |
|---|---|---|---|---|---|---|---|---|
| | | | Base (2023) | DM (2036) | DS (2036) | | | |
| | | | | | | | | |
| BT_6 | Veteran beech | 13.81 | 17.0 | 15.5 | 16.3 | 0.8 | 10 | 7.9 |

**Ancient Woodland**

1.5.3 Woodland comprises approximately 50% of the habitats within the study area. The majority of woodland within the study area is broadleaved and mixed woodland. Species present within these woodlands include a range of native and non-native species, including ash (*Fraxinus excelsior*), oak (*Quercus sp.*), elder (*Sambucus nigra*), sycamore (*Acer pseudoplatanus*) and beech (Photograph 1). Coniferous woodland, including mixed woodland (mainly coniferous), is less frequent in the study area and these areas generally comprise Douglas fir (*Pseudotsuga menziesii*) and spruce (*Picea sp*.) with small areas of Scot's pine (*Pinus sylvestris*) (Photograph 2 and 3).

**Photograph 1: Semi-natural broadleaved woodland (w1g), dominated by beech, within Murthly Estate.**

**Photograph 2: Other coniferous woodland (w2c), with some broad leaved species in Dalpowie Plantation.**

**Photograph 3: Area of coniferous plantation woodland (w2c) adjacent to the River Tay.**

1.5.4 Most of the woodland sites considered in this assessment are identified on the AWI as either of semi-natural origin or LEPO. The wider landscape is largely occupied by managed forest, some of which is conifer plantation on ancient woodland soils (PAWS). To the west of the A9, the Craigvinean Forest covers 1937ha and supports a range of habitats (Forestry and Land Scotland, 2020). Managed forests have existed in this locality since the mid-18th century. To the east of the A9, there are parcels of connected ancient woodland, in the River Tay valley and beyond for more than 5km. Woodlands in this area include Craig a Barns, Birkenburn, Drumbuie Wood, Craig Wood, Rotmell Wood (773ha), Silver Side and Hilton Wood. These are predominantly privately-owned conifer plantations for the purpose of forestry. Although the woodland polygons are modelled separately in this assessment, they form part of a connected wooded landscape and therefore the impact of N deposition on the integrity of the wider woodland ecosystem is considered.

1.5.5 Of those polygons covered by the Craigvinean Land Management Plan (Forestry and Land Scotland, 2020; FLS, 2024), many are actively managed for forestry purposes (including clear-felling, low impact silviculture) or have management planned to 2029 and beyond (Table A12.5-5). Future management plans include thinning 1293ha of conifer woodland and restocking 531ha of woodland with a variety of commercial crops and native species. It is of note that management practices are likely to have a greater impact on vegetation composition than the effects of increased nitrogen deposition (Forestry Research, Undated).

1.5.6 Table A12.5-5 summarises the baseline ecological and air quality information available for the woodland sites that are screened in for assessment. It is of note that many of the polygons are under the footprint of the proposed scheme and therefore subject to landtake. Of the sites screened in for assessment, only ECO_I and ECO_K appear to support the semi-natural woodland climax community of broadleaved deciduous woodland. Most of the sites that are listed as ancient woodland of semi-natural origin on the AWI support at least some coniferous plantation woodland (PAWS). Some sites also had undesirable species present such as bracken (*Pteridium aquilinum*) or rhododendron (*Rhododendron ponticum*) (ECO_A, ECO_C, ECO_D,

ECO_E, ECO_I, ECO_K, ECO_M, ECO_U, ECO_X, ECO_Y, and ECO_AH). Therefore, the assessment takes into consideration the influence of past, current and future management and potential interactions with increased nitrogen deposition.

**Table A12.5-5: Baseline Information for AW**

| Site ID | Size (ha) | Approximate distance from road (m)* | AW Type | Main UKHab Classification** | Modelled Habitat | Existing N deposition kgN/ha/yr | Lower CL kgN/ha/yr | Current Management | Future Management |
|---|---|---|---|---|---|---|---|---|---|
| ECO_A Byres Wood | 6.7 | 37 | Semi-natural Origin, PAWS | w2c – coniferous woodland – other | CW | 14.12 | 3 | ▪ Unknown | ▪ Felling/thinning followed by restocking (dates unknown) |
| ECO_C | 60.7 | 29 | LEPO | w1h – other woodland – mixed | CW | 14.12 | 3 | ▪ Unknown | ▪ Thinning (dates unknown) |
| ECO_D | 23.9 | 18 | Semi-natural origin, partially PAWS | w1h – other woodland – mixed | CW | 14.05 | 3 | ▪ Unknown | ▪ Felling/thinning followed by restocking (dates unknown) |
| ECO_E | 23.9 | 16 | Semi-natural origin, partially PAWS | w2c - coniferous woodland – other | CW | 14.12 | 3 | ▪ Felling (in progress) | ▪ Restocking (dates unknown) |
| ECO_H | 316.2 | 5 | LEPO | w2b – other Scot’s pine woodland | CW | 14.06 | 3 | ▪ Unknown | ▪ Felling/thinning followed by restocking (dates unknown) |

| **Site ID** | **Size (ha)** | Approximate distance from road (m)* | **AW Type** | **Main UKHab Classification**** | **Modelled Habitat** | **Existing N deposition kgN/ha/yr** | **Lower CL kgN/ha/yr** | **Current Management** | **Future Management** |
|---|---|---|---|---|---|---|---|---|---|
| ECO_I | 34.0 | 42 | Semi-natural origin | w1f7 – other lowland mixed deciduous woodland | BDW | 13.92 | 10 | ▪ Unknown | ▪ Unknown |
| ECO_J | 260.1 | 64 | LEPO | N/A | CW | 13.77 | 3 | ▪ Not known | ▪ Felling (2029/30) |
| ECO_K | 5.4 | 32 | Semi-natural origin | w1f7 – other lowland mixed deciduous woodland | BDW | 13.69 | 10 | ▪ Low impact silviculture | ▪ Minimum intervention |
| ECO_M | 40.7 | 61 | Semi-natural origin, PAWs | w1h – other woodland – mixed | CW | 13.81 | 3 | ▪ Felling 2021/2022<br>▪ Thinning of beech , Douglas fir and Norway spruce (*Picea abies*) | ▪ Clear-fell with seed trees (2025/26) |
| ECO_N | 40.7 | 8 | Semi-natural origin, PAWs | w2c – other coniferous woodland plantation | CW | 13.93 | 3 | ▪ Low impact silviculture<br>▪ Weed control/ground preparation<br>▪ Thinning | ▪ Low impact silviculture |

| **Site ID** | **Size (ha)** | Approximate distance from road (m)* | **AW Type** | **Main UKHab Classification**** | **Modelled Habitat** | **Existing N deposition kgN/ha/yr** | **Lower CL kgN/ha/yr** | **Current Management** | **Future Management** |
|---|---|---|---|---|---|---|---|---|---|
| ECO_P | 64.9 | 22 | Semi-natural origin, PAWS | w2c – other coniferous woodland | CW | 13.72 | 3 | ▪ Low impact silviculture<br>▪ Thinning to leave an open slight line for deer management (2022/23)<br>▪ Weed control/ground preparation<br>▪ Aim to establish broadleaved woodland | ▪ Low impact silviculture |

| Site ID | Size (ha) | Approximate distance from road (m)* | AW Type | Main UKHab Classification** | Modelled Habitat | Existing N deposition kgN/ha/yr | Lower CL kgN/ha/yr | Current Management | Future Management |
|---|---|---|---|---|---|---|---|---|---|
| ECO_R | 64.9 | 18 | Semi-natural origin | w2c – other coniferous woodland | CW | 13.72 | 3 | ▪ Clear-fell with seed trees (2021-2022) – removal all non-native conifers and majority of pole stage beech, Retain native species for PAWS restoration ahead of minimum intervention management.<br>▪ Thinning of beech, Douglas fir, Norway spruce<br>▪ Restocking 2022/23 – sessile oak (*Quercus petraea*), beech and other mixed broadleaved sp. | ▪ Clear-fell with seed trees (2025/26) |

| Site ID | Size (ha) | Approximate distance from road (m)* | AW Type | Main UKHab Classification** | Modelled Habitat | Existing N deposition kgN/ha/yr | Lower CL kgN/ha/yr | Current Management | Future Management |
|---|---|---|---|---|---|---|---|---|---|
| ECO_U Rotmell Wood | 773.7 | 50 | LEPO | w1h – other woodland – mixed | CW | 13.51 | 3 | ▪ Unknown | ▪ Unknown |
| ECO_X | 23.9 | 58 | LEPO | Clear-felled | CW | 14.06 | 3 | ▪ Unknown | ▪ Thinning (dates unknown) |
| ECO_Y | 15.9 | 41 | Semi-natural origin | N/A | BDW | 13.92 | 10 | ▪ Unknown | ▪ Unknown |
| ECO_Z | 6.5 | 86 | Roy | N/A | BDW | 13.92 | 10 | ▪ Unknown | ▪ Unknown |
| ECO_AB | 1.6 | 97 | LEPO | N/A | CW | 13.81 | 3 | ▪ Unknown | ▪ Unknown |
| ECO_AC | 6.4 | 109 | Semi-natural origin, PAWS | N/A | CW | 13.81 | 3 | ▪ Unknown | ▪ Unknown |
| ECO_AH | 64.9 | 28 | Semi-natural origin, PAWS | w2c – other coniferous plantation | CW | 13.93 | 3 | ▪ Low impact silviculture | ▪ Low impact silviculture<br>▪ Clear-fell (2030/31)<br>▪ Minimum intervention |

*Approximate distance from edge of woodland to the proposed scheme, based on the distance to the nearest A9 ARN road link (See Table 8.13 in Chapter 8: Air Quality)
**Where a transect goes through more than one habitat type, the main habitat type relevant to the transect is presented in this table. Full descriptions provided in subsequent sections.

ECO_A

1.5.7 ECO_A is within a polygon of 6.7ha in Byres Wood that is listed as ancient woodland of semi-natural origin, part of which is PAWS. For modelling purposes, the site was assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.12kg N/ha/yr, with a modelled base year (2023) of 21.8kg N/ha/yr. The predicted DS N deposition is 20.3kg N/ha/yr, with an increase (DS-DM) of 1.8kg N/ha/yr, which is 58.7% of the LCL (Table A12.5-6).

1.5.8 The area closest to the A9 was surveyed as other broadleaved woodland, with abundant silver birch (*Betula pendula*) and frequent sycamore. The shrub layer and ground flora included frequent rhododendron, bracken and creeping soft-grass (*Holcus mollis*). This broadleaved deciduous woodland, which extends approximately 20m from the edge of the road is secondary woodland which will be lost to the construction of the proposed scheme, but will be replanted as mixed woodland (Figure 10.6). The conifer plantation from behind this is dominated by Douglas fir and western hemlock-spruce (*Tsuga heterophylla*). Frequent species included bracken, wood-sorrel (*Oxalis acetosella*) and rhododendron. Broad buckler-fern (*Dryopteris dilatata)*, silver birch and beech were occasional. These data provide no evidence of ancient woodland of semi-natural origin in the vicinity of the modelled transect.

1.5.9 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 60m into the woodland (Table A12.5-6). Given that the remaining woodland is non-native conifer plantation, which is to be felled and then restocked (Table A12.5-5), the effect of forestry management far exceeds the possible impacts of increased N deposition. Therefore no effect on the integrity of the wider woodland habitat is predicted and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in an effect which is slight adverse (not significant) or moderate adverse (significant). Given that the current vegetation is non-native conifer plantation under forestry management, the effect is assessed as slight adverse (not significant).

ECO_C

1.5.10 ECO_C is within a polygon of 60.7ha that is listed on the AWI as LEPO. For modelling purposes, the site was assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.12kg N/ha/yr, with a modelled base year (2023) of 23.2kg N/ha/yr. The predicted DS N deposition is 21.0kg N/ha/yr, with an increase (DS-DM) of 1.6kg N/ha/yr, which is 52.7% of the LCL (Table A12.5-6).

1.5.11 The site is a mature mixed plantation woodland. (w1h – other woodland – mixed). The most frequent trees species were Douglas fir and western hemlock-spruce, with an understorey of rhododendron. Other tree species present included western red-cedar (*Thuja plicata*), silver birch and beech (which is considered to be non-native in Scotland). Frequent tree species include oak sp., Sitka spruce (*Picea sitchensis*) and sycamore. The ground flora was very sparse, consisting of bryophytes and small isolated patches of species such as dog's mercury (*Mercurialis perennis*), rough meadow-grass (*Poa trivialis*), male-fern (*Dryopteris filix-mas*), herb-Robert (*Geranium robertianum*), wood avens (*Geum urbanum*), remote sedge (*Carex remota*), bluebell (*Hyacinthoides non-scripta*) and wood--sorrel.

1.5.12 The increase in N deposition is predicted to be permanent (>15 years) and to extend approximately 60m into the woodland (Table A12.5-6), including trees that are to be removed as part of the proposed scheme. The transect is in a large (60.7ha) block of woodland between the existing A9 and the River Tay, extending away from the A9 to the east (Figure 12.16). Although there are ancient woodland indicators present in the ground flora, none of these are considered sensitive to increased nitrogen deposition and some have been found to respond positively to increased N (Pitcairn et al., 2006). Therefore, no higher plant species are predicted to be lost as a result of the increase in N deposition. Coupled with the fact that the woodland is planted with primarily non-native conifer species, some of which is to be removed as part of the proposed scheme, no effect on the integrity of this area of ancient woodland is anticipated. Therefore, the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is a mixed woodland with non-native conifer species under forestry management, some of which is under the footprint of the proposed scheme, the effect is assessed as slight adverse (not significant).

ECO_D

1.5.13 ECO_D is within a polygon of 23.9ha of ancient woodland of semi-natural origin, part of which is PAWS. For modelling purposes, the site was assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.05kg N/ha/yr, with a modelled base year (2023) of 29.3kg N/ha/yr. The predicted DS N deposition is 25.8kg N/ha/yr, with an increase (DS-DM) of 3.4kg N/ha/yr, which is 111.9% of the LCL (Table A12.5-6).

1.5.14 The site was surveyed as w1h – other woodland – mixed but there is coniferous plantation adjacent to the road, that is due to be removed as part of the proposed scheme, with Douglas fir and European larch (*Larix decidua*) the most abundant species, with frequent grand fir and rhododendron, and occasional sycamore, silver birch and Norway maple (*Acer platanoides*). The ground flora comprised frequent common bent (*Agrostis capillaris*), wood-sorrel, honeysuckle (*Lonicera periclymenum*), fern species, and dog's mercury. The woodland to be retained (>20m from the road), was dominated by western red-cedar with very limited ground flora.

1.5.15 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 90m from the edge of the woodland (Table A12.5-6). The AWI polygon is part of a much larger block of woodland to the west of the existing A9 (Figure 12.16). The woodland closest to the road (approximately 8m from the road edge) supports some ancient woodland indicator species in the ground flora, but this area is to be removed as part of the proposed scheme. None of these ancient woodland indicator species are considered sensitive to increased nitrogen deposition and some have been found to respond positively to increased N (Pitcairn et al., 2006). Therefore, no higher plant species are predicted to be lost due to increased N deposition. Possible future expansion of the dense stands of rhododendron and Portugal laurel (*Prunus lusitanica*) is likely to have more effect on the native ground flora than increased nitrogen deposition. These factors, along with the fact that the woodland is planted with non-native conifer species, suggest that no effect on the integrity of this area of ancient woodland is anticipated. Therefore, the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the retained vegetation is non-native conifer plantation with limited ground flora, the effect is assessed as slight adverse (not significant).

ECO_E

1.5.16 ECO_E is within the same AWI polygon as ECO_D, but is on the opposite side of the A9, extending from the southbound carriageway in a north-easterly direction. The polygon is listed as ancient woodland of semi-natural origin, part of which is PAWS. For modelling purposes, the site was assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.12kg N/ha/yr, with a modelled base year (2023) of 26.1kg N/ha/yr. The predicted DS N deposition is 25.0kg N/ha/yr, with an increase (DS-DM) of 3.7kg N/ha/yr, which is 123.6% of the LCL (Table A12.5-6).

1.5.17 This site was surveyed as w2c - coniferous woodland – other and consists of coniferous plantation dominated by western hemlock-spruce, grand fir and Douglas fir. Within 20m of the existing A9 the understorey and ground flora was limited, but included bluebell (an ancient woodland indicator) and hedge woundwort (*Stachys sylvatica*). This area is under the footprint of the proposed scheme. Further away from the road the ground flora in the plantation showed an acidic influence with wood-sorrel, heath bedstraw (*Galium saxatile*) and common haircap (*Polytrichum commune)* occasionally present. This woodland is currently being managed (felled) and will be replanted, primarily with native mixed broadleaves and open ground and mixed conifer/mixed broadleaves. This will be achieved through natural regeneration and supplementary planting. Beyond 90m from the road, some open areas with acid grassland and heath vegetation were recorded.

1.5.18 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 80m from the edge of the woodland (Table A12.5-6). The AWI polygon is part of a larger block of woodland between the existing A9 and the River Tay (Figure 12.16). The woodland closest to the road (approximately 16m) supports some typical woodland ground flora, including hedge woundwort and bluebell, which is an ancient woodland indicator species. However, this area is due to be removed as part of the proposed scheme. Furthermore, these species are not considered sensitive to increased nitrogen deposition (Pitcairn et al., 2006). Further from the road, the more acidic ground flora (heath bedstraw and wood-sorrel) are potentially sensitive to increased N deposition but are within dense non-native conifer plantation, so the influence of shading and forest management is likely to mask any effects of increased nitrogen deposition (and deposition drops off with distance). This area is part of an ecological mitigation area (Figure 10.6: Landscape and Ecology Mitigation), which will undergo management to enhance its biodiversity value. The beneficial effect of this management on vegetation composition will exceed any negative effects as a result of increased N deposition. The open areas of heath and acid grassland are beyond the area affected by increased N deposition.

1.5.19 Therefore, the presence of mature non-native conifer plantation and anticipated future management of this site is likely to exert more influence on the woodland ground flora than the possible effect of increased nitrogen deposition. Therefore, no effect on the integrity of this area of ancient woodland is anticipated and the impact level is assessed as minor adverse.

A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is coniferous plantation rather than ancient semi-natural woodland, and that future management to improve biodiversity is part of the proposed scheme, the effect is assessed as slight adverse (not significant).

<u>ECO_H</u>

1.5.20 ECO_H is in a narrow strip of woodland between the A9 and the River Tay but in the AWI it is part of a large 316ha block of LEPO that extends to the west of the A9 (Figure 12.16). The site supports coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.06kg N/ha/yr, with a modelled base year (2023) of 21.4kg N/ha/yr. The predicted DS N deposition is 21.3kg N/ha/yr, with an increase (DS-DM) of 3.0kg N/ha/yr, which is 101% of the LCL (Table A12.5-6).

1.5.21 The woodland is coniferous plantation dominated by Scot’s pine, with other planted trees including western hemlock-spruce, Douglas fir, sweet chestnut (*Castanea sativa*), oak sp. and Norway spruce. The ground flora included ancient woodland indicator species, with abundant great wood-rush (*Luzula sylvatica*) and bluebell, with frequent wood-sorrel and rare slender St John’s-wort (*Hypericum pulchrum*).

1.5.22 The increase in N deposition is predicted to be permanent (>15 year) and to extend the width of the woodland strip, approximately 60m from the edge of the woodland (Table A12.5-6). However, approximately a strip of approximately 20m of woodland is due to be removed as part of the proposed scheme. The only ancient woodland indicator species that is considered sensitive to increased nitrogen deposition is wood-sorrel (Pitcairn et al., 2006) and there is a possibility that this species could decline or be lost. However, given that the transect is within a narrow strip of a much larger LEPO, some of which is under the footprint of the proposed scheme, and is separated from the rest of the AWI polygon by the existing road and the railway, there would be no effect on the integrity of the AWI polygon as a whole. Therefore, the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is coniferous plantation, some of which is to be lost as a result of the proposed scheme, and that the increase in N deposition is within a narrow strip of fragmented woodland, the effect is assessed as slight adverse (not significant).

<u>ECO_I</u>

1.5.23 ECO_I is within a polygon of 34ha on the AWI that is listed as ancient woodland of semi-natural origin. It is separated from the existing A9 by the railway and is adjacent to a large (260ha) block of LEPO that extends to the west of the A9 (Figure 12.16). The site visit noted felled trees on the railway embankment with tall ruderal vegetation and classified it as clear-felled/w1f7 – other lowland mixed deciduous woodland with a LCL of 10kg N/ha/yr. Aerial imagery suggests that the site supports broadleaved deciduous woodland, which is likely to be of semi-natural origin, albeit with some planted conifers. The existing N deposition rate is 13.92kg N/ha/yr, with a modelled base year (2023) of 19.9kg N/ha/yr. The predicted DS N deposition is 19.1kg N/ha/yr, with an increase (DS-DM) of 1.8kg N/ha/yr, which is 18.1% of the LCL (Table A12.5-6).

1.5.24 The increase in N deposition is predicted to be permanent (>15 year) and to extend approximately 60m from the edge of the woodland (Table A12.5-6). No landtake is anticipated within this polygon and this area is to be used for ecological mitigation (Figure 10.6). The impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the predicted N deposition (DS) is within the range of critical loads for broadleaved deciduous woodland (10-20kg N/ha/yr), the effect is assessed as slight adverse and not significant.

<u>ECO_J</u>

1.5.25 ECO_J is within a polygon of 250ha that is listed on the AWI as LEPO. It is separated from the existing A9 by the railway (Figure 12.16) extends to the west and south on the slopes of Birnam Hill. The area around the transect supports coniferous plantation with some broadleaved woodland areas. However, access constraints meant the area could not be surveyed in detail. The edge of the woodland is approximately 64m from the edge of the road and is due to be felled within the next decade (FLS, 2024). For modelling purposes, the site was assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.77kg N/ha/yr, with a modelled base year (2023) of 16.8kg N/ha/yr. The predicted DS N deposition is 16.5kg N/ha/yr, with an increase (DS-DM) of 1.1kg N/ha/yr, which is 36.7% of the LCL (Table A12.5-6).

1.5.26 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 40m from the edge of the woodland (Table A12.5-6). The transect is within a large AWI polygon of 250ha of LEPO woodland to the west of the existing A9 (Figure 12.16). This area is subject to forest management, with the area closest to the road due to be felled in 2030-2034. The effect of forest management on vegetation composition of the woodland will have an effect that far exceeds the effect of an increase in N deposition. Furthermore, if the restocking plans are for native broadleaves, then the DS N deposition is within the CL range of this habitat. Therefore, there is no effect on the integrity of this area of woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is coniferous plantation and is due to be felled, the effect is assessed as slight adverse (not significant).

<u>ECO_K</u>

1.5.27 ECO_K is within a narrow strip of 5.4ha of ancient woodland of semi-natural origin between the existing A822 and the railway (Figure 12.16). The site supports w1f7 – other lowland mixed deciduous woodland with a LCL of 10kg N/ha/yr. The existing N deposition rate is 13.69kg N/ha/yr, with a modelled base year (2023) of 18.8kg N/ha/yr. The predicted DS N deposition is 19.8kg N/ha/yr, with an increase (DS-DM) of 3.3kg N/ha/yr, which is 33.5% of the LCL (Table A12.5-6).

1.5.28 The woodland closest to the road was recorded as broadleaved deciduous woodland, with abundant beech and sycamore (neither species is native in Scotland). Sessile oak and lime (*Tilia sp.*) became more common with distance from the road, but beech and sycamore were still abundant. The ground flora included ancient woodland indicator species such as great wood-rush, bluebell and common cow-wheat (*Melampyrum pratense*). Rhododendron, a non-native species, was occasional in the understorey. From approximately 50m, grassland habitat was recorded.

1.5.29 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 40m from the edge of the woodland (Table A12.5-6). The proposed scheme includes removal of a strip of approximately 5m of woodland adjacent to the road and therefore the retained woodland strip between the road and the railway is predicted to receive N deposition above the 0.4kg N/ha/yr threshold. However, only the eastern tip of the woodland strip is adjacent to the ARN, with the remainder separated from the road by the River Braan (Figure 12.16). Although there are ancient woodland indicators present in the ground flora, only common cow-wheat is considered potentially sensitive to increased nitrogen deposition and others have been found to respond positively to increased N (Pitcairn et al., 2006). The width of the woodland strip will be reduced as a result of the proposed scheme and therefore no effect on the integrity of this area of woodland is predicted as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the woodland is subject to habitat loss as a result of the proposed scheme, the effect of N deposition on the retained woodland is assessed as slight adverse (not significant).

<u>ECO_M</u>

1.5.30 ECO_M is within PAWS, listed on the AWI as ancient woodland of semi-natural origin. The transect is between the existing A9 and the River Tay in an area of woodland that will be subject to landtake as part of the proposed scheme. However, it is part of a larger polygon of 40.7ha on the AWI that extends along the River Tay and to the south side of the A9. The site supports w1h – other woodland – mixed but for the purposes of modelling has been assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.81kg N/ha/yr, with a modelled base year (2023) of 17.1kg N/ha/yr. The predicted DS N deposition is 16.8kg N/ha/yr, with an increase (DS-DM) of 1.3kg N/ha/yr, which is 42.2% of the LCL (Table A12.5-6).

1.5.31 The woodland closest to the A9 was identified as mixed broadleaved, with ash and naturally regenerated sycamore most common, with occasional mature beech and oak. Grand fir was recorded as rare. The ground flora supported ancient woodland indicator species such as bluebell, greater stitchwort (*Stellaria holostea*) and pignut (*Conopodium majus*). With increasing distance from the road, beech became the most abundant species, the woodland mixture changed to having beech as the most abundant tree present, with scattered conifers, including non-native specimen trees. Recent management included felling in 2021/2022 (Forestry and Land Scotland, 2020) and current management includes thinning of beech, Douglas fir and Norway spruce. It is proposed to clear-fell and re-plant with seed trees in 2025/26.

1.5.32 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 50m from the edge of the woodland (Table A12.5-6). However, the part of the woodland where ECO_M is located (and where species composition data were collected), is predicted to be lost to new infrastructure (SuDS) as part of the proposed scheme (Figure 10.6). It is possible that some of the retained woodland in this AWI polygon would also be subject to an increase in N deposition above the threshold, but it is of note that another transect (ECO_O) in this polygon was modelled and did not exceed the threshold so was screened out (Figure 8.6).

1.5.33 Habitat loss as a result of the proposed scheme and the current and future forestry management plans will have far greater impact on the vegetation composition of this woodland than an increase in N deposition. Therefore, there is no effect on the integrity of this area of woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given other impacts affecting this area of woodland, the effect is assessed as slight adverse (not significant).

ECO_N

1.5.34 ECO_N is within the same AWI polygon as ECO_M, which is PAWS and listed as ancient woodland of semi-natural origin. The transect is on the south side of the A9, adjacent to the northbound carriageway and is part of a larger polygon of 40.7ha on the AWI. The site supports w2c – other coniferous woodland plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.93kg N/ha/yr, with a modelled base year (2023) of 31.7kg N/ha/yr. The predicted DS N deposition is 26.3kg N/ha/yr, with an increase (DS-DM) of 1.4kg N/ha/yr, which is 47.5% of the LCL (Table A12.5-6).

1.5.35 This transect transitions from closely managed neutral grassland road verge into coniferous woodland dominated by mature larch (*Larix sp.*) and Douglas fir, with Norway spruce, Sitka spruce, grand fir and beech also present. The ground flora was variable but quite dense in places, with wood-sorrel and tufted hair-grass (*Deschampsia cespitosa*) the most common species. Wood-sorrel is an ancient woodland indicator species which is considered to be sensitive to increased N deposition (Pitcairn et al., 2006). This site is currently subject to low impact silviculture, which is intended to continue. A band of approximately 10m width is to be removed as a result of the proposed scheme.

1.5.36 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 60m from the edge of the woodland (Table A12.5-6). Although the woodland is non-native conifer plantation, it is possible that wood sorrel could decline or be lost from the ground flora in the woodland closest to the road. However, this woodland is part of a much larger area of AWI woodland, formed of multiple AWI polygons, on this side of the A9. Therefore, there is unlikely to be an effect on the integrity of the woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is conifer plantation which supports some ancient woodland indicator species but is part of a much larger woodland block, the effect is assessed as slight adverse (not significant).

ECO_P

1.5.37 ECO_P is within an AWI polygon of 64.9ha which is PAWS and listed as ancient woodland of semi-natural origin. The transect overlaps with a strip of approximately 20m depth to be lost as a result of the proposed scheme, with earthworks within the wider area extending approximately 60m into the woodland parcel. Mixed woodland will be replanted on the embankments (Figure 10.6) with the retained woodland to the west forming part of an ecological mitigation area. The site supports w2c – other coniferous woodland plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.72kg N/ha/yr, with a modelled base year (2023) of 15.2kg N/ha/yr. The predicted DS N deposition is 17.1kg N/ha/yr, with an increase (DS-DM) of 2.6kg N/ha/yr, which is 88.2% of the LCL (Table A12.5-6).

1.5.38 The site is a Douglas fir plantation, with scattered beech. The site is subject to low impact silviculture, including weed control and thinning, with the aim of establishing broadleaved woodland. Thinning operations have allowed a higher cover of ground flora to develop, with a variety of ferns and herbs, including great wood-rush, lady-fern (*Athyrium filix-femina*), wood-sorrel, tufted hair-grass, dog's mercury and bluebell. Some of these are ancient woodland indicator species, with great wood-rush and wood-sorrel potentially sensitive to N deposition, whereas dog's mercury and bluebell have been shown to respond positively to increased N deposition (Pitcairn et al., 2006).

1.5.39 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 70m from the edge of the woodland (Table A12.5-6). Although the woodland is non-native conifer plantation, there are species in the ground flora that could decline or be lost in response to increased N deposition. However, there are other typical woodland species that may be expected to increase. This woodland is part of a much larger area of AWI woodland, formed of multiple AWI polygons, on this side of the A9. Given that some of this polygon is to be removed as part of the proposed scheme, with the remainder retained to provide essential ecological mitigation and managed for biodiversity benefit, there is unlikely to be an effect on the integrity of the woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given the factors explained here, the effect is assessed as slight adverse (not significant).

<u>ECO_R</u>

1.5.40 The ECO_R transect crosses two AWI polygons but the one closest to the A9 is in the same polygon as ECO_P. This part of the polygon is on the east side of the A9, adjacent to the River Tay and is ancient woodland of semi-natural origin but is not mapped as PAWS. The transect overlaps with a strip of approximately 20m depth to be lost as a result of the proposed scheme. The retained woodland is part of an ecological mitigation area. The site was identified as w2c – other coniferous woodland plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.72kg N/ha/yr, with a modelled base year (2023) of 23.2kg N/ha/yr. The predicted DS N deposition is 23.7kg N/ha/yr, with an increase (DS-DM) of 4.3kg N/ha/yr, which is 144.4% of the LCL (Table A12.5-6).

1.5.41 The area of woodland closest to the road is dominated by Douglas fir with occasional sessile oak. The ground flora supported ancient woodland indicator species such as wood-sorrel, dog's mercury, bluebell, bugle (*Ajuga reptans*), climbing corydalis (*Ceratocapnos claviculata*) and wood anemone (*Anemone nemorosa*). Honeysuckle and bracken were also frequent. The site is subject to forest management, with objectives to remove all non-native conifers and the majority of pole stage beech, retaining native species.

1.5.42 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 100m from the edge of the woodland (Table A12.5-6). Although the woodland is non-native conifer plantation, there are species in the ground flora that could decline or be lost in response to increased N deposition. However, there are other typical woodland species that may be expected to increase. This woodland is part of a much larger area of AWI woodland, formed of multiple AWI polygons, which extends both sides of the River Tay and the A9. The woodland is subject to management practices which aim to replace conifers with native broadleaves and this will have far more effect on species composition than the predicted increase in N deposition. Therefore, there is unlikely to be an effect on the integrity of the woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is conifer plantation which supports some ancient woodland indicator species but is part of a much larger woodland block subject to forest management, the effect is assessed as slight adverse (not significant).

<u>ECO_U</u>

1.5.43 ECO_U is within Rotmell Wood, which is a large (773.7ha) AWI polygon mapped as LEPO. The woodland on the road embankment between the A9 and the minor road was found to support w1h – other woodland – mixed but beyond the road edge the polygon supports coniferous plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.51kg N/ha/yr, with a modelled base year (2023) of 17.7kg N/ha/yr. The predicted DS N deposition is 17.4kg N/ha/yr, with an increase (DS-DM) of 1.6kg N/ha/yr, which is 53.5% of the LCL (Table A12.5-6).

1.5.44 The woodland closest to the A9 was regenerating mixed woodland, with trees ranging in age from seedling to semi-mature. Tree species comprised birch, sycamore, Sitka spruce, larch, Douglas fir, ash (with visible dieback), bird cherry (*Prunus padus*) and sessile oak. The understorey and ground flora species included bracken, broom (*Cytisus scoparius*), bramble (*Rubus fruticosus* agg.) and rhododendron. None of these species are ancient woodland indicators or are considered sensitive to increased N deposition.

1.5.45 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 50m from the edge of the woodland (Table A12.5-6). Much of this area is broadleaved woodland which has a LCL of 10kg/N/ha/yr, compared with a LCL of 3kg/N/ha/yr for coniferous woodland, suggesting it is less sensitive to N deposition. The transect is within a large AWI polygon of 773.7ha of LEPO woodland to the east of the existing A9 (Figure 12.16). Although there is no management information available for this part of the study area, aerial imagery shows clear-felling to the east, indicating that the area is subject to forestry management. The effect of forest management on vegetation composition of the woodland will have an effect that far exceeds the effect of an increase in N deposition. Therefore, there is no effect on the integrity of this area of woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is secondary woodland close to the road and coniferous plantation beyond, the effect is assessed as slight adverse (not significant).

ECO_X

1.5.46 ECO_X is within a very large AWI polygon (>500ha) mapped as LEPO which extends west from the A9 into the wider area. The area in which the transect is located has been clear-felled and for the purposes of modelling has been assumed to support coniferous plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 14.06kg N/ha/yr, with a modelled base year (2023) of 16.3kg N/ha/yr. The predicted DS N deposition is 17.6kg N/ha/yr, with an increase (DS-DM) of 2.3kg N/ha/yr, which is 77.6% of the LCL (Table A12.5-6).

1.5.47 This area closest to the A9 was a plantation that had been clear-felled. Occasional oak standards had been left unfelled, and silver birch and downy birch (*Betula pubescens*) were present. The most abundant species were broom and wavy hair-grass (*Avenella flexuosa*).

1.5.48 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 80m from the edge of the woodland (Table A12.5-6). The conifers have been felled and the habitat is grassland and scrub with occasional broadleaved trees. Broadleaved woodland has a LCL of 10kg/N/ha/yr, compared with a LCL of 3kg/N/ha/yr for coniferous woodland. This area will be retained for ecological mitigation (Figure 10.6). The transect is within a larger area of LEPO woodland that extends to the south-west of the existing A9 (Figure 12.16). The effect of forest management on vegetation composition of the woodland will have an effect that far exceeds the effect of an increase in N deposition. Therefore, there is no effect on the integrity of this area of woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the current vegetation is secondary woodland close to the road and coniferous plantation beyond, the effect is assessed as slight adverse (not significant).

ECO_Y

1.5.49 ECO_Y is within a polygon of 15.9ha on the AWI that is listed as ancient woodland of semi-natural origin. It is separated from the existing A9 by the railway and is between large blocks of LEPO that extends for approximately 600ha to the west of the A9 (Figure 12.16). The site visit noted felled trees on the railway embankment which then transitioned to woodland. Aerial imagery indicates that the woodland is predominantly broadleaved deciduous and therefore is considered to have a LCL of 10kg N/ha/yr. The existing N deposition rate is 13.92kg N/ha/yr, with a modelled base year (2023) of 19.4kg N/ha/yr. The predicted DS N deposition is 18.9kg N/ha/yr, with an increase (DS-DM) of 1.9kg N/ha/yr, which is 19.4% of the LCL (Table A12.5-6).

1.5.50 The woodland could not be surveyed for detailed information on habitat composition. The increase in N deposition is predicted to be permanent (>15 year) and to extend approximately 70m from the edge of the road (Table A12.5-6). No landtake is anticipated within this polygon.

Aerial imagery suggests that the site supports broadleaved deciduous woodland, which is likely to be of semi-natural origin, albeit with some planted conifers. Broadleaved woodland has a critical load range of 10-20kg N/ha/yr and therefore the increase would represent 19% of the LCL if this habitat had been modelled rather than coniferous woodland. The impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the predicted N deposition (DS) is within the range of critical loads for broadleaved deciduous woodland (10-20kg N/ha/yr), the effect is assessed as slight adverse and not significant.

ECO_Z

1.5.51 ECO_Z is a small (6.5ha) block of 'Roy' woodland site on the edge of Birnam, adjacent to an agricultural field. There appear to be buildings and roads within the polygon (Figure 12.16). The woodland was not subject to survey for vegetation composition but aerial imagery indicates it supports broadleaved deciduous woodland with a LCL of 10kg N/ha/yr. The existing N deposition rate is 13.92kg N/ha/yr, with a modelled base year (2023) of 16.9kg N/ha/yr. The predicted DS N deposition is 16.1kg N/ha/yr, with an increase (DS-DM) of 0.7kg N/ha/yr, which is 6.7% of the LCL (Table A12.5-6).

1.5.52 The increase in N deposition is predicted to be permanent (>15 year) and to extend approximately 20m, which is the depth of the woodland strip at this location. Aerial imagery suggests that the site supports broadleaved deciduous woodland, which dates from at least 1750. However, the woodland fragment is small, isolated and has already been built on. Therefore, no effect on integrity of the site is anticipated. The impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the site appears to be an isolated fragment of semi-natural woodland vegetation the effect is assessed as slight adverse and not significant.

ECO_AB

1.5.53 ECO_AB is a narrow strip (1.6ha) of LEPO woodland on the north bank of the River Tay (Figure 12.16). It is adjacent to other small blocks of woodland but does not form part of a large expanse. The woodland was not subject to survey for vegetation composition but aerial imagery indicates it supports mixed woodland, so for the purposes of modelling has been assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.81kg N/ha/yr, with a modelled base year (2023) of 15.2kg N/ha/yr. The predicted DS N deposition is 15.1kg N/ha/yr, with an increase (DS-DM) of 0.5kg N/ha/yr, which is 18.1% of the LCL (Table A12.5-6).

1.5.54 The increase in N deposition is predicted to be permanent (>15 year) and to extend approximately 20m. Given that the site is a narrow strip of woodland on the bank of the river and borders an area of grassland to the north, no effect on integrity of the site is anticipated. The impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given that the site appears to be a fragment of planted woodland the effect is assessed as slight adverse and not significant.

ECO_AC

1.5.55 ECO_AC is adjacent to ECO_AB but is in a small (6.4ha) AWI polygon of ancient woodland of semi-natural origin and PAWS. It is adjacent to other small blocks of woodland which extend along and to the north of the River Tay, but does not form part of a large expanse. The woodland was not subject to survey for vegetation composition but aerial imagery indicates it supports mixed woodland, so for the purposes of modelling has been assumed to support coniferous woodland with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.81kg N/ha/yr, with a modelled base year (2023) of 14.8kg N/ha/yr. The predicted DS N deposition is 14.8kg N/ha/yr, with an increase (DS-DM) of 0.4kg N/ha/yr, which is 14.5% of the LCL (Table A12.5-6).

1.5.56 The increase in N deposition is predicted to be permanent (>15 year) and to extend approximately 10m from where the woodland abuts the River Tay. Given that only the edge of the site exceeds the threshold of 0.4kg N/ha/yr, no effect on integrity of the site is anticipated. The impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Given the very small area affected, the effect is assessed as slight adverse and not significant.

ECO_AH

1.5.57 ECO_AH is in the same AWI polygon as ECO_P, which is PAWS and listed as ancient woodland of semi-natural origin. The site supports w2c – other coniferous woodland plantation with a LCL of 3kg N/ha/yr. The existing N deposition rate is 13.93kg N/ha/yr, with a modelled base year (2023) of 20.2kg N/ha/yr. The predicted DS N deposition is 20.8kg N/ha/yr, with an increase (DS-DM) of 3.3kg N/ha/yr, which is 110.4% of the LCL (Table A12.5-6).

1.5.58 The site is a coniferous plantation of Douglas fir and Norway spruce with good ground cover in areas, with a variety of ferns and herbs. In an area of windthrow, beech, sessile oak and holly (*Ilex aquifolium*) have regenerated. The site is subject to low impact silviculture. Although no detailed vegetation composition data is available, it is to be expected that this area of woodland might support similar ground flora to that recorded in the location of ECO_P, where ancient woodland indicator species were recorded, some of which are potentially sensitive to N deposition, and others which might respond positively to increased N deposition (Pitcairn et al., 2006).

1.5.59 The increase in N deposition is predicted to be permanent (>15 year) and to extend to approximately 90m from the edge of the woodland (Table A12.5-6). Although the woodland is non-native conifer plantation, there are species in the ground flora that could decline or be lost in response to increased N deposition. However, there are other typical woodland species that may be expected to increase. This woodland is part of a much larger area of AWI woodland, formed of multiple AWI polygons, on this side of the A9. Given also that some of this polygon (approximately 30m strip) is to be removed as part of the proposed scheme, there is unlikely to be an effect on the integrity of the woodland as a result of the increase in N deposition and the impact level is assessed as minor adverse. A minor adverse impact on a feature of National importance could result in significance of slight (not significant) or moderate (significant) effect. Considering the factors described here, the effect is assessed as slight adverse (not significant).

**Table A12.5-6: Ecological assessment results of nitrogen deposition**

| Transect ID | Modelled Habitat type | AWI type | UKHab Classific-ation | Distance to Nearest A9 ARN Road Link (DS 2036) (m) | Total Deposition (kgN/ha/yr) | | | | Minimum CL (kgN/ ha/yr) | (DS-DM)/CL (%) | Incr-ease over 0.4 kg N/ha/ yr | Transect Extent Potent-ially Impact-ed (m) | Dur-ation (yr) | Impact level | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Base 2023 | DM 2036 | DS 2036 | Change (DS-DM 2036) | | | | | | | |
| ECO_A_0 | CW | Semi-natural origin, PAWS | w2c – other coniferous plantation | 37 | 21.8 | 18.5 | 20.3 | 1.8 | 3 | 58.7 | 1.4 | 60 | >15 | Minor | Slight – not significant |
| ECO_C_0 | CW | LEPO | w1h – other woodland – mixed | 29 | 23.2 | 19.4 | 21.0 | 1.6 | 3 | 52.7 | 1.2 | 60 | >15 | Minor | Slight – not significant |
| ECO_D_0 | CW | Semi-natural origin and partially PAWS | w1h – other woodland – mixed | 18 | 25.8 | 21.1 | 24.4 | 3.4 | 3 | 111.9 | 3 | 90 | >15 | Minor | Slight – not significant |
| ECO_E_0 | CW | Semi-natural origin and partially PAWS | w2c - other coniferous plantation | 16 | 26.1 | 21.3 | 25.0 | 3.7 | 3 | 123.6 | 3.3 | 80 | >15 | Minor | Slight – not significant |

| Transect ID | Modelled Habitat type | AWI type | UKHab Classific-ation | Distance to Nearest A9 ARN Road Link (DS 2036) (m) | Total Deposition (kgN/ha/yr) | | | | Minimum CL (kgN/ ha/yr) | (DS-DM)/CL (%) | Incr-ease over 0.4 kg N/ha/ yr | Transect Extent Potent-ially Impact-ed (m) | Dur-ation (yr) | Impact level | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Base 2023 | DM 2036 | DS 2036 | Change (DS-DM 2036) | | | | | | | |
| ECO_H_0 | CW | LEPO | w2b – other Scot's pine woodland | 5 | 21.4 | 18.3 | 21.3 | 3.0 | 3 | 100.9 | 2.6 | 60 | >15 | Minor | Slight – not significant |
| ECO_I_0 | CW | Semi-natural origin | Clear-felled parts/w1f7 – other lowland mixed deciduous woodland | 42 | 19.9 | 17.3 | 19.1 | 1.8 | 10 | 18.1 | 1.4 | 60 | >15 | Minor | Slight – not significant |
| ECO_J_0 | CW | LEPO | N/A | 64 | 16.8 | 15.4 | 16.5 | 1.1 | 3 | 36.7 | 0.7 | 40 | >15 | Minor | Slight – not significant |
| ECO_K_0 | BDW | Semi-natural origin | w1f7 | 32 | 18.8 | 16.5 | 19.8 | 3.3 | 10 | 33.5 | 2.9 | 40 | >15 | Minor | Slight – not significant |
| ECO_M_0 | CW | Semi-natural origin, PAWs | w1h – other woodland – mixed | 61 | 17.1 | 15.5 | 16.8 | 1.3 | 3 | 42.2 | 0.9 | 50 | >15 | Minor | Slight – not significant |

| Transect ID | Modelled Habitat type | AWI type | UKHab Classific-ation | Distance to Nearest A9 ARN Road Link (DS 2036) (m) | Total Deposition (kgN/ha/yr) | | | | Minimum CL (kgN/ ha/yr) | (DS-DM)/CL (%) | Incr-ease over 0.4 kg N/ha/ yr | Transect Extent Potent-ially Impact-ed (m) | Dur-ation (yr) | Impact level | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Base 2023 | DM 2036 | DS 2036 | Change (DS-DM 2036) | | | | | | | |
| ECO_N_0 | CW | Semi-natural origin, PAWs | w2c - other coniferous plantation | 8 | 31.7 | 24.9 | 26.3 | 1.4 | 3 | 47.5 | 1 | 60 | >15 | Minor | Slight – not significant |
| ECO_P_0 | CW | Semi-natural origin, PAWS | w2c - other coniferous plantation | 22 | 15.2 | 14.5 | 17.1 | 2.6 | 3 | 88.2 | 2.2 | 70 | >15 | Minor | Slight – not significant |
| ECO_R_0 | CW | Semi-natural origin | w2c - other coniferous plantation | 18 | 23.2 | 19.4 | 23.7 | 4.3 | 3 | 144.4 | 3.9 | 100 | >15 | Minor | Slight – not significant |
| ECO_U_0 | CW | LEPO | w1h - other woodland – mixed | 50 | 17.7 | 15.8 | 17.4 | 1.6 | 3 | 53.5 | 1.2 | 50 | >15 | Minor | Slight – not significant |
| ECO_X_0 | CW | LEPO | Clear-felled | 58 | 16.3 | 15.2 | 17.6 | 2.3 | 3 | 77.6 | 1.9 | 80 | >15 | Minor | Slight – not significant |
| ECO_Y_0 | CW | Semi-natural origin | N/A | 41 | 19.4 | 17.0 | 18.9 | 1.9 | 10 | 19.4 | 1.5 | 70 | >15 | Minor | Slight – not significant |

| Transect ID | Modelled Habitat type | AWI type | UKHab Classific-ation | Distance to Nearest A9 ARN Road Link (DS 2036) (m) | Total Deposition (kgN/ha/yr) | | | | Minimum CL (kgN/ ha/yr) | (DS-DM)/CL (%) | Incr-ease over 0.4 kg N/ha/ yr | Transect Extent Potent-ially Impact-ed (m) | Dur-ation (yr) | Impact level | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Base 2023 | DM 2036 | DS 2036 | Change (DS-DM 2036) | | | | | | | |
| ECO_Z_0 | BDW | Roy | N/A | 86 | 16.9 | 15.5 | 16.1 | 0.7 | 10 | 6.7 | 0.3 | 20 | >15 | Minor | Slight – not significant |
| ECO_AB_0 | CW | LEPO | N/A | 97 | 15.2 | 14.5 | 15.1 | 0.5 | 3 | 18.1 | 0.1 | 20 | >15 | Minor | Slight – not significant |
| ECO_AC_0 | CW | Semi-natural origin, PAWS | N/A | 109 | 14.8 | 14.3 | 14.8 | 0.4 | 3 | 14.5 | 0 | 10 | >15 | Minor | Slight – not significant |
| ECO_AH_0 | CW | Semi-natural origin, PAWS | w2c - other coniferous plantation | 28 | 20.2 | 17.5 | 20.8 | 3.3 | 3 | 110.4 | 2.9 | 90 | >15 | Minor | Slight – not significant |

## 1.6 Conclusion

1.6.1 The modelled results indicate a large increase in nitrogen deposition for many of the ancient and veteran trees and ancient woodland sites that were screened in for ecological assessment. However, the overall effect of this increase in N deposition is concluded as not significant for all sites due to a varying combination of the following factors:

- The increase in N deposition is not anticipated to alter the key characteristics or integrity of veteran and ancient trees.
- Sites are part of a much more extensive wooded landscape that is not affected by the increase in N deposition as a result of the proposed scheme.
- Although ancient woodland indicator species are present at some sites, most of these are not considered sensitive to increased N deposition.
- Some of the sites support non-native conifers and rhododendron.
- Many sites are subject to current and future forestry management that will have far more effect on species composition than the increase in N deposition.
- Some of the sites are subject to habitat loss as part of the proposed scheme, which is a much greater impact than increased N deposition and this reduces the extent of habitat exposed to N deposition.
- Some of the retained woodland is within ecological mitigation areas that will deliver essential ecological mitigation and will be managed to benefit biodiversity.

1.6.2 Therefore, no specific mitigation or compensation measures are required in relation to N deposition. However, woodland planting has been proposed throughout the proposed scheme, as shown on Figure 10.6 (Landscape and Ecology Mitigation), to compensate for loss of woodland in line with the Woodland Strategy (Appendix A12.6).

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# Annex 1: Ancient/Veteran tree

**Ancient/Veteran Trees**

**Table A12.5-7: Arboricultural survey results for ancient and veteran trees identified within the ARN.**

| Ancient/Veteran Tree ID | Field Observations |
|---|---|
| ATI_1 – Ancient Tree | Not surveyed |
| ATI_5 – Ancient Tree | Not surveyed |
| BT_1 – Veteran Tree | Tree species: European beech (*Fagus sylvatica)*<br>Tree form: phoenix regeneration<br>Crown: crown loss, only a remnant crown outline present<br>Damage: storm damage present<br>DBH: 110cm<br>Deadwood: present<br>Epicormic growth: present on trunk<br>Lichens: present<br>Fungi: not present<br>Holes: not present<br>Hollowing: present<br>Growth: live growth present<br>Management: unknown<br>Split limbs: none<br>Tear-outs: present<br>Stubs: present<br>Water pocket: not present<br><br>**Summary comments:**<br>Large beech tree with fallen canopy. Features include tear out wounds and stumps. Tree attempting to regenerate from lower branches. |
| BT_2 – Veteran Tree | Tree species: pedunculate oak (*Quercus robur*)<br>Tree form: naturally pollard<br>Crown: nearly full crown outline<br>Damage: storm damage present<br>DBH: 141cm<br>Deadwood: present<br>Epicormic growth: present in crown<br>Lichens: present<br>Fungi: not present |

| | |
|---|---|
| | Holes: present<br>Hollowing: present<br>Growth: live growth present – mostly full<br>Management: unknown<br>Split limbs: none<br>Tear outs: present<br>Stubs: present<br>Water pockets: not present<br><br>**Summary comments:**<br>Brown and white rot evident. Tree sheltered by fallen beech tree resulting in an imbalanced crown. Holes and cavities in main stem. |
| BT_3 – Veteran Tree | Tree species: pedunculate oak<br>Tree form: maiden<br>Crown: partial crown outline<br>Damage: storm damage present<br>DBH: 200cm<br>Deadwood: present<br>Epicormic growth: present in crown<br>Lichens: not present<br>Fungi: present<br>Holes: present<br>Hollowing: present<br>Growth: live growth present - partial<br>Management: no evidence<br>Split limbs: none<br>Tear outs: present<br>Stubs: present<br>Woodpecker holes: not present<br><br>**Summary comments:**<br>Large basal cavity and tear outs on the southern and eastern side of the tree. Epicormic growth present throughout the crown. Stubs extending from ground into canopy. |
| BT_4 – Veteran Tree | Tree species: grand fir (*Abies grandis*)<br>Tree form: maiden<br>Crown: nearly full crown outline<br>Damage: storm damage present<br>DBH: 220cm<br>Deadwood: present |

| | |
|---|---|
| | Epicormic growth: no present<br>Lichens: not present<br>Fungi: present<br>Holes: not present<br>Hollowing: not present<br>Growth: live growth present – mostly full<br>Management: no evidence<br>Split limbs: none<br>Tear-outs: present<br>Stubs: present<br>Water pockets: present<br><br>**Summary comments:**<br>Water pockets at 8m. Bark necrosis evident. Crown sparse. Stubs and tear outs present throughout. |
| BT_5 – Veteran Tree | Tree species: pedunculate oak<br>Tree form: maiden<br>Crown: partial crown outline<br>Damage: storm damage present<br>DBH: 131cm<br>Deadwood: present<br>Epicormic growth: present in the crown<br>Lichens: not present<br>Fungi: not present<br>Holes: not present<br>Hollowing: present<br>Growth: live growth present – partial<br>Management: unknown<br>Split limbs: none<br>Tear-outs: not present<br>Stubs: present<br>Water pocket: not present<br><br>**Summary comments:**<br>Approximately half of the stems and canopy lost. Remaining stems standing but decaying to heartwood. Stubs present. Deadwood present in the crown. |
| BT_6 – Veteran Tree | Tree species: European beech<br>Tree form:  naturally pollard<br>Crown: remnant crown outline<br>Damage: storm damage present |

| | |
|---|---|
| | DBH: 80cm<br>Deadwood: present<br>Epicormic growth: present on trunk<br>Lichens: not present<br>Fungi: present<br>Holes: present<br>Hollowing: present<br>Growth: live growth present – residual<br>Management: no evidence<br>Split limbs: none<br>Tear-outs: not present<br>Stubs: not present<br>Water pocket: present<br><br>**Summary comments:**<br>Monolith with regrowth from 2m. Animal gnawing at base. Hollows in old branch stubs. |

**UKHab Species List for Each Transect**

**Table A12.5-8: Transect ECO_A species list**

| ECO_A Transect Points | UKHab species list |
|---|---|
| ECO_A_0 – ECO_A_1 | Secondary birch woodland<br>**Abundant**:<br>Silver birch (*Betula pendula*), wood-sorrel (*Oxalis acetosella*)<br>**Frequent**:<br>bracken (*Pteridium aquilinum*), rhododendron (*Rhododendron ponticum*), creeping soft-grass (*Holcus mollis*), sycamore (*Acer pseudoplatanus*).<br>**Occasional**:<br>Raspberry (*Rubus idaeus*), cleavers (*Galium aparine*), *Viola sp.*, common bent (*Agrostis capillaris*), golden male-fern (*Dryopteris affinis*), tufted hair-grass (*Deschampsia cespitosa*).<br>**Rare**:<br>Ash (*Fraxinus excelsior*), larch sp. (*Larix* sp.), alder (*Alnus glutinosa*), wild angelica (*Angelica sylvestris*), goat willow (*Salix caprea*), grey willow (*Salix cinerea*), hawthorn (*Crataegus monogyna*), wych elm (*Ulmus glabra*), hedge wound-wort (*Stachys sylvatica*), wild strawberry (*Fragaria vesca*). |
| ECO_A_2 – ECO_A_4 | Plantation of mature western hemlock (*Tsuga heterophylla)* and Douglas fir (*Pseudotsuga menziesii*) with occasional mature beech. |

| ECO_A Transect Points | UKHab species list |
|---|---|
| | **Abundant**:<br>Douglas fir, western hemlock-spruce<br>**Frequent**:<br>bracken (locally abundant), wood-sorrel, rhododendron<br>**Occasional:**<br>Broad buckler-fern (*Dryopteris dilatata*), silver birch, beech<br>**Rare:**<br>Larch sp., chickweed-wintergreen (*Trientalis europaea*), hard-fern (*Blechnum spicant*), oak sp. (*Quercus* sp.) |
| ECO_A_5 – ECO_A_18 | N/A. Not surveyed |

**Table A12.5-9: Transect ECO_C species list**

| ECO_C Transect Points | UKHab species list |
|---|---|
| ECO_C_0 – ECO_C_4 | Mature mixed plantation. Western hemlock-spruce, Douglas fir, western red-cedar, silver birch, beech, and rhododendron recorded as present.<br>Ground flora mainly very sparse. A small number of bryophytes in places, but small patches with dog's mercury, male fern, wood-sorrel, wood avens.<br><br>Mixed – part deciduous and part conifer<br><br>**Abundant:**<br>Rhododendron<br>Frequent: western hemlock-spruce, Douglas fir<br>**Occasional:**<br>Oak sp., Sitka spruce (*Picea sitchensis*), sycamore<br>**Rare:**<br>Hard-fern, remote sedge (*Carex remota*), wood-sorrel, common bluebell (*Hyacinthoides non-scripta*), male fern, rowan (*Sorbus aucuparia*), wych elm, Norway maple (*Acer platanoides*), ash, rough meadow grass (*Poa trivialis*), tufted hair-grass, wood avens (*Geum urbanum*), herb-Robert (*Geranium robertianum*). |
| ECO_C_5 – ECO_C_10 | N/A. Not surveyed. |

**Table A12.5-10: Transect ECO_D species list**

| ECO_D Transect Points | UKHab species list |
|---|---|
| ECO_D_0 – ECO_D_1 | Woodland comprising mainly Douglas fir and European larch (*Larix decidua*) between the track and the existing A9. There |

| ECO_D Transect Points | UKHab species list |
|---|---|
| | are intermittent birches along the edge of the woodland, closest to the A9. Very mossy in parts and with stands of tall ruderal species. Enchanters nightshade and dog's mercury present.<br>**Abundant:**<br>Douglas fir, European larch<br>**Frequent:**<br>Wood-sorrel, common bent, rhododendron, grand fir<br>**Occasional:**<br>Tufted hair-grass, male-fern (*Dryopteris filix-mas*), honeysuckle (*Lonicera periclymenum)*<br>**Rare:**<br>Sycamore, Norway maple, silver birch, dog's mercury (*Mercurialis perennis*) |
| ECO_D_2 – ECO_D_3 | A line of tall coniferous trees (western red cedar) with ground flora absent or negligible. Adjacent narrow strip of Larix and Abies. Occasional rhododendron present.<br>**Dominant:**<br>Western red cedar (*Thuja plicata*)<br>**Abundant:**<br>Larch sp., fir sp. (*Abies* sp).<br>**Occasional:**<br>Rhododendron |
| ECO_D_4 | Semi-mature woodland. Partly designed landscape with semi-natural elements. Broken line of mature yews, which are likely planted. Dense stands of Portugal laurel frequent and rhododendron and mature oaks occasional. Red-berried elder was recorded as rare.<br>**Frequent**<br>Yew (*Taxus baccata*), Portugal laurel (*Prunus lusitanica*)<br>**Occasional:**<br>Rhododendron, wood sorrel, male fern, cleavers, mature oak sp.<br>**Rare:**<br>Common box (*Buxus sempervirens*), northern beech fern (*Phegopteris connectilis*), foxglove (*Digitalis purpurea*), European gooseberry (*Ribes uva-crispa*), common nettle (*Urtica dioica*), red elder (*Sambucus racemosa*) |
| ECO_D_5 | Sycamore-dominated woodland with areas of dense rhododendron. Signs of management apparent in places.<br>**Abundant:** |

| ECO_D Transect Points | UKHab species list |
|---|---|
| | Sycamore, rhododendron<br>**Frequent:**<br>Birch sp. (*Betula sp.*), male fern.<br>**Occasional:**<br>Common nettle, yew, larch sp.<br>**Rare:**<br>Common holly (*Ilex aquifolium*), Portugal laurel, ash, dog's mercury, herb Robert, sessile oak (*Quercus petraea*) |
| ECO_D_6 – ECO_D_11 | N/A |

**Table A12.5-11: Transect ECO_E species list**

| ECO_E Transect Points | UKHab species list |
|---|---|
| ECO_E_0 - ECO_E_1 | A planted row of mature western hemlock along the A9-side of the access track with planted European larch present.<br>**Dominant:**<br>Western hemlock<br>**Occasional:**<br>Sycamore<br>Ground flora included bluebell, hedge woundwort and ground ivy. |
| ECO_E_2 - ECO_E_8 | Western hemlock, grand fir and Douglas fir plantation with a poor understorey and ground flora. Occasional patches of wood sorrel and heath bedstraw.<br>**Dominant:**<br>Western hemlock and Douglas fir<br>**Occasional:**<br>wood sorrel, heath bedstraw (*Galium saxatile*), common haircap moss (*Polytrichum commune*)<br>**Rare:**<br>Oak sp. (hybrid), common figwort (*Scrophularia nodosa*) |
| ECO_E_9 - ECO_E_10 | Bracken with scattered scrub (predominately broom) and scattered trees, including silver birch. Some acid grassland and heath vegetation in places e.g. bilberry (*Vaccinium myrtillus*), heath bedstraw, wavy hair-grass, great wood-rush (*Luzula sylvatica*). Some patches of common haircap.<br>**Abundant:**<br>Bracken<br>**Frequent**:<br>Bilberry, heath bedstraw, wavy hair-grass, great wood-rush, raspberry |

| ECO_E Transect Points | UKHab species list |
|---|---|
| | **Occasional**<br>Broom (*Cytisus scoparius*), silver birch, common haircap |
| ECO_E_11 – ECO_E_19 | N/A. Not surveyed |

**Table A12.5-12: Transect ECO_H species list**

| ECO_H Transect Points | UKHab species list |
|---|---|
| ECO_H_0 – ECO_H_3 | **Dominant:**<br>Scot's pine (*Pinus sylvestris*)<br>**Abundant:**<br>Great wood-rush, common bluebell<br>**Frequent:**<br>Wood-sorrel<br>**Occasional:**<br>Common holly (self-seeded), male-fern, beech<br>**Rare:**<br>Pedunculate oak, common hazel (*Corylus avellana*), Norway maple, rowan, St John's-wort (*Hypericum pulchrum*) |
| ECO_H_4 – ECO_H_5 | Mixed planted trees along access track. Line of mature fir sp. on western side of track with occasional beech. On the eastern side of track, sycamore, goat willow, silver birch and elder was present. Sycamore was the most frequent of these species. Variegated yellow archangel present.<br>**Frequent:**<br>Fir sp. |

**Table A12.5-13: Transect ECO_I species list**

| ECO_I Transect Points | UKHab species list |
|---|---|
| ECO_I_0 | Railway embankment with felled trees. Patches of bare ground, raspberry, bramble, rosebay willowherb, bracken, scaly male fern, dog rose, birch seedlings, sycamore seedlings, creeping buttercup present. |
| ECO_I_1 – ECO_I_18 | N/A. Not surveyed |

**Table A12.5-14: Transect ECO_J species list**

| ECO_J Transect Points | UKHab species list |
|---|---|
| ECO_J_0 | Not surveyed in detail. Edge of coniferous plantation and broadleaved woodland areas. |
| ECO_J_1 – ECO_J_14 | N/A. Not surveyed |

**Table A12.5-15: Transect ECO_K species list**

| ECO_K Transect Points | UKHab species list |
|---|---|
| ECO_K_0 – ECO_K_3 | Woodland which is contain a greater proportion of beech compared to oak species. Ground flora was generally absent. Sweet chestnut was also recorded in this area.<br>**Abundant:**<br>Beech, sycamore<br>**Occasional:**<br>Broad buckler-fern, male fern, common bluebell, Rhododendron<br>**Rare:**<br>Sessile oak, great wood-rush, goat willow, common lime (*Tilia x europeae*) |
| ECO_K_4 | Broadleaved woodland. Mature oaks (80cm diameter at breast height), beech and sycamore present.<br>**Abundant:**<br>Beech, sycamore, sessile oak<br>**Frequent:**<br>Male fern, broad buckler-fern, common nettle, hedge wound-wort<br>**Occasional:**<br>Wood avens, herb-Robert, wild strawberry, butterbur (*Petasites hybridis*), cleavers, cock's-foot (*Dactylis glomerata*), common bluebell, common cow-wheat (*Melampyrum pratense*)<br>**Rare:**<br>Elder (*Sambucus nigra*), hawthorn, wych elm, broad-leaved willowherb, wood anemone, birch sp., ash, ground elder (*Aegopodium podagraria*), pignut (*Conopodium majus*), great wood-rush |
| ECO_K_5 | Habitat comprises grassland. |

**Table A12.5-16: Transect ECO_M species list**

| ECO_M Transect Points | UKHab species list |
|---|---|
| ECO_M_0 – ECO_M_2 | Ash and naturally regenerated sycamore were common, with occasional mature beech and oak (DBH up to 60cm). Grand fir was also recorded, but the woodland has been classed as broadleaved.<br>**Frequent:**<br>Sycamore, ash, common bluebell, greater stitchwort (*Stellaria holostea*) |

| ECO_M Transect Points | UKHab species list |
|---|---|
| | **Occasional:**<br>Sessile oak, ash, tufted hair-grass, common nettle, pignut<br>**Rare:**<br>Grand fir, great wood-rush, yellow pimpernel (*Lysimachia nemorum*), rhododendron, herb-Robert, Orpine (*Hylotelephium telephium*) |
| ECO_M_3 – ECO_M_7 | Mixed semi-natural woodland, variable with scattered coniferous species including non-native specimen trees (possibly part of a designed landscape). This included a small group of large cypress. Beech frequent. Mature oaks occasional<br>**Abundant:**<br>Beech<br>**Frequent:**<br>Wood-sorrel<br>**Occasional:**<br>Sessile oak, great wood-rush, oak fern (*Gymnocarpium dryopteris*) (locally abundant), bugle (locally abundant), sycamore, male fern<br>**Rare:**<br>Yew, alder , grand fir, common bluebell, beech fern (*Phegopteris connectilis*), dog's mercury, rhododendron, hard-fern, Douglas fir, ash, common hazel, wood anemone |
| ECO_M_8 – ECO_M_11 | N/A. Not surveyed. |

**Table A12.5-17: Transect ECO_N species list**

| ECO_N Transect Points | UKHab species list |
|---|---|
| ECO_N_0 – ECO_N_4 | A9 verge transitioning to woodland. Verge mown close to carriageway but rank away from it. Gravel drainage channel present, approx. 0.5m wide.<br>Woodland comprising mature larch and Douglas fir plantation on steep slope. Some areas of Norway spruce. Occasional beech. Ground flora variable but quite dense in places, with lady fern, wood-sorrel and tufted hair-grass the most common species.<br>**Abundant:**<br>Larch sp., Douglas fir<br>**Frequent:**<br>Lady-fern<br>**Occasional:**<br>Norway spruce, beech |

| | |
|---|---|
| | **Rare:**<br>Sitka spruce, grand fir, northern beech fern, northern oak fern, hard- fern, hard shield-fern (*Polystichum aculeatum*), herb-Robert, rhododendron |
| ECO_N_5 – ECO_N_20 | N/A. Not surveyed. |

**Table A12.5-18: Transect ECO_P species list**

| ECO_P Transect Points | UKHab species list |
|---|---|
| ECO_P_0 – ECO_P_5 | Douglas fir plantation with thinning operations undertaken allowing greater ground flora cover, including a variety of ferns and herbs. Scattered beech. Grand fir saplings.<br>**Dominant:**<br>Douglas fir<br>**Abundant:**<br>Great wood rush, lady-fern<br>**Frequent:**<br>Wood sorrel, tufted hair-grass, wood fern sp. (*Dryopteris* sp.)<br>**Rare:**<br>Beech, dog's mercury, oak-fern, common bluebell |
| ECO_P_6 – ECO_P_19 | N/A. Not surveyed. |

**Table A12.5-19: Transect ECO_R species list**

| ECO_R Transect Points | UKHab species list |
|---|---|
| ECO_R_0 – ECO_R_3 | Dominated by Douglas fir, with spruce also present. Some variation in trees with some oak near the riverside edge, and other broadleaves along the field boundary. Holly seedlings. Sycamore, oak, rowan. Scattered mature sessile oaks.<br>**Dominant:**<br>Douglas fir<br>**Abundant:**<br>Wood-sorrel<br>**Frequent:**<br>Honeysuckle, bracken, dog's mercury<br>**Occasional:**<br>Sessile oak, bugle, broad-leaved willowherb, common bluebell<br>**Rare:**<br>Climbing corydalis (*Ceratocapnos claviculata*), wood anemone |
| ECO_R_4 – ECO_R_9 | N/A. Not surveyed. |

**Table A12.5-20: Transect ECO_U species list**

| ECO_U Transect Points | UKHab species list |
|---|---|
| ECO_U_0 | Area of regenerating mixed woodland on steep embankment. Trees range from seedling to semi-mature. Sitka spruce, larch, Douglas fir, birch, oak, sycamore, bird cherry. Varies from dense stands to more open areas. Patches of bracken and male fern, patches<br>**Frequent:**<br>Birch sp., bracken, male fern, broom<br>**Occasional:**<br>Sycamore, Sitka spruce, larch sp., Douglas fir, bramble (*Rubus fruticosus* agg.), raspberry<br>**Rare:**<br>Bird cherry (*Prunus padus*), ash (dieback noted), sessile oak, Rhododendron |
| ECO_U_1 – ECO_U_16 | N/A. Area not surveyed. |

**Table A12.5-21: Transect ECO_X species list**

| ECO_X Transect Points | UKHab species list |
|---|---|
| ECO_X_0 – ECO_X_4 | Clear-felled plantation with stumps and some brash. Oak standards left standing during felling.<br>**Abundant:**<br>Broom, wavy hair-grass<br>**Frequent:**<br>Gorse (*Ulex europaeus*), silver birch (full grown and seedlings), downy birch (*Betula pubescens*, full grown and seedlings) red fescue (*Festuca rubra*), common bent, Yorkshire fog (*Holcus lanatus*), tufted hairgrass, raspberry, bramble, lady's glove<br>**Occasional:**<br>Bracken, soft rush (*Juncus effusus*), oak sp., heath bedstraw, rhododendron, cock's foot, great wood-rush<br>**Rare:**<br>Common bluebell |
| ECO_X_5 – ECO_X_17 | N/A. Not surveyed. |

**Table A12.5-22: Transect ECO_Y species list**

| ECO_Y Transect Points | UKHab species list |
|---|---|
| ECO_Y_0 | Railway embankment with felled trees, which transitions to woodland which was not surveyed. The embankment had patches of bare ground.<br>**Occasional:** |

| | |
|---|---|
| | Raspberry, bramble agg., rosebay willowherb (*Chamaenerion angustifolium*), bracken, broad buckler-fern, dog-rose (*Rosa canina*), birch sp. (saplings), sycamore (saplings) |
| ECO_Y_1 – ECO_Y_18 | N/A. Not surveyed. |

**Table A12.5-23: Transect ECO_Z species list**

| ECO_Z Transect Points | UKHab species list |
|---|---|
| ECO_Z_0 – ECO_Z_3 | N/A. Not surveyed. |

**Table A12.5-24: Transect ECO_AB species list**

| ECO_AB Transect Points | UKHab species list |
|---|---|
| ECO_AB_0 – ECO_AB_4 | N/A. Not surveyed. |

**Table A12.5-25: Transect ECO_AC species list**

| ECO_AC Transect Points | UKHab species list |
|---|---|
| ECO_AC_0 – ECO_AC_10 | N/A. Not surveyed. |

**Table A12.5-26: Transect ECO_AH species list**

| ECO_AH Transect Points | UKHab species list |
|---|---|
| ECO_AH_0 – ECO_AH_6 | Coniferous plantation of Douglas fir and Norway spruce with good ground cover in areas, including a variety of ferns and herbs. In an area of windthrow, latent species have reclaimed the canopy, including beech, sessile oak and holly.<br>**Dominant:**<br>Douglas fir, Norway spruce<br>**Occasional:**<br>Rhododendron<br>**Rare:**<br>Beech, sessile oak, holly, Scot’s pine |
| ECO_AH_7 – ECO_AH_20 | N/A |