A12 Chelmsford to A120 widening scheme

TR010060

6.3 ENVIRONMENTAL STATEMENT

APPENDIX 9.15 ASSESSMENT OF AIR QUALITY IMPACTS ON ECOLOGY RECEPTORS

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A12 Chelmsford to A120 widening scheme

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ENVIRONMENTAL STATEMENT

APPENDIX 9.15 ASSESSMENT OF AIR QUALITY IMPACTS ON ECOLOGY RECEPTORS

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1 Executive summary

1.1.1 This report accords with the requirements of Design Manual for Roads and Bridges standards LA 104 Environmental Assessment and Monitoring, LA 105 Air Quality and LA 108 Biodiversity.

1.1.2 Nitrogen deposition at ecological receptors within 200m of the Affected Road Network was modelled (as reported in Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1]). Receptors that were screened in for ecological assessment of nitrogen deposition were those that exceeded the following change in nitrogen deposition thresholds:

- A change in nitrogen deposition of more than 1% of the lower critical load for the applicable habitat
- A change in nitrogen deposition of more than 0.4kg N/ha/yr, as this is indicative of the lowest change in nitrogen deposition likely to lead to the loss of one species

1.1.3 For the construction phase, six receptors, consisting of one verified veteran tree, four potential veteran trees and one potential ancient tree were screened in for ecological assessment. For the operational phase, eight designated sites and 23 potential and verified veteran and ancient tree locations were screened in.

1.1.4 Desk study data and information from detailed site investigations (where possible) were used to inform the assessment of ecological effects. For designated sites and areas of ancient woodland, the extent of the area predicted to be affected by increased nitrogen deposition was calculated. For all receptors, the time taken for the Do-Something NO_x concentration to reduce to the Do-Minimum NO_x concentration was calculated as an indicator of the duration of impact.

1.1.5 The assessment concludes that the ecological effects on the six receptors during construction would not be significant, mainly because the duration of impact would be a maximum of four years (the duration of the construction programme).

1.1.6 During operation, the only designated site with a predicted significant effect is Perry's Wood Local Wildlife Site (which is valued at a national level as it supports ancient woodland). The increase in nitrogen deposition as a result of the proposed scheme is predicted to affect approximately 20% of this site for approximately 11 years. Given the national importance of ancient woodland, the significance of this effect is large adverse (significant). All other designated sites and veteran trees are assessed as not significant.

2 Introduction

2.1 Background

2.1.1 The A12 Chelmsford to A120 widening scheme (the 'proposed scheme') comprises improvements to the A12 between junction 19 (Boreham interchange) at TL 741094, and junction 25 (Marks Tey interchange) at TL 917238, a distance of approximately 24km, or 15 miles. The scheme involves widening the A12 to three lanes throughout (where it is not already three lanes) with a bypass between junctions 22 and 23 and a second bypass between junctions 24 and 25. It also includes safety improvements, including closing off existing private and local direct accesses onto the main carriageway, and providing alternative provision for walkers, cyclists and horse riders to existing routes along the A12, which would be removed.

2.1.2 The proposed scheme is classed as a Nationally Significant Infrastructure Project under the Planning Act (2008), triggering the need to apply for a Development Consent Order.

2.1.3 Anthropogenic emissions of ammonia (NH_3) and nitrogen oxides (NO_x) to the atmosphere have increased significantly over the last century, due mainly to agricultural intensification and burning of fossil fuels. Global emissions of oxidised nitrogen from fossil fuel combustion and reduced nitrogen from agricultural sources are causing an increase in nitrogen deposition (referred to as N deposition throughout the rest of this report), both as dry deposition in gaseous form and as wet deposition in precipitation. There is an increasing body of knowledge of the potential impacts of N deposition on semi-natural vegetation, many of which are sensitive to increases in N deposition as their ecological function, species composition and diversity depend on low levels of nutrient nitrogen. Most impacts on semi-natural vegetation as a result of increased N deposition are therefore through increased nutrient levels, but there is also a pathway for impact through acidification of soil and water and disruption of nutrient cycling processes.

2.2 Purpose of the report

2.2.1 This document presents the results of an assessment of potential effects of air quality changes at sites of biodiversity importance resulting from the construction and operation of the proposed scheme. The assessment considers statutory and non-statutory designated sites, ancient woodland and veteran trees within 200m of the Affected Road Network (ARN) for the proposed scheme where it is predicted that N deposition would increase above threshold levels set out in the Design Manual for Roads and Bridges (DMRB) LA 105 Air Quality (Highways England, 2019).

2.2.2 The methodology followed is described in Section 3 of this report, with further detail in Annex A. The results of screening are presented in Section 4. Baseline descriptions of the receptors screened in for assessment are provided in Section 5, with further detail on the results of ecological site investigations, where undertaken, in Annexes B to F of this report. Section 6 is a literature review to inform the impact assessment, which is presented in Section 7.

3 Methodology

3.1 Overview

3.1.1 The ecological assessment of the effects of N deposition resulting from the proposed scheme accords with the requirements DMRB standards LA 104 Environmental Assessment and Monitoring (Highways England 2020a), LA 105 Air Quality (Highways England, 2019) and LA 108 Biodiversity. (Highways England, 2020b).

3.1.2 The assessment methodology also refers to CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1. The professional judgement of a competent expert for biodiversity has been applied to the overall assessment of impact level and significance, as per DMRB LA 105, DMRB LA 108 and CIEEM (2018).

3.1.3 The assessment comprises the following elements:

- desk study to identify ecological features for consideration
- screening assessment to identify sites for assessment of the effects of N deposition
- site investigation to inform assessment of N deposition
- assessment of ecological significance of N deposition

3.2 Desk study

3.2.1 DMRB LA 105 (Highways England, 2019) requires an assessment on ecological features of international, national and local nature conservation importance within 200m of the ARN. The ARN is defined in Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1] following application of the scoping criteria within DMRB LA 105.

3.2.2 According to DMRB LA 105, the impact of construction activities on vehicle movements requires assessment if the construction programme is predicted to last longer than two years. The construction of the proposed scheme is anticipated to last four years and therefore modelling of traffic and N deposition for the construction period has been undertaken. The construction traffic assessment and air quality modelling were undertaken for 2025, which is representative of the year when construction activity is likely to be greatest (i.e. the peak construction year).

3.2.3 The operational ARN was identified using traffic modelling for 2027 (opening year scenario). The construction based ARN has been combined with the operational ARN for practical assessment reasons. A spatial representation of the combined construction and operational ARNs is shown in Figure 6.1 of the Environmental Statement [TR010060/APP/6.2].

3.2.4 Ecological features within 200m of the combined ARN were identified, with the following included in the air quality screening assessment:

- International importance – Ramsar sites, Special Protection Areas (SPA) and Special Areas of Conservation (SAC)

- National importance – Sites of Special Scientific Interest (SSSI), ancient woodland and veteran and ancient trees
- County importance – Local Nature Reserves (LNR), Local Wildlife Sites (LWS), Roadside Nature Reserves (RNR) and Nature Improvement Areas

3.2.5 Hereafter, the features included in the assessment are referred to as 'sites'. The locations of all sites considered in the screening assessment are shown in Figure 6.7 [TR010060/APP/6.2] of the Environmental Statement and Figure 1 of this report.

3.2.6 The sites were identified as part of the desk study for the proposed scheme, as described in the Phase 1 Habitat Survey Report (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) and Chapter 9: Biodiversity, of the Environmental Statement [TR010060/APP/6.1].

3.2.7 Field surveys undertaken as part of the Phase 1 Habitat Survey contributed additional information, such as the locations of woodland with ancient characteristics that are not listed on the Ancient Woodland Inventory (henceforth known as 'potential ancient woodland') and trees with multiple features that are likely to meet the criteria of ancient and/or veteran tree status but are not recorded on the Ancient Tree Inventory (Woodland Trust, 2021). Details are provided in the Phase 1 Habitat Survey Report (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) and Arboriculture Impact Assessment (Appendix 8.4 of the Environmental Statement [TR010060/APP/6.3]).

3.2.8 Information about habitats within SSSIs was taken from site citations. For LWS and other sites of county importance information about habitats was taken from site descriptions obtained as part of the desk study.

3.3 Screening

3.3.1 Screening was carried out to identify sites for further assessment of N deposition. Screening incorporates the steps in the flow diagram, Figure 2.98, in DMRB LA 105 as follows:

- Calculate the Do-Minimum (DM) and Do-Something (DS) proposed scheme N deposition
- Is the total N deposition with the proposed scheme less than the applicable lower critical load? (the applicable lower critical load is for the habitat for which the site is designated and /or that is most sensitive to nitrogen)
- Is the change in N deposition with and without the proposed scheme less than 1% of the lower critical load?
- Identify whether the site air quality attribute is either restore or maintain[1]

[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, sites were assumed to have a 'restore' attribute.

- 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 lower critical load range[2]
- Does the change in N deposition associated with the proposed scheme lead to the loss of one species?

3.3.2 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 (sand dunes, heathland, bog and acid grassland) and therefore DMRB LA 105 instructs to take a figure of 0.4 kg N/ha/yr, as this is the lowest change in N deposition likely to lead to the loss of one species in any of the studied habitats, excluding nutrient impoverished sand dunes. Therefore, sites are screened in for further assessment if the change in N deposition is greater than 0.4 kg N/ha/yr.

3.3.3 The modelling that informs the screening process is described fully in Appendix 6.3: Dispersion modelling process, of the Environmental Statement [TR010060/APP/6.3] and is summarised below.

3.3.4 The background N deposition rates and critical loads for specific habitats were obtained from the Air Pollution Information System (APIS[3]). The habitats for each site were determined from site citations and aerial imagery. If a site is designated for more than one habitat type then the habitat with the lowest critical load was modelled. However, in the case of Whetmead LNR / LWS, where most of the site is grassland, and the strip of woodland on the western boundary of the site is to be removed as part of the proposed scheme, it was considered appropriate to produce calculations for grassland rather than woodland, even though woodland has a lower critical load than grassland.

3.3.5 Transects from the edge of the designated habitat boundary up to 200m from the edge of the road were modelled in 10m increments. Professional judgement was used to position the transects, such that they were located in habitats for which the sites were designated and /or that are most sensitive to nitrogen. The ecological transect locations modelled in this assessment are shown on Figure 6.7 of the Environmental Statement [TR010060/APP/6.2] and Figure 2 of this report.

3.3.6 There are two SSSIs within 200m of the ARN; Tiptree Heath SSSI and Marks Tey Brickpit SSSI. However, as a geological feature, Marks Tey Brickpit is not sensitive to changes in N deposition. Nitrogen sensitive habitats were identified in Tiptree Heath SSSI (dry shrub heath, acid grassland and broadleaved woodland) and three ecological transects were modelled for the site in this assessment. Traffic modelling indicated that vehicle flows are likely to be reduced near Tiptree Heath SSSI as a result of the proposed scheme.

3.3.7 A total of 43 designated sites, of which 12 have dual designations, were identified within 200m of the ARN. The 43 sites include a named woodland (Porter's Grove) which is within Boreham Road Gravel Pits LWS and was identified in a field survey to potentially be of ancient woodland quality. The list of sites considered in screening is in Table 3.1, which replicates Table 6.12 of Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1].

[2] The lowest change in N deposition is derived from Table 21 in Caporn *et al*. (2016).
[3] http://www.apis.ac.uk/

3.3.8 Veteran and ancient trees of both potential and verified status were considered in the assessment. A total of 52 verified and potential veteran tree locations were identified in the study area, the locations of which are shown on Figure 6.7 of the Environmental Statement [TR010060/APP/6.2] and Figure 2 of this report. Five of these locations represent groups of trees identified during arboricultural surveys. Based on these surveys, the total number of veteran trees within 200m of the ARN was 65. All assessed ecological transects and veteran tree locations are shown on Figure 6.7 of the Environmental Statement [TR010060/APP/6.2] and Figure 2 of this report.

Table 3.1 Summary of sites with nitrogen sensitive features and habitats modelled in this assessment

Site name	Site designation	Number of transects modelled	Habitat	Lower critical load (kg N/ha/yr)	Average background[4] deposition rate (kg N/ha/yr
Tiptree Heath	SSSI	3	Dwarf shrub heath	10	18.5
Lady Grove	Ancient woodland/LWS	3	Broadleaved, mixed and yew woodland	10	32.8
Kelvedon Hall Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	32.5
Inworth Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	32.5
Perry's Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	32.5
Layer Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	41.9
Gol Grove/Hanging Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	32.9
Kiln Wood	Ancient woodland/LWS	1	Broadleaved, mixed and yew woodland	10	29.8
Boreham Road Gravel Pits/ Porter's Grove	LWS/potential ancient woodland	2	Broadleaved, mixed and yew woodland	10	31.8
Whetmead	LNR/LWS	2	Neutral grassland	20	16.94

[4] Background deposition rates are based on a three year average (2017-2019) and were obtained from APIS in March 2021.

Site name	Site designation	Number of transects modelled	Habitat	Lower critical load (kg N/ha/yr)	Average background[4] deposition rate (kg N/ha/yr
Spring Lane Meadows	LNR/LWS	1	Broadleaved, mixed and yew woodland	10	31.6
Hilly Fields	LNR/LWS	1	Broadleaved, mixed and yew woodland	10	31.6
Galleywood Common	LNR/LWS	4	Neutral grassland	20	18.3
Sir Hughes' Woods	LWS	1	Broadleaved, mixed and yew woodland	10	32.8
Sandon Pit	LWS	1	Calcareous grassland	15	18.3
Sandon Riverside	LWS	1	Broadleaved, mixed and yew woodland	10	33.6
Stonage Wood	LWS	1	Broadleaved, mixed and yew woodland	10	33.6
Braxted Park	LWS	3	Broadleaved, mixed and yew woodland	10	32.5
Inworth Grange Pits	LWS	1	Acid grassland	10	18.3
Brockwell Meadows	LWS	1	Neutral grassland	20	18.3
Tiptree Church	LWS	1	Neutral grassland	20	18.3
Pods and Conyfield Woods	LWS	2	Broadleaved, mixed and yew woodland	10	32.5
Stanway Pits	LWS	1	Calcareous grassland	15	18.3
Cook's Lane Lexden	LWS	1	Broadleaved, mixed and yew woodland	10	31.6
Cymbeline Meadows	LWS	1	Neutral grassland	20	17.9
Spring Grove	LWS	1	Broadleaved, mixed and yew woodland	10	31.6

Site name	Site designation	Number of transects modelled	Habitat	Lower critical load (kg N/ha/yr)	Average background[4] deposition rate (kg N/ha/yr
West House Wood	LWS	1	Broadleaved, mixed and yew woodland	10	31.6
Smythe's Green	LWS	1	Neutral grassland	20	23.2
Lower Road, Birch Verges	LWS	1	Neutral grassland	20	18.3
Lower Road, Birch Verges	LWS	1	Broadleaved, mixed and yew woodland	10	32.9
Ram Plantation	LWS	1	Broadleaved, mixed and yew woodland	10	32.9

3.3.9 Table 3.1 shows the existing average background deposition rate is greater than the lower critical load of the modelled habitat in 25 of the designated sites identified in the air quality study area. The only sites for which the background deposition rate is lower than the lower critical load are those with neutral grassland as the modelled habitat.

3.3.10 For the purposes of the N deposition modelling, veteran trees were considered as 'broadleaved, mixed and yew woodland' with a lower critical load of 10 kg N/ha/yr. The average nitrogen background deposition rates ranged from 29.96 to 38.22 kg N/ha/yr across all veteran trees in the assessment. Therefore, the existing average background deposition rate is greater than the lower critical load at all veteran tree locations in the air quality study area.

3.3.11 The total N deposition rates associated with road-increment NO_2 and ammonia (NH_3) were calculated at each ecological receptor location for the peak construction year (2025), DM (predicted for scheme opening year of 2027 but assuming the proposed scheme was not progressed) and DS (predicted for scheme opening year and assuming the proposed scheme was progressed) scenarios. The conversion of road increment NO_2 (in $\mu g/m^3$) to N deposition (kg N/ha/yr) was as follows:

- grassland and similar habitats: 1 $\mu g/m^3$ of NO_2 = 0.14 kg N/ha/yr
- forests and similar habitats: 1 $\mu g/m^3$ of NO_2 = 0.29 kg N/ha/yr

3.3.12 The calculation of N deposition from road-increment NH_3 applied the Draft National Highways (2021) ammonia N deposition tool (version 2.0), as described in Appendix 6.3 of the Environmental Statement [TR010060/APP/6.3].

3.3.13 The road N deposition rate for each point along the transect was then added to the corresponding background N deposition rate obtained from the APIS website[5] and compared with the lowest critical load for habitats at the sites.

3.3.14 Sites were screened in for further assessment where the N deposition in the DM and DS scenarios was greater than 1% of the relevant lower critical load for the site and greater than 0.4 kg N/ha/yr, as explained above.

3.4 Site investigation

3.4.1 Figure 2.98 of DMRB LA 105 states that the purpose of the site investigation is to determine whether there are '*species located in the area where the assessment has determined an increase in N deposition that could lead to loss of one species*'. This is interpreted as identification of ecological features potentially sensitive to N deposition that could be impacted as a result of the proposed scheme.

3.4.2 Sites where the predicted N deposition exceeded the 0.4kg N/ha/yr threshold were subject to ecological site investigation. Site visits were undertaken in August 2021 and May 2022, to identify and record the following:

- vegetation composition, structure and condition, and record of any vegetation gradients
- vascular plant species sensitive to N deposition
- evidence of site management
- habitat condition (using Defra Metric 3.1) and any evidence of pressures and threats determining current habitat condition

3.4.3 Within each site, the area investigated comprised that predicted to be exposed to an increase in N deposition greater than 0.4 kg N/ha/yr, together with adjacent areas, in order to fully investigate the condition of the site, identify vegetation gradients or other trends and to locate nitrogen sensitive species.

3.4.4 Vegetation composition was recorded using lists of vascular plant species together with a qualitative record of their abundance using the DAFOR scale ('dominant', 'abundant', 'frequent', 'occasional' or 'rare'). Where a quantitative record of vegetation was considered to be required, quadrats were recorded following the method of the National Vegetation Classification (Rodwell, 2006). Bryophytes and lichens were recorded where these formed a significant proportion of the vegetation and/or were likely to form nitrogen sensitive assemblages. However, epiphytic bryophytes and lichens were not surveyed in detail.

3.4.5 Representative photographs were collected to illustrate the features recorded.

[5] Background deposition rates are based on a three year average (2017-2019) and were obtained from APIS in March 2021

3.5 Ecological assessment

3.5.1 The ecological assessment of the effects of N deposition on the sites screened in as per DMRB LA 105 (Highways England, 2019) was undertaken in accordance with DMRB LA 104 (Highways England, 2020a) and LA 108 (Highways England, 2020b). The assessment also aligned with CIEEM (2018) and relied on professional judgement for determination of impact level and significance. Further detail on the approach taken is given below, with respect to:

- variables used to describe baseline and condition
- determination of importance of designated sites and habitats
- characterisation of impacts
- determination of impact levels and significance

Variables used to describe baseline and condition

3.5.2 Site-specific information has been gathered from desk study and detailed site investigation. This was used to describe the baseline and to inform the assessment of level of impact. Published information and site-specific variables considered were:

- Citation / reason for site designation (where available):
  - Aerial imagery of designated site / habitat to help inform habitat distribution
  - Species composition (using species-specific Ellenberg indicator values for nitrogen to indicate the existing degree of nutrient enrichment and species sensitive to nitrogen – see below)
  - Evidence of gradients in vegetation composition, structure and condition to provide an indication of exist influences on site/habitat
  - Existing site management and pressures and threats e.g. over/under-grazing; significant recreation pressure leading to impacts such as trampling, soil compaction, increased nutrient loading, evidence of existing degradation due to N deposition from external sources such as adjacent land use

Species composition and Ellenberg values

3.5.3 Detailed site investigations focussed on the areas of the site which the air quality modelling predicted would be affected by a change in nitrogen above the 0.4 kg N/ha/yr screening threshold (see ‘Extent’ sub-section below). Plant species lists were compiled during the detailed site investigations and Ellenberg indicator values assigned following Hill *et al.* (2004) and Hill *et al*. (2007).

3.5.4 Ellenberg indicator values provide an indication of existing nutrient status and help to identify species that are potentially sensitive to N deposition and therefore could be at risk of loss due to a scheme related increase in N deposition (in accordance with DMRB LA 105 which requires an assessment of whether the predicted change in N deposition could lead to the theoretical loss of one plant species from the site).

3.5.5 The Ellenberg indicator value for nitrogen gives a general indication of preference for soil fertility, with low values corresponding to species with high stress tolerance to nutrient/nitrogen levels (Grime *et al*., 1997). They are closely correlated with the stress values of Grime (1979; 2001). As there is limited evidence for the actual response and degree of sensitivity of individual species to N deposition, these are referred to as species 'potentially sensitive to N deposition'.

3.5.6 The Ellenberg Index has been used on local and regional scales to detect the impact of N deposition on species composition (reported in Pitcairn *et al*., 2006). It is considered that the index is a useful tool for detecting floristic shifts consistent with increased nutrient availability and ecosystem eutrophication (Sutton *et al*., 2004, Pitcairn *et al*., 2006).

3.5.7 Research has shown that Ellenberg indicator values correlate well with atmospheric N deposition, confirming the validity of the method in indicating enhanced N deposition. It also provided a useful assessment of the nitrogen status of a site, particularly along known gradients in N deposition (Mitchell *et al*., 2005).

3.5.8 Work by Pitcairn *et al*., (2006) categorised species typical of different habitats as nitrophobes or nitrophiles, depending on their response to enhanced N deposition. Although many species characteristic of more fertile sites such as mixed deciduous woodlands may have quite high Ellenberg indicator values, they are sensitive to high levels of N deposition and hence can be referred to as nitrophobes.

3.5.9 Nitrophiles include those species of a high Ellenberg indicator value, known to exist in the habitat type and species which can be classed as potential nitrophiles. Potential nitrophiles may be species with a low Ellenberg indicator value but known to respond rapidly to increased nitrogen. In some cases the potential nitrophiles may be constant or common species in that community but research has shown the potential for these species to respond to increased nitrogen (Pitcairn *et al*., 2006).

3.5.10 The lists of nitrophiles and nitrophobes in the Pitcairn *et al.,* (2006) report have been used to help characterise possible responses to N deposition in the sites under consideration in this assessment. Those species with an Ellenberg indicator value of 1-3 are likely to be nitrophobes and considered to be potentially sensitive to N deposition. Ellenberg indicator values for nitrogen are given in Table 3.2.

Table 3.2 Ellenberg nitrogen indicator values

Ellenberg Nitrogen value	Explanation
1	Indicator of extremely infertile sites
2	Between 1 and 3
3	Indicator of more or less infertile sites
4	Between 3 and 5
5	Indicator of sites of intermediate fertility
6	Between 5 and 7
7	Plant often found in richly fertile places
8	Between 7 and 9
9	Indicator of extremely rich situations, such as cattle resting places or near polluted rivers

Evidence of gradients in vegetation composition, structure and condition

3.5.11 The assessment of effects on the integrity of a site or habitat needs to consider the area's structure, function, composition and connectivity. To inform this, evidence for the presence of vegetation gradients (changes in vegetation structure and composition with distance from the existing road) are considered to indicate whether any existing factors such as site management or nutrification/pollution from external sources may have influenced the area's development towards its current structure. The impact of any additional nitrogen loading on habitats needs to consider these baseline conditions and how they may influence the habitat response to increased nitrogen loading.

Existing pressures and threats

3.5.12 Evidence of any pressures on, or threats to, an area's condition is also used to inform the baseline condition for the site. Factors include grazing intensity leading to habitat succession or changes in species composition and site structure; recreational use leading to vegetation trampling, soil compaction, littering, nutrient enrichment from dogs; adjacent land use where activities such as farming can be significant sources of N deposition. Such factors can strongly influence vegetation structure and composition and will inform how additional nitrogen loading may affect it.

Determination of importance

3.5.13 The importance of the designated habitats has been determined using Table 3.9 in DMRB LA 108 Biodiversity (Highways England, 2020b).

3.5.14 The following geographic levels of importance have been assigned:

- International importance – Ramsar sites, SPA SAC
- National importance –SSSI, ancient woodland and veteran trees
- County importance – LNR, LWS, RNR and Nature Improvement Areas

Characterisation of impacts

3.5.15 The range of variables described above, which influence an area's structure, function and composition, as well as the connectivity of associated habitats both within and outwith its boundaries, highlight the complex adaptive nature of these ecosystems. When considering the characterisation of the impact of increased N deposition on an area, it is critical that the conditions which influence its structure, function, composition and connectivity are assessed on a site-specific basis. This fundamental approach is relevant to all ecological impact assessment.

3.5.16 Table 3.11 of DMRB LA 108 describes the different levels of impact (from major to no change) 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).

3.5.17 According to DMRB LA 108, and in line with CIEEM guidance on Ecological Impact Assessment (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

3.5.18 These are addressed in turn below.

Positive or negative

3.5.19 Air quality modelling generates values for N deposition for the DM scenario which is the predicted opening year for the scheme but without the proposed scheme being implemented, and a DS scenario which is the predicted opening year for the scheme with the proposed scheme having been implemented. Full detail of this is provided in Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1]. It is possible that modelling might predict that some designated habitats will experience a DS N deposition that is lower than DM and therefore a potential beneficial effect. However, these receptors are not screened in for ecological assessment and so are not considered here. Only designated habitats 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.

Duration and reversibility

3.5.20 Duration of impact (for sites and veteran trees) was estimated by calculating the time taken for the DS NO_x emissions to reduce to the DM NO_x emissions at opening year. This calculation takes into account the forecast reductions in 'per vehicle' emissions based on the Defra Emission Factor Toolkit and gives an indication of when the total emissions from the road as a result of the proposed scheme would return to levels before the proposed scheme was implemented. The calculation interpolates total emissions between the opening year (2027) and design year (2042) DS scenarios (therefore takes into consideration growth in traffic), meaning that the maximum duration calculated by this method is 15 years and, if the modelled emissions have not reduced to the DM value in that timeframe, the output is given as greater than 15 years. Further details of this method are provided in Annex A of this report.

3.5.21 Whilst there is an increase in emissions at a number of sites with a range of durations where N deposition from the road will return to pre-proposed scheme levels, as the fleet transitions to electric, particularly cars and vans, this will mean that emissions of NOx 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 designated habitat. Furthermore, it is considered that many ecosystem changes due to long-term low levels of N deposition are theoretically reversible, although may require intervention through habitat management to remove biomass, nutrient loading and competition from dominant species from the system. Research on the recovery of grassland and heathland habitats after experimental changes in N deposition are reported in UKREATE (2007).

3.5.22 In view of the above, 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. For example, a poorly managed heavily degraded site may present less opportunity for restoration / reversibility of impacts than a site currently in good condition under favourable management. Where information is limited or there is any uncertainty in terms of impact level, a precautionary approach is adopted and it is assumed that the impact is irreversible. The individual site assessments explain the rationale for determination of reversibility.

Extent

3.5.23 For designated sites and habitats, the extent of impact has been estimated by using modelled transects, 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 a polygon generated within the site, parallel to the ARN, which provided an estimate of the extent of the site which would be affected by a change in N deposition above the 0.4 kg N/ha/yr threshold. The percentage of the site affected was calculated by dividing the affected area extent by the total area of the site. Extent could not be calculated for veteran trees, as these are point receptors.

3.5.24 Examination of aerial imagery and detailed site investigation contributed to the assessment of the distribution of sensitive habitats within the site and which habitat types coincide with the affected area.

3.5.25 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. Therefore, the calculated area represents a worst case, with any effects due to increased N deposition most likely to be evident closer to the road. The assessment considers the potential for changes in vegetation composition (the loss of one species in accordance with DMRB LA 105) within the affected areas and if there is a risk of habitat loss (e.g. a change from one habitat type to another).

3.5.26 The extent of area affected with respect to the net area in hectares and the proportion of the site affected is a key factor in identifying possible impacts on site integrity, in terms of a site's structure, function, composition and connectivity. This therefore has to take into account the site-specific baseline when considering how integrity may be affected. For example, if the site investigation determines that there are existing edge effects or degradation of habitat due to an existing high N deposition baseline or management practices, then an adverse effect on integrity of the site from additional N deposition may be less likely.

3.5.27 The potential for an effect on site integrity is also dependent on 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. The interaction between the different factors influencing site integrity is assessed on a site-specific basis using professional judgement.

Magnitude

3.5.28 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 nitrogen deposited on the sites under consideration vary, as does the baseline N deposition.

3.5.29 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 background, DM and DS values.

3.5.30 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 Section 7 of this report. 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

3.5.31 Given that N deposition is ongoing (albeit declining during the operational phase of the proposed scheme) and is measured in units of kg per hectare per year, frequency is categorised as 'annual' for all designated habitats.

Timing

3.5.32 As described above under frequency, N deposition continues throughout the operational phase of the proposed scheme. Therefore, timing is described as 'ongoing' for all designated habitats.

Determination of impact levels and significance

3.5.33 The professional judgement of a competent expert for biodiversity has been applied to the overall assessment of impact level and significance, as per DMRB LA 105, DMRB LA 108 and CIEEM (2018).

Impact level

3.5.34 Impact level is defined in Table 3.11 of DMRB LA 108 which describes the different levels of impact (from major to no change). 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 extent, magnitude, frequency and/or timing of the impact).

3.5.35 In order to make assessments of effects on integrity or key characteristics of a resource, it is critical to define what these mean.

3.5.36 Integrity is defined as '*the coherence of a site's ecological structure and function across its whole area*' (European Commission, 2000). In assessing the potential for effects on integrity, it is essential 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.

3.5.37 Key characteristics are considered to be the reasons for which a site is designated. For statutory designated sites the reasons for designation are described in the site citation but for non-statutory designations such as LWS, the key characteristics may be less obvious and require determination through further desk study or site survey. The key characteristics of ancient woodland sites depend on the vegetation community that the site supports and factors such as its geology, soils and management history. Therefore, these are considered on a site-specific basis.

3.5.38 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.

3.5.39 The existing coherence of ecological structure and function of area of designated habitat is relevant to the assessment of potential effects on integrity. For example, previous agricultural intensification or infrastructure development may have resulted in fragments of habitat that are no longer considered of sufficient size to support the typical ecosystem processes and functioning of that habitat type. Research on woodland edge effects suggests that the edge effect extends to approximately 90m (McCollin *et al*., 2017) and therefore a woodland patch would need to more than 180m wide to support 'core habitat' that supports the typical ecosystem processes.

Significance

3.5.40 A matrix for determining the significance of effects is presented in Table 3.13 of DMRB LA 108 and is reproduced in Table 9.9 of Chapter 9: Biodiversity [TR010060/APP/6.1].

3.6 Limitations

3.6.1 Site investigations were carried out in summer 2021 at those sites where the results of air quality modelling indicated a change in N deposition of more than 0.4 kgN/ha/yr. However, at that time, ammonia was not included in the N deposition modelling. Ammonia emissions were added into the air quality modelling in December 2021. Inclusion of ammonia to the model resulted in a higher change in N deposition and additional sites were screened in.

3.6.2 Before the inclusion of ammonia in the model, the only sites that were screened in were Whetmead LNR/LWS, Perry's Wood LWS/AW and the veteran trees T316 Oak, T422 Willow, T506 Elm, T649 Elm and T744 Oak. There is no published methodology for site investigations in relation to N deposition. The veteran trees were all visited as part of the arboricultural survey and Whetmead LNR/LWS was surveyed as part of the Phase 1 Habitat Survey. Perry's Wood is beyond the Order Limits and was not part of the Phase 1 Habitat Survey, so a specific site investigation was undertaken in August 2021.

3.6.3 An additional six designated sites and 17 veteran trees were screened in for ecological assessment following the inclusion of ammonia in the model. Detailed site investigations were undertaken for those sites where access was permitted in May 2022. Detailed site investigations were not undertaken at the potential ancient woodland at Porter's Grove (within Boreham Road Gravel Pits LWS), Cook's Lane, Lexden LWS and West House Wood LWS because access was not granted in time for the site visits in May 2022. For these sites, the information on the habitat types and their sensitivity has been inferred from published citations and aerial mapping. The lack of detailed site investigation data is not considered to affect the outcomes of the assessments in this report.

3.6.4 For veteran trees, information gathered during the arboricultural survey was consulted where applicable. Arboricultural survey information was not available for all of the trees that were screened in following inclusion of ammonia in the model. The absence of baseline information is indicated in Table 5.2 (in Section 5 of this report). However, the lack of detailed site investigation data for these trees is not considered to affect the outcomes of the assessments in this report.

4 Results of screening

4.1 Construction

4.1.1 The air quality modelling results are presented in detail in Chapter 6: Air quality [TR010060/APP/6.1] and Appendix 6.5: Air quality results [TR010060/APP/6.3], of the Environmental Statement.

4.1.2 A summary of the construction phase screening results for the designated receptors is presented in Table 4.1 (adapted from Table 6.14 in Chapter 6: Air quality [TR010060/APP/6.1]). The results show that six of the modelled receptor locations (one verified veteran tree, four potential veteran trees and one potential ancient tree) had a predicted total deposition rate above the lower critical load, a predicted change in N deposition of more than 1% of the lower critical load and more than 0.4 kg N/ha/yr.

Table 4.1 Summary of ecological receptors with potentially significant effects during construction

Site	Modelled Site ID	Distance to nearest modelled road (m)[a]	Lower critical load (CL) (kg N/ha/yr)	Average background N deposition (kg N/ha/yr)	Total N deposition (DS) (kg N/ha/yr)	DM to DS change in estimated nutrient N deposition (kg N/ha/yr)	Change/CL (%)
T685 Elm (VV)[b]	ECO_TREE_39	7.7	10	32.9	62.9	0.69	6.9
T636 Oak (PV)	ECO_TREE_37	8.7	10	38.2	66.2	0.65	6.5
T439 Lime (PV)	ECO_TREE_26	32.3	10	30.0	61.9	0.85	8.5
T441 Lime (PV)	ECO_TREE_27	39.8	10	30.0	63.3	0.88	8.8
T443 Horse chestnut (PV)	ECO_TREE_28	44.7	10	30.0	69.0	1.04	10.4
T624 Ash (PA)	ECO_TREE_54	18.6	10	38.2	66.2	0.65	6.5

[a] The range over which modelled receptors were found to have potentially significant effects. Distances are measured to the nearest road centreline in the ARN.

[b] VV = verified veteran tree location, PV = potential veteran tree location, PA = potential ancient tree location

4.2 Operation

4.2.1 Table 4.2 (adapted from Table 6.17 of Chapter 6: Air quality [TR010060/APP/6.1]) shows that in the DS scenario, eight designated sites (including one dual designation) and 23 veteran tree locations (including 16 potential and six verified veteran trees, and one verified ancient tree) had a predicted total N deposition rate above the lower critical load, and a predicted change in N deposition that both exceeds 1% of the lower critical load and 0.4 kg N/ha/year. The habitats identified within the designated sites that were screened in were woodland and neutral grassland. As explained above, neither of these correspond with the habitats in Table 21 of Caporn *et al.* (2016) and therefore a figure of 0.4kgN/ha/yr (which is for upland and lowland heath) is appropriate to indicate the lowest change in N deposition which could bring about the loss of one species.

4.2.2 The full set of receptor results for all of the transects are provided in Appendix 6.5 of the Environmental Statement [TR010060/APP/6.3].

Table 4.2 Summary of ecological receptors with potentially significant effects during operation

Designated site	Modelled site ID	Distance to nearest modelled road (m)[a]	Lower critical load (CL) (kg N/ha/yr)	Average background N deposition (kg N/ha/yr)	Total N deposition (DS) (kg N/ha/yr)	DM to DS change in estimated nutrient N deposition (kg N/ha/yr)	Change/CL (%)
Boreham Road Gravel Pits LWS/ potential ancient woodland at Porter's Grove	ECO_F1	157.1 - 207.1	10	31.8	35.4 – 36.2	0.47 - 0.6	4.74 - 6.03
Whetmead LNR/LWS – Transect 1	ECO_H1	22.5 - 131.2	20	16.9	20.2 – 29.3	0.60-3.04	2.99-15.20
Whetmead LNR/LWS – Transect 2	ECO_H2	12.4 - 142.3	20	16.9	20.1 – 36.6	0.61 - 6.49	3.04-32.46
Braxted Park LWS	ECO_J3	2.2 - 22.2	10	30.0	32.1 – 33.7	0.45 - 1.4	4.53 - 14.01
Brockwell Meadows LWS	ECO_O	11.6 - 50.2	20	18.3	20.1 – 20.6	0.47 - 0.72	2.37 - 3.61
Perry's Wood LWS/ancient woodland	ECO_Q	4.9 - 54	10	32.5	34.5 – 42.7	0.45 - 2.82	4.45 - 28.15
Cook's Lane Lexden LWS	ECO_X	20.3 - 49.7	10	31.6	45.7 – 53.5	0.45 - 0.66	4.45 - 6.62
West House Wood LWS	ECO_AC	11.7 - 31.7	10	31.6	52.9 – 64.0	0.45 - 0.65	4.48 - 6.5
Smythe's Green LWS	ECO_AE	3.8 - 13.8	20	23.2	28.7	0.59	2.96
Tree 9259 Sessile oak (VV)[b]	ECO_TREE_5	63.2	10	31.8	38.8	1.21	12.09
Tree 9238 Pedunculate oak (VV)	ECO_TREE_6	167.1	10	31.8	35.5	0.58	5.84
Tree 9346 Wild cherry (VV)	ECO_TREE_7	50.5	10	31.8	40.1	1.4	14

Designated site	Modelled site ID	Distance to nearest modelled road (m)[a]	Lower critical load (CL) (kg N/ha/yr)	Average background N deposition (kg N/ha/yr)	Total N deposition (DS) (kg N/ha/yr)	DM to DS change in estimated nutrient N deposition (kg N/ha/yr)	Change/CL (%)
T124 Willow (PV)	ECO_TREE_8	50.2	10	31.8	44.5	2.14	21.42
Tree 9226 Pedunculate oak (VV)	ECO_TREE_9	140.7	10	31.8	35.7	0.44	4.4
T234 Elm (PV)	ECO_TREE_12	99.8	10	30.0	35.7	1.02	10.18
T308 Willow (PV)	ECO_TREE_14	162.3	10	30.0	33.6	0.59	5.9
T316 Oak (PV)	ECO_TREE_15	25.8	10	30.0	50.1	4.59	45.93
T422 Willow (PV)	ECO_TREE_25	75	10	30.0	37.2	4.21	42.1
T494 Alder (PV)	ECO_TREE_29	80.2	10	32.5	36.5	1.04	10.36
T506 Elm (PV)	ECO_TREE_30	52	10	32.5	42.3	2.54	25.35
T549 Oak (PV)	ECO_TREE_33	148.9	10	32.5	34.2	0.47	4.69
T562 Oak (PV)	ECO_TREE_34	163.1	10	32.5	35.9	1.17	11.73
T649 Elm (VV)	ECO_TREE_38	53.1	10	38.2	47.6	7.26	72.56
T744 Oak (PV)	ECO_TREE_40	128.8	10	32.9	40.9	1.87	18.68
T792 Field maple (PV)	ECO_TREE_41	41.5	10	32.9	46.1	1.43	14.28
T1013 Oak (VV)	ECO_TREE_43	152	10	31.8	35.7	0.44	4.37
T1124 Alder (PV)	ECO_TREE_44	167.7	10	30.0	33.0	0.58	5.8
T1131 Ash (PV)	ECO_TREE_45	170	10	30.0	33.0	0.58	5.8
G1018 Oak (PV)	ECO_TREE_46	99.2	10	31.8	40.1	1.4	14

Designated site	Modelled site ID	Distance to nearest modelled road (m)[a]	Lower critical load (CL) (kg N/ha/yr)	Average background N deposition (kg N/ha/yr)	Total N deposition (DS) (kg N/ha/yr)	DM to DS change in estimated nutrient N deposition (kg N/ha/yr)	Change/CL (%)
G489 Elm, ash, hawthorn, field maple, hornbeam (PV)	ECO_TREE_48	26.6	10	32.5	42.3	2.54	25.35
G543 Elm, field maple (PV)	ECO_TREE_50	30.5	10	32.5	42.3	2.54	25.35
Tree 9322 Pedunculate oak (VA)	ECO_TREE_53	194.9	10	31.8	35.7	0.47	4.74

[a] *The range over which modelled receptors were found to have potentially significant effects. Distances are measured to the nearest road centreline in the ARN.*

[b] *VV = verified veteran tree location, PV = potential veteran tree location, VA = verified ancient tree location*

5 Baseline descriptions of sites screened in for assessment

5.1 Veteran trees (construction only)

5.1.1 The veteran trees baseline was collected as part of the arboricultural survey (with results in Annex E of Appendix 8.4: Arboriculture Impact Assessment ([TR010060/APP/6.3]). The relevant survey information for the trees potentially affected by N deposition during construction is reproduced in Table 5.1. The locations of these trees are indicated on Figure 2 of this report. There are three potential veteran trees to the north-east of Rivenhall End (T439, T441, T443), a verified veteran (T685) to the south of Marks Tey and a potential veteran (T636) and a potential ancient tree (T624) to the north-east of junction 24.

5.1.2 All potentially significant trees are Category A trees, which means they are of high quality with a remaining life expectancy of at least 40 years. Category A1 indicates mainly arboricultural qualities and includes trees that are particularly good examples of their species or those that are essential components of formal or semi-formal arboricultural features. Category A3 are trees with mainly cultural values, including conservation and includes trees, groups or woodlands of significant conservation, historical, commemorative or other value. Therefore, it is considered that trees of Category A3 have the highest value with respect to biodiversity (five of the six trees predicted to be affected by increased N deposition).

Table 5.1 Summary of veteran trees screened in during construction

Tree	Modelled Site ID	Height (m)	Dimeter at Breast Height (DBH) (mm)	Category	Description
T685 Elm (VV)b	ECO_TREE_39	19	1130	A1	Mature tree with crown cavities and epicormic growth. Fair structural and physical condition. Located at side of road but no encroachment due to proposed scheme.
T636 Oak (PV)	ECO_TREE_37	2	1480	A3	Mature tree with deadwood cavities throughout. Fair structural and physical condition. Parasitic fungi *Inonotus drydaeus* and *Pholiota squarrosa* recorded. No encroachment due to proposed scheme.

Tree	Modelled Site ID	Height (m)	Dimeter at Breast Height (DBH) (mm)	Category	Description
T439 Lime (PV)	ECO_TREE_26	37	1601	A3	Over-mature tree with abundant epicormic growth, crown cavities throughout and deadwood. Fair structural and physical condition. Ganoderma (wood-decaying fungus) observed around base. No encroachment due to proposed scheme.
T441 Lime (PV)	ECO_TREE_27	27	1550	A3	Over-mature tree with major deadwood and abundant epicormic growth. Fair structural and physical condition. No encroachment due to proposed scheme.
T443 Horse chestnut (PV)	ECO_TREE_28	22	1510	A3	Over-mature tree with crown cavities throughout. Fair structural and physical condition. Parasitic bracket fungus observed on ground on roadside- possibly *Inonotus* sp. No encroachment by proposed scheme.
T624 Ash (PA)	ECO_TREE_54	12	1400	A3	Over-mature tree with aerial rooting. Historical ancient coppice stool. Multiple stems of approximately 250mm dbh. Some ivy on stem. No encroachment due to proposed scheme.

5.2 Receptors screened in for operational effects

5.2.1 The site descriptions are generally based on desk study information, including citations and interpretation of aerial imagery. Information from field survey is included where available.

Boreham Road Gravel Pits LWS

5.2.2 The site extends to approximately 23ha and supports a series of lakes of various sizes surrounded by woodland. The site includes Holts Farm Quarry lakes which has a diverse habitat of scrub, swamp and open water developed following cessation of quarrying activity. No specific site survey has been undertaken as no potential for significance was predicted before the inclusion of ammonia in the N deposition model. Access was not granted for site survey in 2022.

Potential ancient woodland at Porter's Grove

5.2.3 Porter's Grove forms the southern part of Boreham Road Gravel Pits LWS and is a narrow stand of hornbeam (*Carpinus betulus*) coppice with hazel (*Corylus avellana*) stools and mature pedunculate oak (*Quercus robur*) trees along a stream (area approximately 0.45ha). The shrub layer is represented by hazel and holly (*Ilex aquifolium*). The site was surveyed as part of the Phase 1 Habitat Survey (Target Note 78) (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) but no specific site survey to inform the N deposition assessment was undertaken as no potential for significance was predicted before the inclusion of ammonia in the N deposition model and site access was not granted for 2022.

5.2.4 This area of woodland was noted in the Phase 1 Habitat Survey (Target Note 78) (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) as supporting features indicative of ancient origin, but it is not listed on the Ancient Woodland Inventory and does not appear on mapping from 1799 (British Library, accessed 2022). There is evidence of the woodland in mapping from 1874 (National Library of Scotland, accessed 2022). Given that this woodland is not ancient in origin and lies wholly within Boreham Road Gravel Pits LWS, it is considered as part of that designation.

Whetmead LNR / LWS

5.2.5 This site was surveyed as part of the Phase 1 Habitat Survey (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) and in May 2022, with details provided in Annex B of this report. Whetmead is adjacent to the existing A12 and is a restored landfill of 11.36ha, now supporting grassland, scrub and lagoons. There is a narrow strip of woodland (approximately 30m wide) along the western boundary that is to be removed as part of the proposed scheme. The site is predominantly a mosaic of short rabbit-grazed and trampled grassland, tall rank grassland and tall ruderal vegetation, with scattered hawthorn (*Crataegus monogyna*) and rose (*Rosa*) scrub. There are areas with more diverse grassland, with drought tolerant species, some of which also have low Ellenberg indicator values for nitrogen, such as lady's-bedstraw (*Galium verum;* Ellenberg value of 2) and squirrel-tail fescue (*Vulpia bromoides*; Ellenberg value of 3). Lady's-bedstraw is characterised as a nitrophobe in Pitcairn *et al*. (2006). Also recorded were changing forget-me-not (*Myosotis discolor;* Ellenberg value of 3), and perforate St John's-wort (*Hypericum perforatum*; Ellenberg value of 5). However, on the whole the grassland is species-poor, mostly dominated by nitrophilous species that are typical of nutrient enrichment and have high Ellenberg indicator values. These species include false oat-grass (*Arrhenatherum elatius;* Ellenberg value of 7) with areas to the east being predominantly common nettle (*Urtica dioica*) and cleavers (*Galium aparine*), both of which have Ellenberg values of 8. The non-native hoary cress (*Lepidium draba*) is abundant across the whole area. It was noted during the site visit in May 2022 that the short sward grassland supporting the drought-tolerant and nitrophilous species is more prevalent on the western slope of the restored landfill which is closer to the existing road than the rank grassland and tall herb vegetation which dominates on the eastern slope of the landfill further from the road. It is possible that the membrane or clay that was

used to cap the restored landfill has been breached on this side, as such level of nutrient enrichment is otherwise impossible to explain above the floodplain.

5.2.6 Notable plants recorded within the LWS include pyramidal orchid (*Anacamptis pyramidalis;* Ellenberg value of 3) (desk study record)) and small teasel (*Dipsacus pilosus*; Ellenberg value of 7), which was recorded during the Phase 1 Habitat Survey adjacent to the River Brain through Whetmead LNR.

Braxted Park LWS

5.2.7 Braxted Park is a large site of approximately 201ha and supports an extensive mosaic of semi-improved meadows, broadleaved woodland, parkland, open water, reed and sedge beds, with several veteran oaks and networks of good hedgerows. A variety of small woods are present including oak-dominated stands, broadleaved plantations and wet willow woodland. The large lake is used by a mixture of native and introduced wildfowl and there are several small woodland ponds.

5.2.8 Braxted Park was surveyed in May 2022 to gather specific information with respect to the potential effects of N deposition. Details are provided in Annex C of this report.

5.2.9 The area affected by N deposition (sheet 4 of Figure 2) is limited to a shelterbelt plantation and a green lane following the line of former access track leading to Braxted Hall. The vegetation was typical of broadleaved woodland, showing affinity to ash-field maple-dog's mercury woodland with a few ancient woodland indicators including field maple (*Acer campestre*), dog's mercury (*Mercurialis perennis*), yew (*Taxus baccata*), wood brome (*Bromopsis ramosa*), and small-leaved elm (*Ulmus minor*). None of these species have low Ellenberg values for nitrogen and dog's mercury is noted as a nitrophile, known to respond to increased nitrogen (Pitcairn *et al*., 2006). The green lane consisted of both native and ornamental species with mature specimens of pedunculate oak (*Quercus robur*), Turkish oak (*Quercus cerris*) and horse-chestnut (*Aesculus hippocastanum*).

Brockwell Meadows LWS

5.2.10 Brockwell Meadows LWS is approximately 9.3ha and is adjacent to the proposed scheme. The LWS overlaps with Brockwell Meadows LNR, which is approximately 55m west of the proposed scheme and was screened out of the N deposition assessment. The LWS is associated with the River Blackwater and comprises former floodplain meadows, woodland, a pond and hedgerows.

5.2.11 Brockwell Meadows was surveyed in May 2022 to gather specific information with respect to the potential effects of N deposition. Details are provided in Annex D of this report.

5.2.12 The area affected by increased N deposition was limited to a willow plantation at the south-western tip of the LWS. The vegetation was typical for a managed floodplain setting with the canopy dominated by planted cricket-bat willow (*Salix alba* 'Caerulea'), no understorey and the field layer dominated by tall herbs which are typical of nutrient-enriched conditions, such as common nettle, comfrey (*Symphytum officinale*) and cleavers, all of which have Ellenberg values for nitrogen of 8. There were limited patches of higher diversity, but no

nitrogen-sensitive species were present. The vegetation included species such as wild angelica (*Angelica sylvestris*; Ellenberg value of 5), greater burdock (*Arctium lappa*; Ellenberg value of 5) and greater pond-sedge (*Carex riparia*; Ellenberg value of 7).

Perry's Wood LWS / AW

5.2.13 Perry's Wood was surveyed in 2021 and 2022 to gather specific information with respect to the potential effects of N deposition. Detailed information is presented in Annex E of this report.

5.2.14 The site is a small ancient woodland (approximately 3.7ha) adjacent to the B1023 Kelvedon Road. Historic maps (accessed at https://www.oldmapsonline.org/) indicate that in 1895 it was the same size as currently and surrounded by agriculture (as it is now). In 1799 it was smaller than it is now, suggesting that the southern one third of it is not ancient.

5.2.15 The citation describes a good canopy/understorey structure with good levels of seed regeneration. A pig enclosure to the west of the ponds was noted in the citation as causing disturbance to woodland flora. This pig enclosure was not noted during the site visit in 2021.

5.2.16 The citation[6] states that the canopy is composed of ash (*Fraxinus excelsior*) and pedunculate oak with an understorey of hornbeam coppice, hawthorn, midland hawthorn (*Crataegus laevigata*), crab apple (*Malus sylvestris*), elm (*Ulmus* sp.), field maple (*Acer campestre*), aspen (*Populus tremula*) and hazel. At the time of the site visit, most of the site was dominated by ash, with frequent aspen and field maple. The tree stems were relatively young, mostly arising from coppice stools. The canopy was quite thin, with ash dieback an obvious contributor, and therefore the ground flora well illuminated. Pedunculate oak was locally dominant due to a stand of maiden trees near the eastern boundary (see photo in Table E.2 of Annex E), which was shadier and the understorey less well developed, mostly dominated by bramble. This difference might be due to historic management practices but could be due to geology (e.g. a pocket of wind-blown sand or a gravel deposit). Hornbeam and elm were recorded only rarely.

5.2.17 Trees have been planted recently, probably in the last year. Tree guards were present and there were clear access routes to the planted areas. Trees were just single plantings scattered through the site.

5.2.18 Species in the shrub layer include frequent midland hawthorn and occasional hazel, common ivy, crab apple and elm.

5.2.19 The citation describes the ground flora as generally sparse but includes bluebell (*Hyacinthoides non-scripta*), primrose (*Primula vulgaris*), wood forget-me-not, (*Myosotis sylvatica)* enchanter's nightshade (*Circaea lutetiana*), wood speedwell (*Veronica montana*), remote sedge (*Carex remota*) and bugle (*Ajuga reptans*) with common marsh bedstraw (*Galium palustre*) in damper areas. There are two shaded ponds in the western corner, which support pendulous sedge (*Carex pendula*).

[6] https://www.braintree.gov.uk/downloads/file/421/cbc-0033-2-5-local-wildlife-site-review-colchester-1

5.2.20 During the site visit, the shrub and field layers in most areas were well-developed. The field layer in many areas had abundant grasses and common nettle (Ellenberg value of 8), and other species indicative of higher fertility which are recorded as nitrophiles in Pitcairn *et al*., 2006. These include ground ivy (*Glechoma hederacea;* Ellenberg value of 7*)* and herb robert (*Geranium robertanium;* Ellenberg value of 6 and known to respond to increased nitrogen). The mean Ellenberg value of all the species recorded is 5.73, with 5 species of Ellenberg value 8. The only species that is potentially sensitive to additional nitrogen is compact rush (*Juncus conglomeratus;* Ellenberg value of 3), of which there was only one plant in a disturbed area.

5.2.21 Disturbance and grazing by deer, as well as ash dieback are likely to be having more influence than N deposition on the vegetation composition of the woodland. The presence of deer in particular is well-known to cause changes in woodlands through browsing, disturbance and increased illumination of the ground layer. There were many ash seedlings, mostly aged approximately one year. Many had been browsed by deer, and larger saplings were absent.

5.2.22 There did not appear to be any pattern in the vegetation in relation to distance from the road and no evidence of a gradient in vegetation change due to existing N deposition effects. The boundary along the road was well wooded with trees and shrubs (see photos in Table E.2 of Annex E).

Cook's Lane, Lexden LWS

5.2.23 This site of approximately 7.5ha includes part of the Essex Wildlife Trust's Lexden Gathering Grounds nature reserve and is a mosaic of acidic grassland and broadleaved woodland. The citation states that parts of this woodland may be ancient but it is not listed on the Ancient Woodland Inventory. No specific site survey to inform the N deposition assessment was undertaken as no potential for significance was predicted before the inclusion of ammonia in the N deposition model and no access was granted for survey in May 2022.

West House Wood LWS

5.2.24 This small site (approximately 3.2ha) is an Essex Wildlife Trust nature reserve and the citation states that it comprises mainly ancient wood, with a strip of more recent wood along the northern edge. However, it is not listed on the Ancient Woodland Inventory. No specific site survey to inform the N deposition assessment was undertaken as no potential for significance was predicted before the inclusion of ammonia in the N deposition model and no access was granted for survey in May 2022.

Smythe's Green LWS

5.2.25 The citation[7] for this site describes it as a small area (approximately 1ha) of rough grassland and scrub containing a range of grasses including crested dog's-tail (*Cynosurus cristatus*), sweet vernal-grass (*Anthoxanthum odoratum*) and meadow foxtail (*Alopecurus pratensis*). There are few herb species of special interest and coarse grasses such as false oat-grass and cock's-foot (*Dactylis glomerata*) are becoming more dominant. Herbs include common knapweed (*Centaurea nigra*), common fleabane (*Pulicaria dysenterica*) and greater bird's-foot trefoil (*Lotus pedunculatus*). There are several damp areas comprising abundant hard rush (*Juncus inflexus*) and soft rush (*Juncus effusus*). The site appears to have declined in interest, which may be apportioned to encroachment of bramble (*Rubus fruticosus* agg.) and blackthorn (*Prunus spinosa*) scrub, lack of management and the inappropriate planting of willow (*Salix* sp.) and birch (*Betula* sp.) trees. Lady's bedstraw and spiny restharrow (*Ononis spinosa*) have been recorded in the past but may since have been lost.

5.2.26 Smythe's Green was surveyed in May 2022 to gather specific information with respect to the potential effects of N deposition. Details are provided in Annex F of this report. The survey confirmed that there are high value grassland habitats within the site (beyond the predicted nitrogen-affected area), with a mosaic of neutral and mildly-acidic indicators, interspersed with wet rush-dominated patches and small areas of tall herb. The species-rich part of the site consisted of indicators of poor-nutrient conditions such as lady's bedstraw (Ellenberg value of 2), sheep's sorrel (*Rumex acetosella;* Ellenberg value of 3), sweet vernal-grass (*Anthoxanthum odoratum;* Ellenberg value of 3), field wood-rush (*Luzula campestris;* Ellenberg value of 2), and common milkwort (*Polygala vulgaris;* Ellenberg value of 3).

5.2.27 Grassland closer to the boundary with the road appeared more characteristic of nutrient-enriched conditions, with taller grasses and robust tall herbs, including a higher frequency of tansy (*Tanacetum vulgare;* Ellenberg value of 7) and cow's parsley (*Anthriscus sylvestris),* both of which have a Ellenberg values for nitrogen of 7.

Veteran trees

5.2.28 Veteran, potential veteran and ancient trees that are screened in are listed in Table 5.2. Not all trees had been subject to arboricultural survey due to being outside the arboricultural study area and because some trees were only screened in once ammonia was included in the N deposition modelling.

7 https://cbccrmdata.blob.core.windows.net/noteattachment/Part%201%20Local%20Wildlife%20Sites%20Review%202008%20Essex%20Ecology%20Services.pdf

Table 5.2 Summary of veteran trees screened in during operation

Tree	Modelled Site ID	Height (m)	DBH (mm)	Category	Description
Tree 9259 Sessile oak (VV)[c]	ECO_TREE_5	-	-	-	No survey data
Tree 9238 Pedunculate oak (VV)	ECO_TREE_6	-	-	-	No survey data
Tree 9346 Wild cherry (VV)	ECO_TREE_7	-	-	-	No survey data
T124 Willow (PV)	ECO_TREE_8	-	-	-	No survey data
Tree 9226 Pedunculate oak (VV)	ECO_TREE_9	-	-	-	No survey data
T234 Elm (PV)	ECO_TREE_12	20	1004	A3	Semi-mature, fair condition. Moderate deadwood. Jelly ear fungus on deadwood on floor.
T308 Willow (PV)	ECO_TREE_14	-	-	-	No survey data
T316 Oak (PV)	ECO_TREE_15	21	1010	A3	Over-mature, fair condition. Early signs of retrenchment. Historic major limb loss. Moderate deadwood.
T422 Willow (PV)	ECO_TREE_25	17	1438	A3	Over-mature, fair condition. Canopy cavities. Deadwood. Basal limb failure with phoenix tree growth. Longitudinal stem cracks and hazard beams.
T494 Alder (PV)	ECO_TREE_29	13	780	A3	Over-mature, fair condition. Canopy dieback. Lower epicormic growth. Crown cavities.
T506 Elm (PV)	ECO_TREE_30	6	550	A3	Semi-mature, fair condition. Split stem. Partially collapsed. Basal cavities. Secondary canopy.
T549 Oak (PV)	ECO_TREE_33	17	1158	A3	Over-mature, fair condition. Extensive canopy dieback, Epicormic growth. Historic abiotic damage from agricultural plant. Major deadwood.

Tree	Modelled Site ID	Height (m)	DBH (mm)	Category	Description
T562 Oak (PV)	ECO_TREE_34	21	1390	A3	Over-mature, fair condition. Old pollard at 2.5 m. Secondary canopy with larger diameter deadwood at mid canopy area. Full crown.
T649 Elm (VV)	ECO_TREE_38	22	820	A3	Over-mature, fair condition. Top third dead.
T744 Oak (PV)	ECO_TREE_40	20	1080	A1	Mature, fair condition, Ivy to 8m height. Full crown. Well shaped.
T792 Field maple (PV)	ECO_TREE_41	16	655	A3	Mature, fair condition. Crown and basal cavities. Set by culvert head wall. Dense buttress roots.
T1013 Oak (VV)	ECO_TREE_43	-	-	-	No survey data
T1124 Alder (PV)	ECO_TREE_44	-	-	-	No survey data
T1131 Ash (PV)	ECO_TREE_45	-	-	-	No survey data
G1018 Oak (PV)	ECO_TREE_46	-	-	-	No survey data
G489 Elm, ash, hawthorn, field maple, hornbeam (PV)	ECO_TREE_48	18	1250	A3	Over-mature, fair condition. Prolific ivy. Basal and stem cavities. Deadwood. Historic boundary hedge with mature trees. Five ash, one field maple, one turkey oak, one hornbeam, and two elm with hawthorn undergrowth.
G543 Elm, field maple (PV)	ECO_TREE_50	13	400	A3	Historic hedgerow. Large basal cavities. Potential veteran field maples
Tree 9322 Pedunculate oak (VA)	ECO_TREE_53	-	-	-	No survey data

6 Literature review to inform the assessment

6.1 Potential effects of nitrogen deposition on woodland

6.1.1 The following LWS screened into the assessment are primarily designated for broadleaved woodland habitat:

- Boreham Road Gravel Pits LWS/ potential ancient woodland at Porter's Grove
- Braxted Park LWS
- Perry's Wood LWS/ancient woodland
- Cook's Lane, Lexden LWS
- West House Wood LWS

6.1.2 All of the woodland habitat under consideration is categorised as broadleaved, mixed and yew woodland, with a critical load for N deposition of 10-20kg N/ha/yr. The critical load takes into account the sensitive lower plant communities often present in woodlands and the changes in soil chemistry associated with acidification and eutrophication which can lead to nitrogen leakage, either though leaching (nitrate) or emissions of the greenhouse gases NO or NO_2.

6.1.3 A summary of the scientific research on the potential effects on this type of woodland habitat is provided on the APIS website[8] and the following text is based on the information therein. N deposition is not believed to have a direct, major effect on tree growth in the UK but can have 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).

[8] http://www.apis.ac.uk/node/965

6.1.4 Woodlands tend to intercept larger amounts of both dry and wet N deposition than 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).

6.1.5 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 and common nettle 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).

6.1.6 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, 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.

6.1.7 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).

6.2 Potential effects of N deposition on veteran trees

6.2.1 There are 20 individual trees and three groups of trees screened into the operation assessment, and six individual tress screened into the construction assessment. There is no critical load as such for veteran trees and therefore these receptors have been assigned the same critical load range as broadleaved, mixed and yew woodland of 10-20kg N/ha/yr. There is little or no scientific literature on the specific impacts of N deposition on veteran trees. However, APIS reports that oak foliage may be less susceptible to pests than other species following N enrichment, due to its relatively high tannin content.

6.3 Potential effects of N deposition on neutral grassland

6.3.1 The following three of the LWS are designated for neutral grassland habitat.

- Whetmead LNR/LWS
- Brockwell Meadows LWS
- Smythe's Green LWS

6.3.2 A critical load for N deposition of 20-30kg N/ha/yr is used for neutral grasslands, based on the values given for 'low and medium altitude hay meadows'. However, it is important to note that hay meadows are low-nutrient systems and are more sensitive to N deposition than most lowland neutral grasslands (such as those being considered here) that are not managed in the same manner as meadows. Therefore, the critical load of 20-30kg N/ha/yr is a conservative estimate for the somewhat nutrient-enriched grasslands present in the study area for the proposed scheme and it is possible that these grasslands are not nitrogen sensitive. The relatively low levels added by atmospheric N deposition are likely to have little additional effect on the sward (Maskell *et al*., 2010).

6.3.3 The key indicators of exceedance of critical load in neutral grassland habitats are an increase in tall grasses and a decrease in diversity (RoTAP, 2012; Maskell *et al*., 2010).

6.3.4 In general, species diversity in grasslands is negatively correlated with nutrient status and hence the grasslands in the study area of the proposed scheme are already lower in diversity than a typical hay meadow due to high levels of background N deposition and different management regimes. It is of note that other factors can also cause the nutrient status of grasslands to increase such as lack of or unsuitable management, development of scrub, unsuitable grazing regimes and recreation (e.g. dog walking).

6.3.5 Maskell *et al*. (2010) found that there was a very weak negative relationship between N deposition and species richness on mesotrophic (nutrient enriched) neutral grasslands. Maskell reports that extra N deposition had little impact on these inherently fertile grasslands with species richness and plant traits changing very little. Therefore, there are unlikely to be significant changes to the types of neutral grassland that are potentially affected by the proposed scheme (such as at Whetmead LNR/LWS).

6.3.6 In general, species diversity in grasslands is negatively correlated with nutrient status and hence the grasslands in the study area of the proposed scheme are already lower in diversity than a typical hay meadow. In low-nutrient systems, an increase in N deposition is likely to cause a decline in species diversity, enabling the fast-growing, robust and species to out-compete the low-growing forbs that are adapted to low nutrient conditions. It is of note that other factors can also cause the nutrient status of grasslands to increase such as lack of or unsuitable management, development of scrub, unsuitable grazing regimes and recreation (e.g. dog walking).

6.4 Responses to increased N deposition above the critical load

6.4.1 Although UK emissions of nitrogen oxides have fallen in the last two decades (Defra, 2022), it is likely that sites in the study area of the proposed scheme have been subject to historic levels of deposition above the critical load. Given that the current background deposition at all the woodland sites (and veteran trees) screened in for ecological assessment already exceeds the higher critical load for broadleaved, mixed and yew woodland of 20kg N/ha/yr, it is possible that changes in nutrient cycling, vegetation composition and ecosystem function have already occurred at these sites. These sites are likely to already be showing symptoms of N deposition throughout 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.

6.4.2 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. 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).

6.4.3 Some of existing N deposition studies on vegetation change in woodlands have contradictory outcomes around which species were found to respond to N deposition (see Pitcairn *et al*., 1998 & 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).

7 Impact assessment

7.1 Construction impacts

7.1.1 Table 4.1 indicates that six of the modelled receptor locations had a predicted total deposition rate above the lower critical load, with both a predicted change in N deposition of more than 1% of the lower critical load and of more than 0.4 kg N/ha/yr. These receptors comprise one verified veteran tree, four potential veteran trees and one potential ancient tree. The lower critical load of 10kg N/ha/yr is currently exceeded at all receptors, with a background N deposition of at least 30kg N/ha/yr.

7.1.2 The predicted DS deposition rate is in excess of 60kg N/ha/yr for all six trees, but the magnitude of the DS-DM change in N deposition varies from 0.65-1.04kg N/ha/yr.

7.1.3 It is of note that none of these trees are screened in during the operation phase, which suggests that the duration of impact would be a maximum of four years (the duration of the construction phase). This is a worst case as the modelling was only undertaken for the construction traffic representative of the peak construction year (the worst case scenario) and it is likely that traffic flows and subsequent N deposition will fluctuate over the construction period.

7.1.4 The magnitude of the increase in N deposition (6.5%-10.4% of the lower critical load) and temporary duration of the changes in N deposition as a result of the proposed scheme are considered to result in a temporary and reversible effect which does not affect the integrity or key characteristics of the individual veteran trees. Therefore, it is concluded that the impact level of construction traffic on the veteran trees is negligible and not significant.

7.2 Operation impacts

7.2.1 The sites assessed are shown on Figure 2 of his report. The figure also shows the extents of areas within each site where N deposition is predicted to exceed the threshold for theoretical loss of one species used in the assessment (i.e. 0.4kg N/ha/yr). The assessment of effects on designated sites during operation is shown in Table 7.1 below.

7.2.2 The approach to assessment of N deposition on veteran trees is different to habitats because it is considered that the relatively small increases in N deposition as a result of the proposed scheme will not affect the key characteristics or ‘integrity’ of the trees themselves (see Section 3.5 of this report). The physical characteristics of a veteran tree such as age, size, structure and presence of dead and decaying wood are not likely to be affected by increased N deposition. Even a permanent (15 or more years) increase in N deposition is not anticipated to alter the key characteristics of the trees. Although this assessment is of the trees themselves, rather than epiphytic lower plant communities, it is worth noting that the veteran trees in the study area are already adjacent to busy roads and observations during site visits are that the trees tend to support very little in the way of bryophytes or lichens. This could be due to climatic factors e.g. temperature and humidity as well as background N deposition. Therefore, all the trees that are screened into the assessment (Table 4.2) are assessed as a negligible impact level, which for a resource of national value results in slight significance (not significant).

Table 7.1 Assessment of likely significant N deposition effects from operation of the proposed scheme on designated habitats

Site	Resource importance	Habitat Modelled and Lower Critical Load	Magnitude of impact (maximum figures for site)	Impact extent (ha/% of site)	Estimated Impact Duration (years)	Assessment	Impact Level	Significance
Boreham Road Gravel Pits LWS/ Porters Grove potential AW	County	Woodland 10kg N/ha/yr	Background: 31.78kg N/ha/yr Total N deposition (DM): 35.62kg N/ha/yr Total N deposition (DS): 36.22kg N/ha/yr Change DM to DS: 0.6kg N/ha/yr (6% of Lower Critical Load)	0.15ha 0.65%	7	The designated site is not adjacent to the road. The area affected by N deposition is at the southern tip of the designation, which is occupied by broadleaved deciduous woodland (Porter's Grove), with a lower critical load of 10 kg N/ha/yr. Porter's Grove is an old, but not ancient woodland and occupies 0.45ha of the 23ha designation. Therefore, approximately one third of this wooded area is predicted to be affected. However, there is more extensive woodland around the gravel pits in the northern part of the LWS and the total percentage of the LWS estimated to be affected is less than 1%. There is no detailed site survey information for this site, but the woodland habitat in Porter's Grove is likely to be representative of this woodland type in the study area with few or no nitrogen-sensitive species present. Therefore, an increase in N deposition is unlikely to result in the loss of one species. Given the area affected and the vegetation type, no effect on the integrity of the LWS is predicted. The time taken for DS NO_x emissions to reduce to DM levels is estimated at 7 years, so is temporary and any effects would be likely to be reversible. According to DMRB LA 108, the significance of a negligible impact level on a site of county value could be either neutral or slight. Given that there is a lack of survey data to inform the baseline, a precautionary approach has been taken.	Negligible	Slight (not significant)
Whetmead LNR/LWS	County	Grassland 20kg N/ha/yr	Background = 16.94kg N/ha/yr Total N deposition (DM) = 30.15kg N/ha/yr Total N deposition (DS) = 36.64kg N/ha/yr Change DM to DS: 6.49kg N/ha/yr (32.5% of Lower Critical Load)	5.25ha 46.17%	10	A large proportion (5.25ha, 46%) of the LWS / LNR is affected by increased N deposition. The Phase 1 Habitat Map (Appendix 9.8 of the Environmental Statement [TR010060/APP/6.3]) indicates that the habitats affected include a strip of woodland (approximately 0.89ha) along the western edge of the designation but the remaining area affected (4.36ha) is semi-improved grassland. The whole area of woodland habitat along the western edge is to be lost as a result of the proposed scheme. Therefore, it is estimated that approximately 41.6% of the remaining designation (grassland habitat) would be affected by increased N deposition. The grassland habitat within the site is a mosaic of short rabbit-grazed and trampled grassland, tall rank grassland and tall ruderal vegetation. The vegetation type is typical of mesotrophic, circum-neutral soils in south-east England. The baseline description indicates that the most nutrient-enriched vegetation, which is dominated by nitrophilous species with high Ellenberg values is on the eastern slope of the restored landfill, further from the road than the short, open, more diverse sward. Therefore, it is likely that the variation in grassland type is more dependent on substrate (drainage, nutrient content, pH etc), topography and rabbit grazing than on aerial N deposition. No change in vegetation composition due to additional N deposition is likely on the areas of rank grassland. However, there are species in the areas of open sward that are sensitive to N deposition (e.g. lady's bedstraw). Pyramidal orchid, which is sensitive to N deposition (Ellenberg value of 3) has been recorded at the site in the past and therefore an increase in N deposition could risk the loss of this species (if indeed it is still present, as it was not recorded during more recent surveys in 2021 and 2022).	Moderate adverse (mitigation proposed in Chapter 9: Biodiversity, reduces this to minor adverse)	Slight (not significant).

Site	Resource importance	Habitat Modelled and Lower Critical Load	Magnitude of impact (maximum figures for site)	Impact extent (ha/% of site)	Estimated Impact Duration (years)	Assessment	Impact Level	Significance
						Although the affected area includes the area of habitat loss, the remaining extent of such an increase in N deposition could result in an adverse effect on site integrity, if the increase in N deposition enables the rank grassland to expand and replace the areas of more open sward and species such as pyramidal orchid and lady's bedstraw are outcompeted by rank grassland species. However, as stated above, the interplay of other factors will also have an influence on the grassland dynamics. The time taken for DS NOx emissions to reduce to DM levels is estimated at 10 years, so is temporary and any changes as a result of increase N deposition could be reversible (but may require intervention through management). Therefore, in accordance with DMRB LA 108, the impact level is assessed as moderate.		
Braxted Park LWS	County	Woodland 10kg N/ha/yr	Background = 29.96kg N/ha/yr Total N deposition (DM) = 32.34kg N/ha/yr Total N deposition (DS) = 33.74kg N/ha/yr Change DM to DS: 1.40kg N/ha/yr (14% of Lower Critical Load)	1.8ha 0.89%	15+	The area affected by N deposition is limited to a shelterbelt plantation and a green lane with vegetation typical of broadleaved woodland with a few ancient woodland indicators including field maple, dog's mercury and wood brome. None of these species have low Ellenberg values for nitrogen and dog's mercury is noted as a nitrophile, known to respond to increased nitrogen (Pitcairn *et al*., 2006). Given that the extent of area affected is less than 1% of the site and that no nitrogen-sensitive species were recorded, it is unlikely that a change in vegetation composition will occur and no effect on site integrity is predicted. Although the duration of impact is permanent, as the time taken for DS NO_x emissions to reduce to DM levels is estimated at 15 or more years, no change to vegetation is anticipated and the impact level is assessed as negligible. According to DMRB LA 108, the significance of a negligible impact level on a site of county value could be either neutral or slight. Given that the duration of increased N deposition is permanent and that there is a lack of scientific data for woodland habitats, a precautionary approach has been taken.	Negligible adverse	Slight (not significant)
Brockwell Meadows LWS	County	Grassland 20kg N/ha/yr	Background = 18.34kg N/ha/yr Total N deposition (DM) = 19.84kg N/ha/yr Total N deposition (DS) = 20.56kg N/ha/yr Change DM to DS: 0.72kg N/ha/yr (3.6% of Lower Critical Load)	0.14ha 1.5%	15+	The area of increase above the 0.4kg N/ha/yr threshold is at the southern tip of the LWS and does not affect the overlapping LNR designation. The area affected by increased N deposition was limited to a willow plantation on the south-western edge of the LWS. The habitat was typical of a managed floodplain setting, planted with cricket-bat willow and the field layer dominated by tall herbs which are typical of nutrient-enriched conditions, such as common nettle, comfrey (*Symphytum officinale*) and cleavers, all of which have Ellenberg values for nitrogen of 8. No nitrogen-sensitive species were present. Given that the area of affected habitat is within the floodplain and therefore receives nutrient inputs from inundation, it is not considered to be nitrogen sensitive and there is considered to be no risk that species will be lost as a result of an increase in N deposition. Furthermore, the area affected does not support the habitats for which the site is designated (floodplain meadow). As main interest feature of the designation is floodplain grassland, a critical load for neutral grassland has been applied. The baseline is below the lower critical load for grassland and the DS is only 0.56kg N/ha/yr above the lower critical load. Only 1.5% of the site is predicted to be affected by increased N deposition and, for the reasons given above, no changes are anticipated that could affect vegetation composition or site integrity.	Negligible	Neutral (not significant)

Site	Resource importance	Habitat Modelled and Lower Critical Load	Magnitude of impact (maximum figures for site)	Impact extent (ha/% of site)	Estimated Impact Duration (years)	Assessment	Impact Level	Significance
						Although the duration of impact is permanent, as the time taken for DS NO_x emissions to reduce to DM levels is estimated at 15 or more years, no change to vegetation is anticipated and the impact level is assessed as negligible. According to DMRB LA 108, the significance of a negligible impact level on a site of county value could be either neutral or slight. Given that the area affected by increased N deposition is already nutrient enriched, and that the lower critical load for grassland is exceeded by a small amount, it is considered that the significance is neutral.		
Perry's Wood AW	National	Woodland 10kg N/ha/yr	Background = 32.48kg N/ha/yr Total N deposition (DM) = 39.89kg N/ha/yr Total N deposition (DS) =42.71 kg N/ha/yr Change DM to DS: 2.82kg N/ha/yr (28.2% of Lower Critical Load)	0.74ha 20.19%	11	The baseline N deposition already exceeds the upper critical load of 20kg N/ha/yr and the DS N deposition is more than double this figure. Site investigation found that the field layer had abundant grasses and common nettle (Ellenberg value of 8), and other nitrophilous species indicative of higher fertility including ground ivy (Ellenberg value of 7) and herb robert (Ellenberg value of 6 and known to respond to increased nitrogen). There did not appear to be any pattern in the vegetation in relation to distance from the road and no evidence of a gradient in vegetation change due to existing N deposition effects. The only species that is potentially sensitive to additional nitrogen is compact rush (Ellenberg value of 3), of which there was only one plant in a disturbed area. The potential loss of this species would not affect the quality of the woodland ground flora of the site and it is probable that other factors (such as disturbance) have more influence than N deposition on the persistence (or not) of this species. Although it is unlikely that there will be a perceptible change in vegetation composition, more than 20% of this site is affected by increased N deposition. Given the lack of scientific data for woodland habitats, a precautionary approach has been taken and it is assumed that there could be an effect on site integrity. The time taken for DS NO_x emissions to reduce to DM levels is estimated at 11 years, so is temporary and any effects could be theoretically reversible. Therefore, the impact level has been assessed as moderate. According to DMRB LA 108, the significance of a moderate impact level on a site of national value could be either moderate or large. Again, a precautionary approach has been taken and significance is assessed as large (both moderate and large are significant effects).	Moderate adverse	Large (significant)
Perry's Wood LWS	Designated as county level but ancient woodland is of national importance.	Woodland 10kg N/ha/yr	Background = 32.48kg N/ha/yr Total N deposition (DM) = 39.89kg N/ha/yr Total N deposition (DS) =42.71 kg N/ha/yr Change DM to DS: 2.82kg N/ha/yr (28.2% of Lower Critical Load)	0.74ha 20.19%	11	Although the LWS is of county value, the boundaries coincide with the ancient woodland, which is of national value. Therefore, the LWS is assessed as the ancient woodland site above.	Moderate adverse	Large (significant) Assessed for the higher value ancient woodland as above

Site	Resource importance	Habitat Modelled and Lower Critical Load	Magnitude of impact (maximum figures for site)	Impact extent (ha/% of site)	Estimated Impact Duration (years)	Assessment	Impact Level	Significance
Cook's Lane Lexden LWS	County	Woodland 10kg N/ha/yr	Background = 31.64kg N/ha/yr Total N deposition (DM) = 52.86kg N/ha/yr Total N deposition (DS) =53.52 kg N/ha/yr Change DM to DS: 0.66kg N/ha/yr (6.6% of Lower Critical Load)	0.21ha 2.82%	2	The baseline N deposition already exceeds the upper critical load of 20kg N/ha/yr and the DS N deposition is high, with an increase above baseline of nearly 22kg N/ha/yr. However, the change due to the proposed scheme (DM to DS) is relatively small (0.66kg N/ha/yr). Given that less than 3% of the site is affected by increased N deposition and the time taken for DS NO_x emissions to reduce to DM levels is predicted to be very short-term (2 years), there is considered to be no effect on site integrity. This results in an impact level of negligible.	Negligible	Neutral (not significant)
West House Wood LWS	County	Woodland 10kg N/ha/yr	Background = 31.64kg N/ha/yr Total N deposition (DM) = 63.39kg N/ha/yr Total N deposition (DS) =64.04 kg N/ha/yr Change DM to DS: 0.65kg N/ha/yr (6.5% of Lower Critical Load)	0.28ha 8.74%	1	The baseline N deposition already exceeds the upper critical load of 20kg N/ha/yr and the DS N deposition is high, with an increase above baseline of approximately 32kg N/ha/yr. However, the change due to the proposed scheme (DM to DS) is relatively small (0.65kg N/ha/yr). Although nearly 9% of the woodland is predicted to be affected by exceedance, the site is small (3ha) and adjacent to housing, with likely impacts of recreation (e.g. dog walking). Given the small increase in N deposition relative to DM as well as the very short (1 year) time taken for DS NO_x emissions to reduce to DM levels, no impact on site integrity is expected as a result of the proposed scheme. This results in an impact level of negligible.	Negligible	Neutral (not significant)
Smythe's Green LWS	County	Grassland 20kg N/ha/yr	Background = 23.24kg N/ha/yr Total N deposition (DM) = 28.07kg N/ha/yr Total N deposition (DS) =28.66 kg N/ha/yr Change DM to DS: 0.59kg N/ha/yr (2.96% of Lower Critical Load)	0.11ha 8.74%	<1	It is predicted that a narrow strip (maximum 10m width, 0.1 ha in area) along the B1022 would be affected by a small increase in N deposition. Only the first point of the transect is predicted an increase in N deposition; after 10m the prediction is for N deposition to decrease, resulting in an overall benefit for the site. The site is only 1ha in size, so this narrow strip constitutes approximately 9% of the site. However, the increase is extremely short-lived, with a duration of less than 1 year. There are high value grassland habitats within the site (beyond the predicted nitrogen-affected area), but grassland closer to the boundary with the road appeared more characteristic of nutrient-enriched conditions, with taller grasses and robust tall herbs with high Ellenberg values for nitrogen. Therefore, there is no likely change to the vegetation composition as a result of the small extent and temporary increase in N deposition Therefore the increase in N deposition is not predicted to affect site integrity and the impact level is assessed as negligible.	Negligible	Neutral (not significant)

8 Conclusion

8.1.1 During construction, one verified veteran tree, four potential veteran trees and one potential ancient tree were screened in for ecological assessment due to increased N deposition. Given that the duration of impact would be a maximum of four years (the duration of the construction phase) and the magnitude of increase in N deposition ranges between 6.5% and 10.4% of the lower critical load, it was concluded that the changes in N deposition as a result of the proposed scheme are likely to result in a temporary and reversible effect which does not affect the integrity or key characteristics of the individual veteran trees.

8.1.2 In the operational phase, the only designated site with a predicted significant effect is Perry's Wood LWS (which is valued at a national level as it supports ancient woodland). The increase in N deposition as a result of the proposed scheme is predicted to affect approximately 20% of this site for an estimated duration of 11 years.

8.1.3 Chapter 9: Biodiversity, of the Environmental Statement ([TR010060/APP/6.1]) sets out the proposals to offset the significant residual effect on Perry's Wood by planting woodland at borrow pit F. Indicative species mixes are described in the Landscape and Ecology Management Plan, which is included in the first iteration of the Environmental Management Plan [TR010060/APP/6.5], and the proposed species composition will reflect the species typical of Perry's Wood and other ancient woodlands in the local area, although not ash due to the prevalence of ash dieback in the area.

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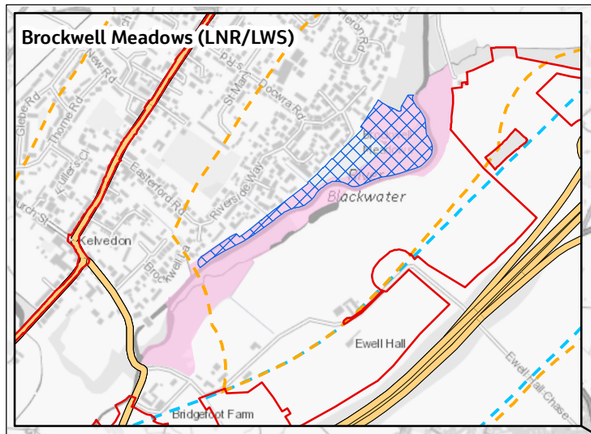
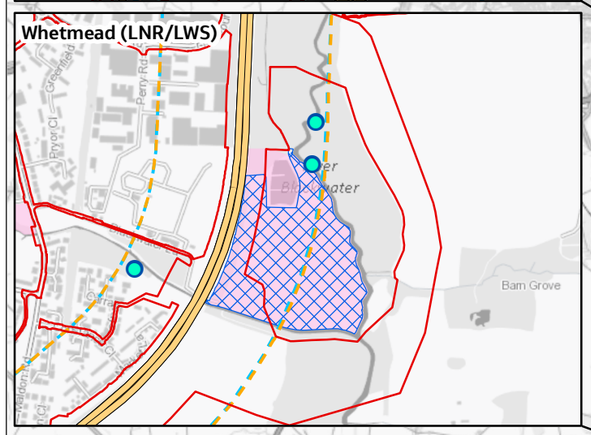
Figures

APPENDIX 9.15 - FIGURE 1





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Abberton Reservoir
West Mersea
A414
A12
A130
A1060
A138
A1114

Marks Tey Brickpit
Stanway Pitt
Gol Grove/Hanging Wood
Ram Plantation
Lower Road, Birch Verges
West House Wood
Spring Grove
Cook's Lane, Lexden
Lexden Springs LNR
Hilly Fields
Brockwell Meadows
Inworth Wood
Perry's Wood
Kelvedon Hall Wood
Pods and Connfield Woods
Smythe's Green
Layer Wood and Grassreasons
Inworth Grange Pits
Tiptree Church
Braxted Park
Tiptree Heath
Whet Mead LNR
Stonage Wood
Boreham Road Gravel Pits
Porters Grove
River Chelmer
Sandon Riverside
Sandon Pit
Sir Hughes' Woods
Gallowood Common
Lady Grove

0 5 km

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N
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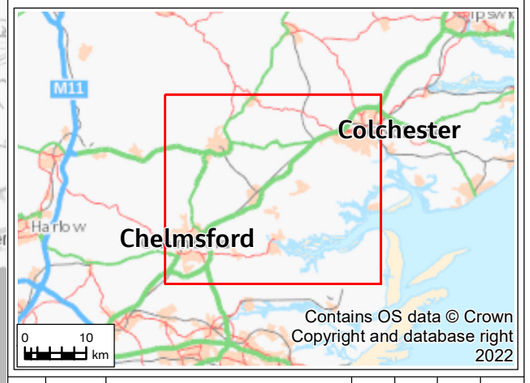
Legend

- Order Limits
- Affected Road Network (ARN) - Construction
- Affected Road Network (ARN) - Operational (200m buffer)
- Affected Road Network (ARN) - Operational
- Affected Road Network (ARN) - Construction (200m buffer)
- Ancient tree
- Veteran tree
- Potential ancient tree
- Potential veteran tree
- Ancient Woodland
- Site of Special Scientific Interest (SSSI)
- Local Nature Reserve (LNR)
- Local Wildlife Site (LWS)
- Porter's Grove Potential Ancient Woodland



Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
ECOLOGY RECEPTORS WITHIN 200M OF THE ARN
SHEET 1 OF 1

Drawing Status: S4 – SUITABLE FOR STAGE APPROVAL

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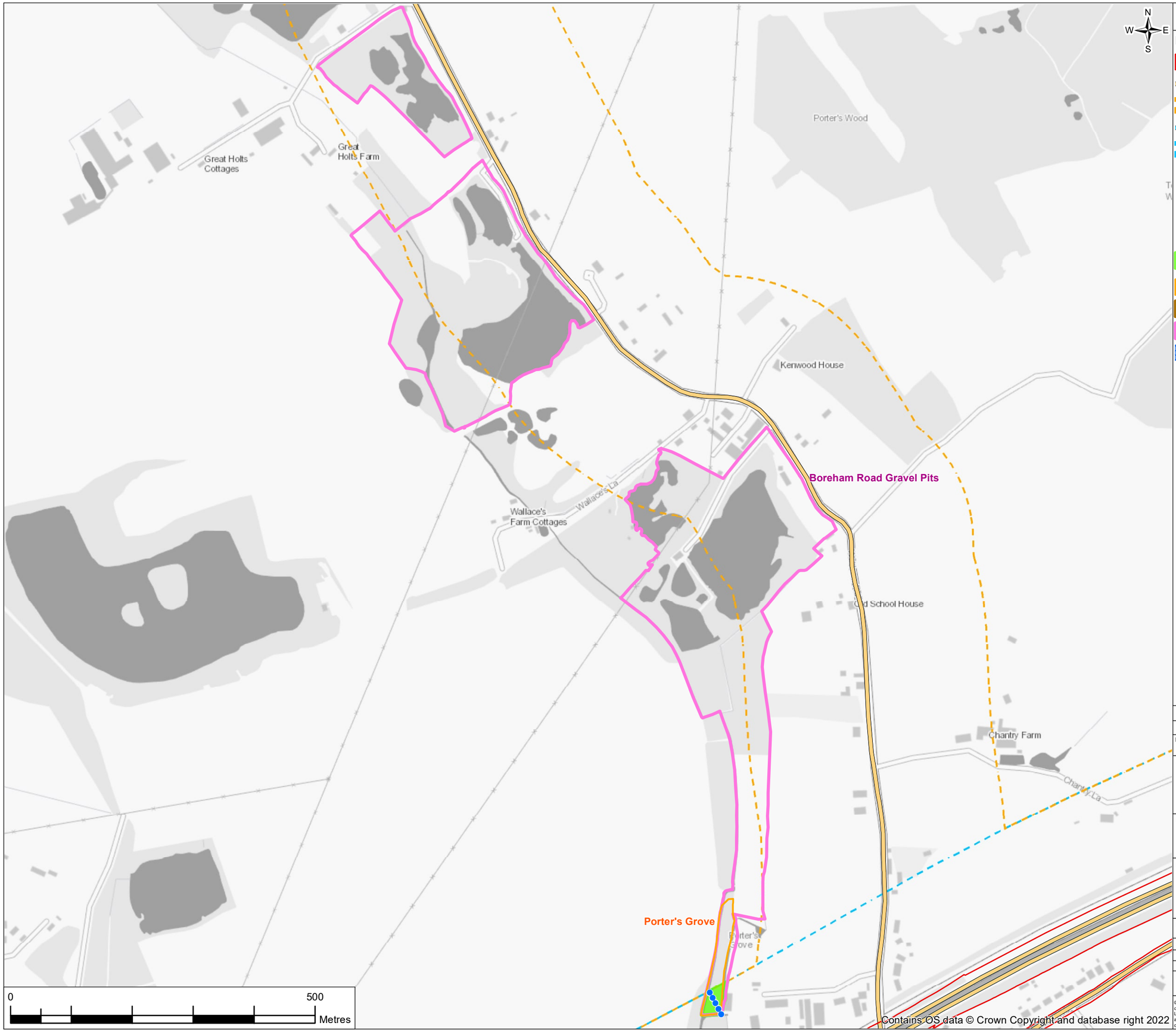
Client No.	HE551497	Rev P01

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0457

APPENDIX 9.15 - FIGURE 2



Legend

- Order Limits
- Affected Road Network (ARN) - Operational
- Affected Road Network (ARN) - Operational (200m buffer)
- Affected Road Network (ARN) - Construction
- Affected Road Network (ARN) - Construction (200m buffer)
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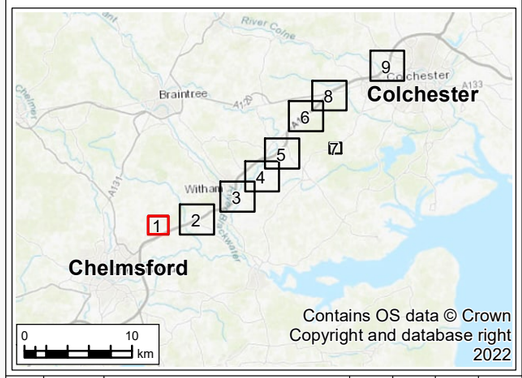
- Veteran Trees (including verified and potential veteran and ancient trees) - screened in for Construction Phase only
- Modelled Air Quality Transect
- Nitrogen Affected Area (indicating where the nitrogen deposition increase is greater than 0.4kg N/ha/yr)
- Porter's Grove Potential Ancient Woodland
- Ancient Woodland
- Local Wildlife Site (LWS)
- Local Nature Reserve (LNR)



Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 1 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

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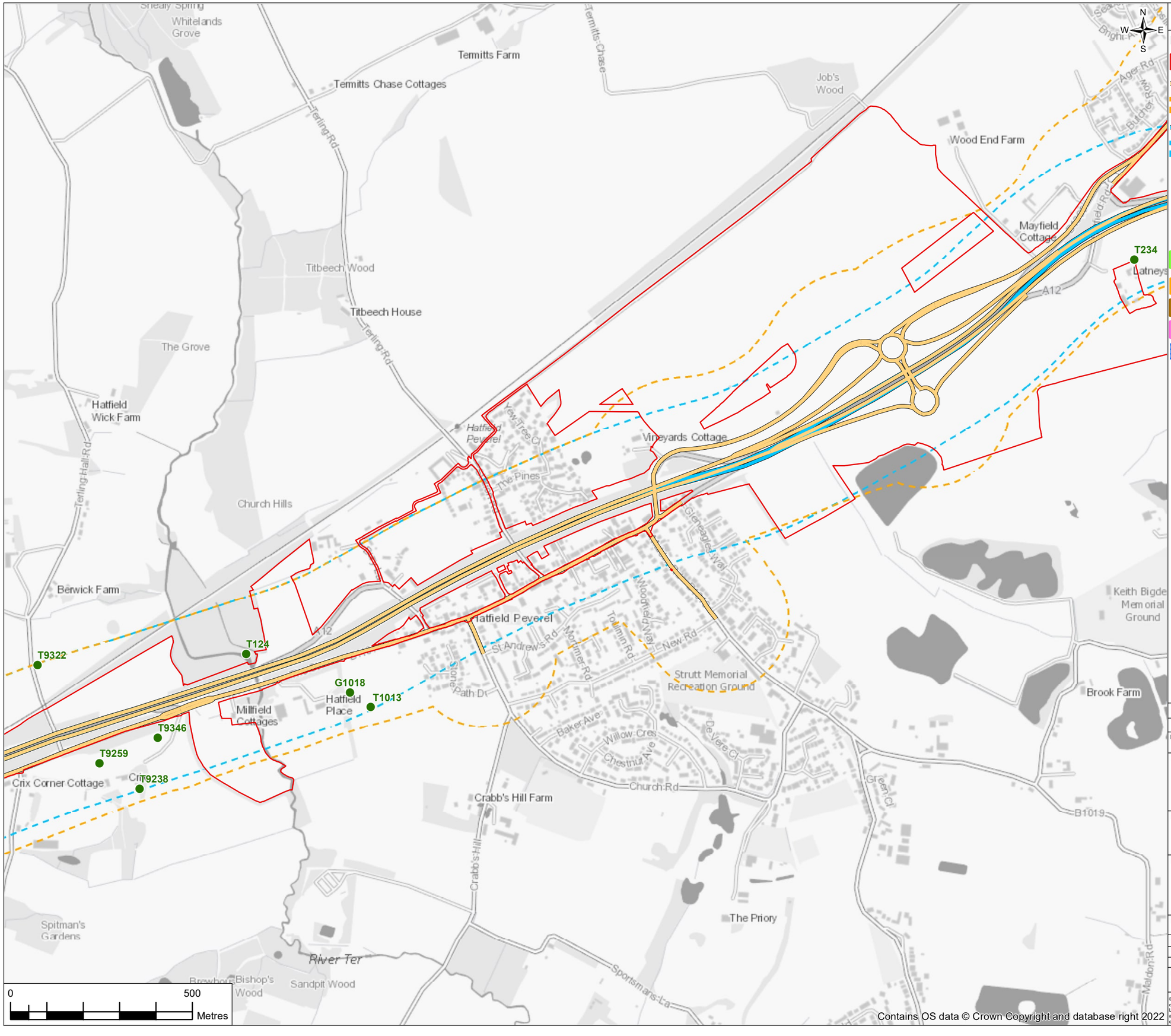
APPENDIX 9.15 - FIGURE 2



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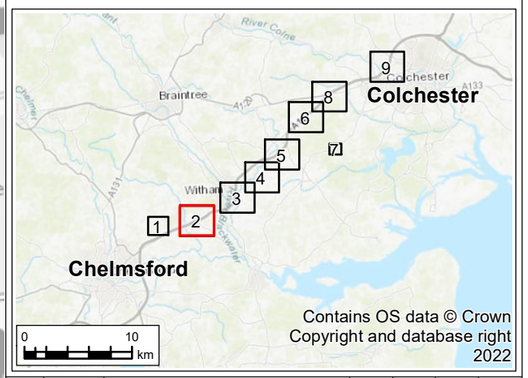

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P01	27/07/22	For DCO application	AD	LA	AJ	SG

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 2 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

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APPENDIX 9.15 - FIGURE 2

Legend

- Order Limits
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- Affected Road Network (ARN) - Construction
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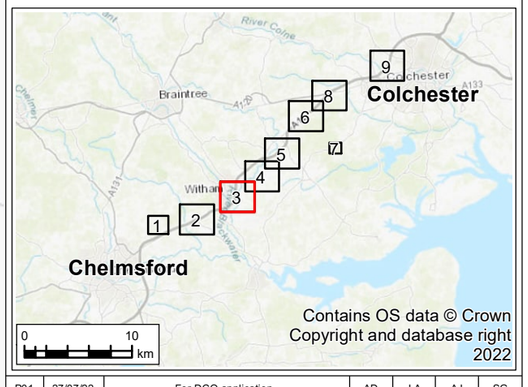

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Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
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Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

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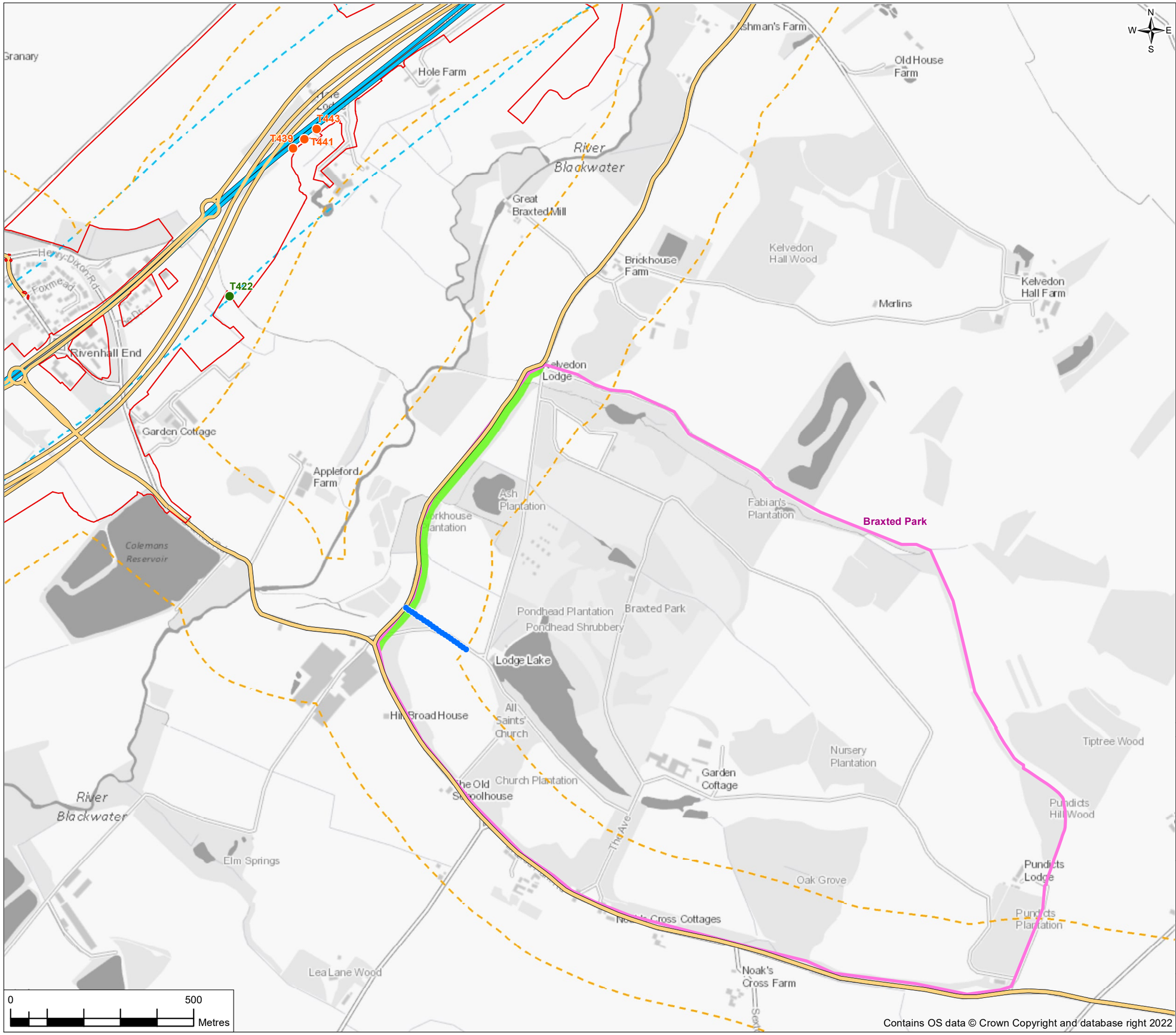
APPENDIX 9.15 - FIGURE 2



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- Affected Road Network (ARN) - Construction (200m buffer)
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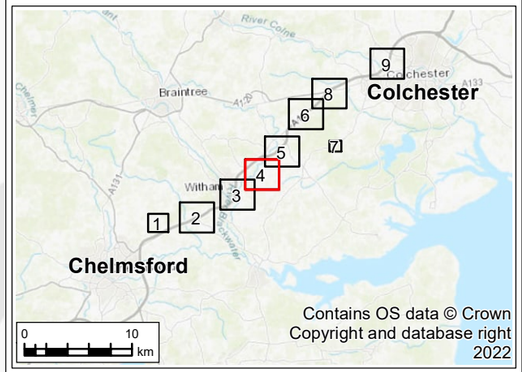

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Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
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APPENDIX 9.15 - FIGURE 2

Legend

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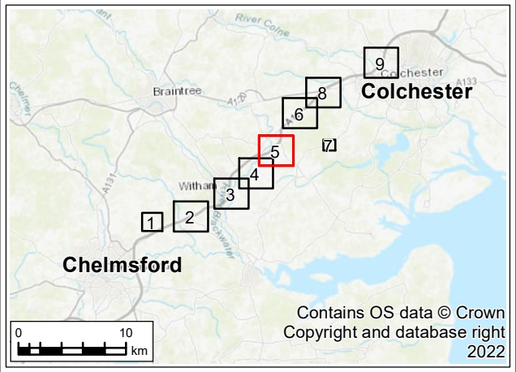
- Affected Road Network (ARN) - Construction
- Affected Road Network (ARN) - Construction (200m buffer)
- Veteran Trees (including verified and potential veteran and ancient trees) - screened in for Operation Phase only
- Veteran Trees (including verified and potential veteran and ancient trees) - screened in for Construction Phase only
- Modelled Air Quality Transect
- Nitrogen Affected Area (indicating where the nitrogen deposition increase is greater than 0.4kg N/ha/yr)
- Porter's Grove Potential Ancient Woodland
- Ancient Woodland
- Local Wildlife Site (LWS)
- Local Nature Reserve (LNR)



P01	27/07/22	For DCO application	AD	LA	AJ	SG
Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

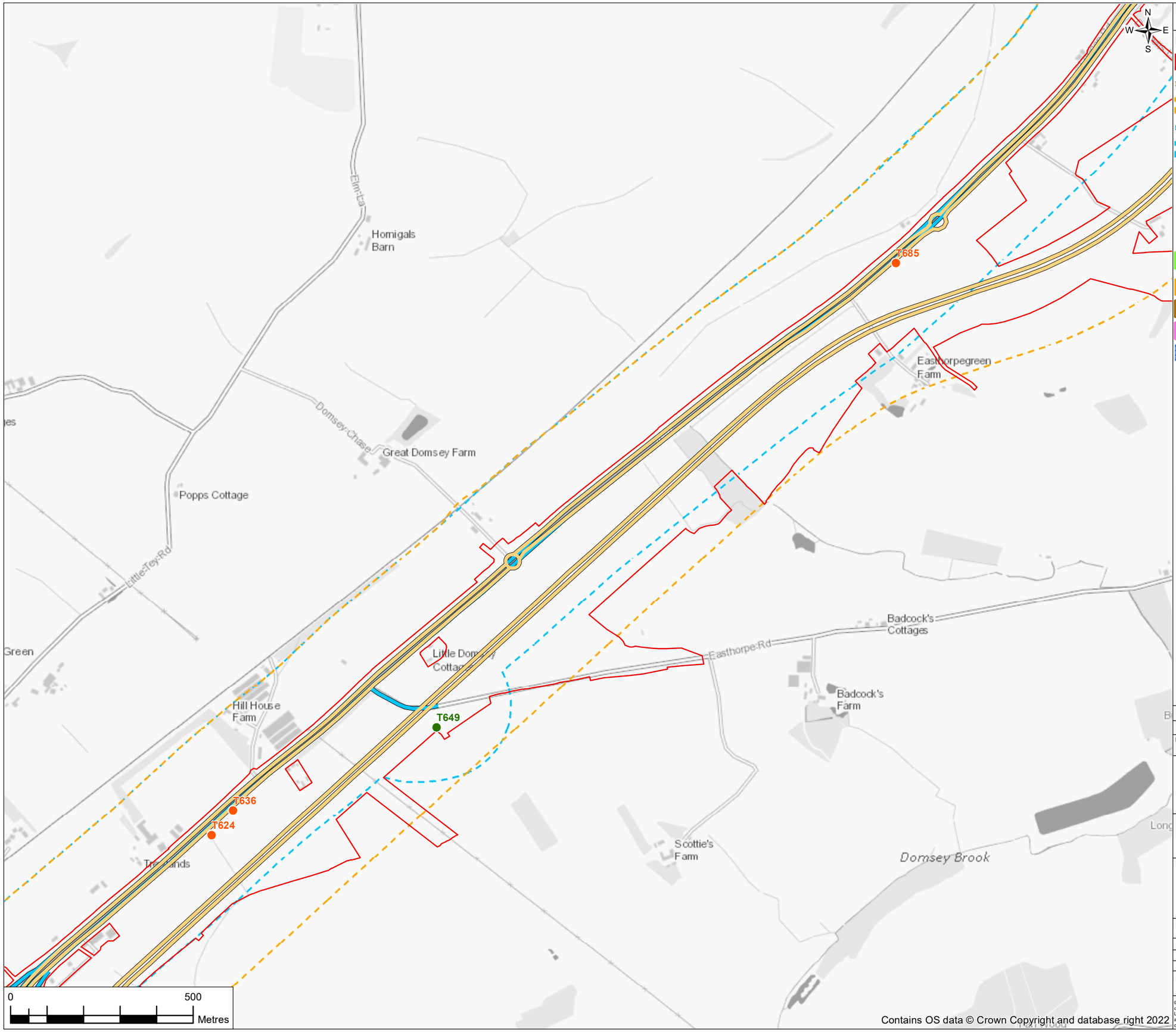
Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 5 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

Scale @ A3	1:10000	DO NOT SCALE
Jacobs No.	B36601D1	
Client No.	HE551497	Rev P01

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0462

APPENDIX 9.15 - FIGURE 2



Legend

- Order Limits
- Affected Road Network (ARN) - Operational
- Affected Road Network (ARN) - Operational (200m buffer)
- Affected Road Network (ARN) - Construction
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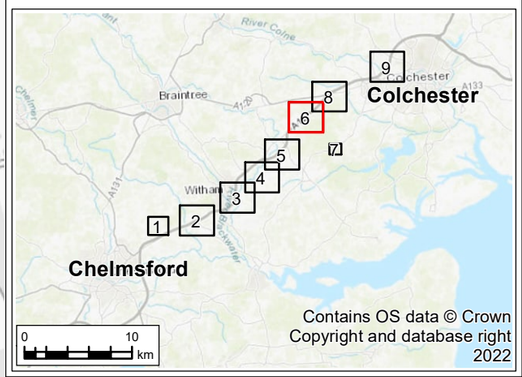


Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	27/07/22	For DCO application	AD	LA	AJ	SG

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

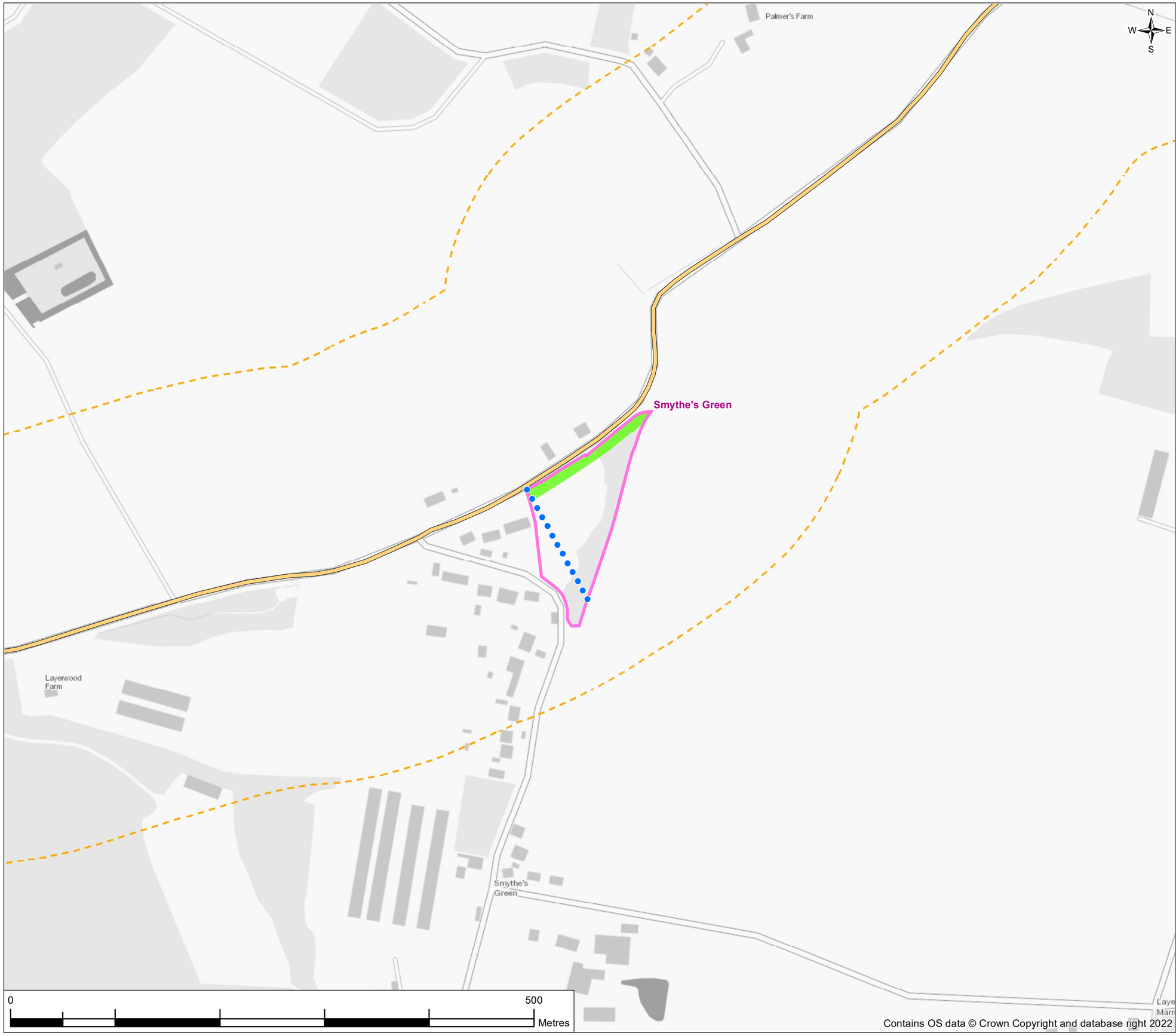
Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 6 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

Scale @ A3	1:10000	DO NOT SCALE
Jacobs No.	B36601D1	
Client No.	HE551497	Rev P01

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0463

APPENDIX 9.15 - FIGURE 2



Legend

- Order Limits
- Affected Road Network (ARN) - Operational
- Affected Road Network (ARN) - Operational (200m buffer)
- Affected Road Network (ARN) - Construction
- Affected Road Network (ARN) - Construction (200m buffer)
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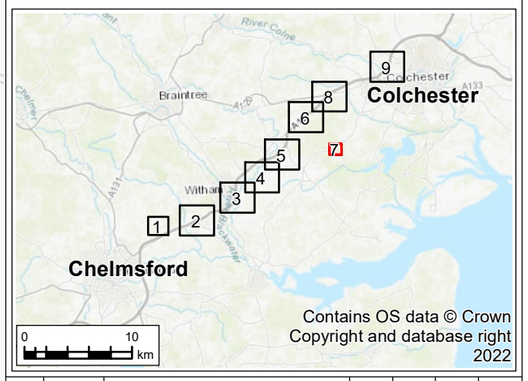


Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	27/07/22	For DCO application	AD	LA	AJ	SG

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

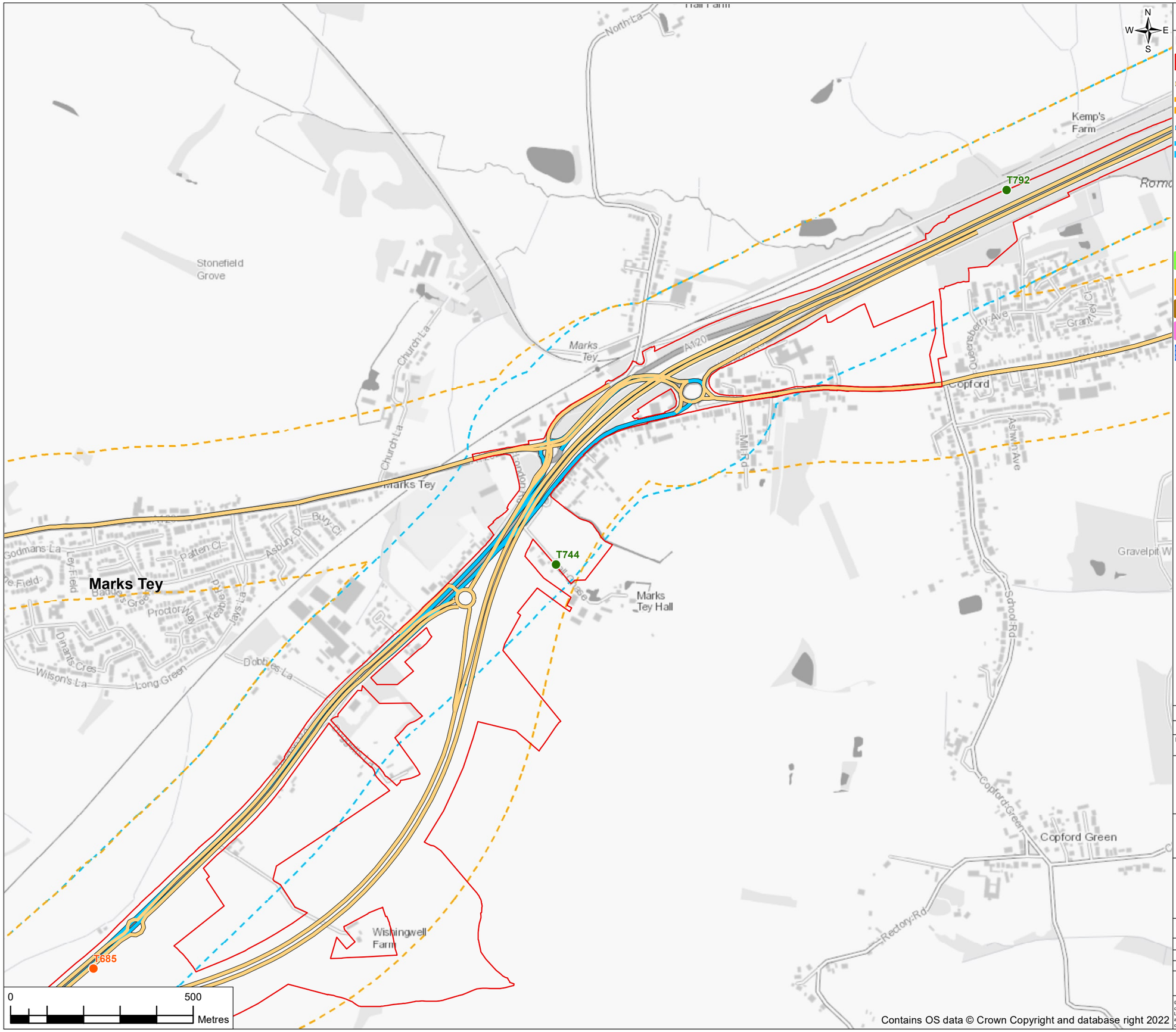
Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 7 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

Scale @ A3	1:3500	DO NOT SCALE
Jacobs No.	B36601D1	
Client No.	HE551497	Rev P01

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0464

APPENDIX 9.15 - FIGURE 2



Legend

- Order Limits
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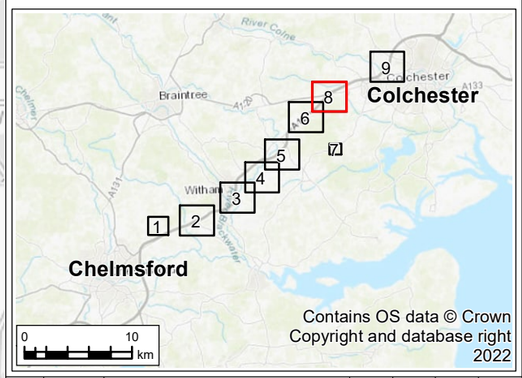


Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	27/07/22	For DCO application	AD	LA	AJ	SG

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

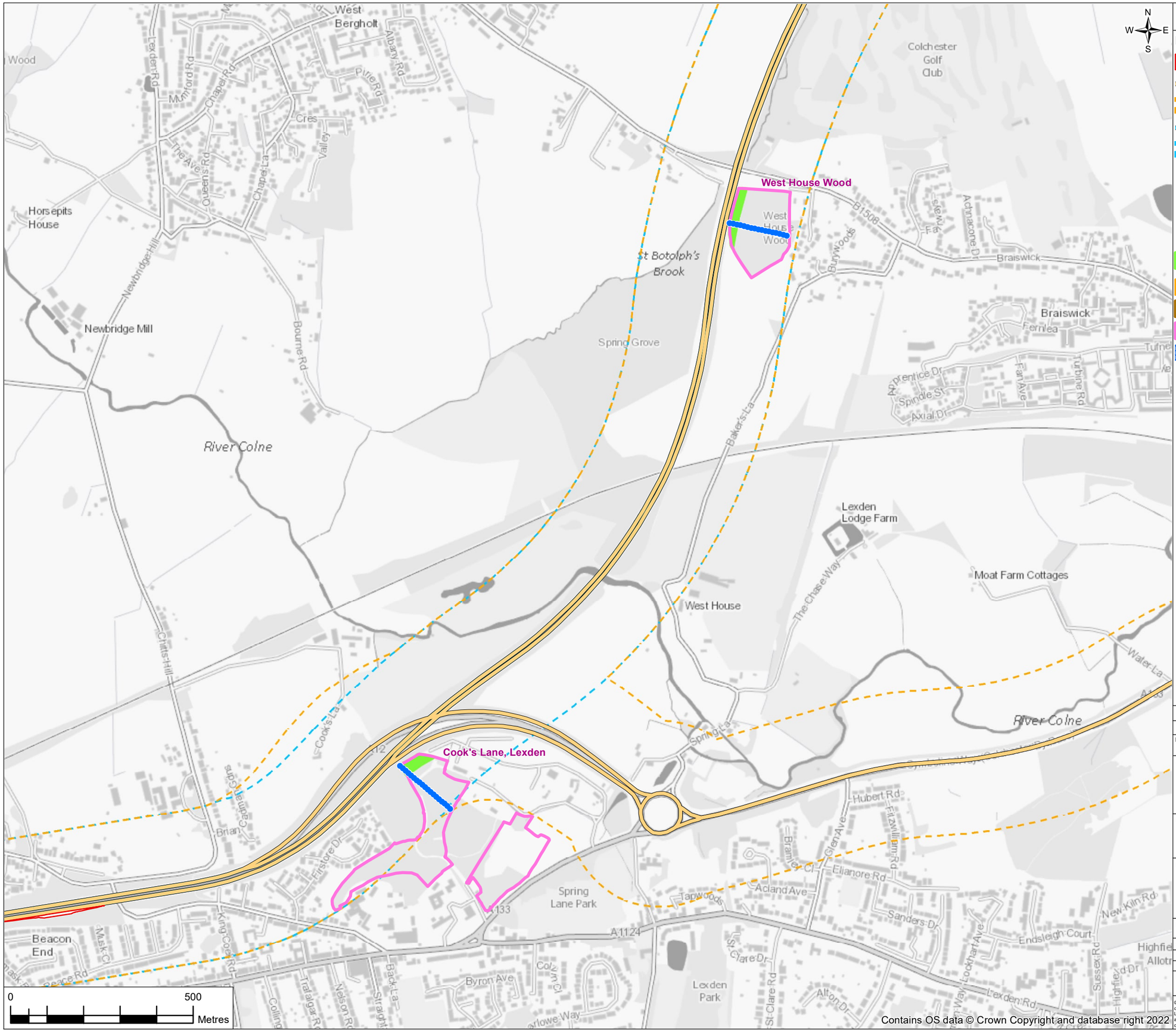
Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 8 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

Scale @ A3	1:10000	DO NOT SCALE	
Jacobs No.	B36601D1	Rev	P01
Client No.	HE551497		

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0465

APPENDIX 9.15 - FIGURE 2



Legend

- Order Limits
- Affected Road Network (ARN) - Operational
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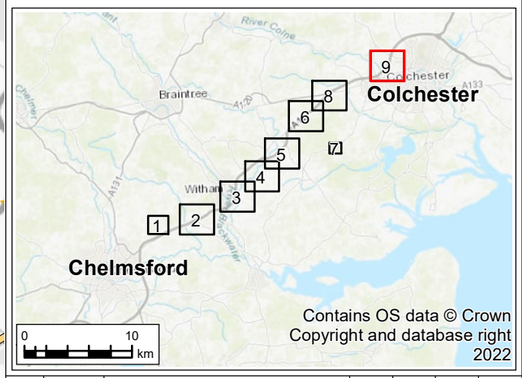

Rev.	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	27/07/22	For DCO application	AD	LA	AJ	SG

Development Consent Order Drawing Number: TR010060/APP/6.3

APFP Regulation: Regulation 5(2)(l)

Client: national highways

Project: REGIONAL DELIVERY PARTNERSHIP
A12 CHELMSFORD TO A120 WIDENING SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT
RECEPTORS SCREENED IN FOR ECOLOGICAL ASSESSMENT (NITROGEN DEPOSITION INCREASE GREATER THAN 0.4KG N/HA/YR) SHEET 9 OF 9

Drawing Status: S4 - SUITABLE FOR STAGE APPROVAL

Scale @ A3	1:10000	DO NOT SCALE
Jacobs No.	B36601D1	
Client No.	HE551497	Rev P01

Drawing Number: HE551497-JAC-LDC-SCHW-SK-GI-0466

Annex A Calculation of duration of scheme impact

A.1 Methodology

A.1.1 Indicative duration of impact calculations were undertaken in order to support the assessment of potential significance from N deposition effects on designated sites. The duration of impact calculation was undertaken for all sites where N deposition effects were found to be potentially significant, according to DMRB LA 105 criteria (i.e. with scheme total N deposition above the minimum critical load; a change in N deposition with the scheme of greater than 1% of the minimum critical load; and a change in N deposition of greater than 0.4 kg N/ha/yr).

A.1.2 The approach applied professional judgement to identify the main links contributing to N deposition, within 200m of the modelled ecological transect or receptor. Annualised road NOx emissions from these links were calculated for the Opening Year (2027) Do-Minimum (DM) and Do-Something (DS) Scenarios and the Design Year (2042) DS scenario. Emissions were estimated by applying speed banded emission factors based on version 10.1 of the Emission Factor Toolkit. A further test was undertaken, for the duration calculations only, using speed banded emission factors included in the Emission Factor Toolkit version 11.0 (released in November 2021 i.e. after the air quality modelling phase had been completed). Version 11.0 included vehicle fleet improvement up to 2050.

A.1.3 The total emissions were linearly interpolated between the 2027 and 2042 DS scenarios to produce an annual emission total for the interim years. The emissions for each year were compared to the Opening Year DM emissions and the first year where the DS emissions were below the Opening Year DM scenario was recorded. This gave an indication of when the impact of the scheme would return to levels before the proposed scheme was implemented. It is worth noting that the differences in duration impact shown between applying versions 10.1 and 11.0 speed banded emission factors were slight and location specific. Duration of proposed scheme impact included the application of the latest speed banded emission factors.

A.2 Limitations

A.2.1 The methodology is subject to several limitations and the results should therefore be considered indicative of the proposed scheme's duration of impact. The limitations are listed below:

- Selection of links. The methodology does not account for the distance between the designated site and the contributing road links. Therefore, changes in the alignment of roads between the DM and DS are not accounted for. Professional judgment was applied to the selection of links in circumstances where the DS resulted in a realignment of the road.
- The calculation of emissions is sensitive to the total link length. Efforts were made to be as consistent as possible between the DM and DS scenarios where applicable.

A.3 Sensitivity test

A.3.1 A sensitivity test was undertaken, which removed the effect of link length from the equation. The result of this generally indicated no change to the predicted duration of proposed scheme impact and was less time-consuming, given the sensitivities mentioned above. It is believed that removing the link length element would provide the least room for error, particularly when comparing schemes with offline sections and junctions.

Annex B Site investigation results – Whetmead LNR/LWS

B.1 Description

B.1.1 Whetmead is adjacent to the existing A12 and is a restored landfill of 11.36ha, now supporting grassland, scrub and lagoons. There is a narrow strip of woodland (approximately 30m wide) along the western boundary. The site is predominantly a mosaic of short rabbit-grazed and trampled grassland, tall rank grassland and tall ruderal vegetation, with scattered hawthorn (*Crataegus* monogyna) and rose (*Rosa*) scrub. There are areas with more diverse grassland, with drought tolerant species, some of which also have low Ellenberg indicator values for nitrogen, such as lady's-bedstraw (*Galium verum;* Ellenberg value of 2) and squirrel-tail fescue (*Vulpia bromoides*; Ellenberg value of 3). Also recorded were changing forget-me-not (*Myosotis discolor;* Ellenberg value of 3), and perforate St John's-wort (*Hypericum perforatum*; Ellenberg value of 5). However, on the whole the grassland is species-poor, mostly dominated by nitrophilous species that are typical of nutrient enrichment and have high Ellenberg indicator values. These species include false oat-grass (*Arrhenatherum elatius;* Ellenberg value of 7) with areas to the east being predominantly common nettle (*Urtica dioica*) and cleavers (*Galium aparine*), both of which have Ellenberg values of 8. The non-native hoary cress (*Lepidium draba*) is abundant across the whole area. It was noted during the site visit in May 2022 that the short sward grassland supporting the drought-tolerant and nitrophilous species is more prevalent on the western slope of the restored landfill which is closer to the existing road than the rank grassland and tall herb vegetation which dominates on the eastern slope of the landfill further from the road. It is possible that the membrane or clay that was used to cap the restored landfill has been breached on this side, as such level of nutrient enrichment is otherwise impossible to explain above the floodplain.

B.1.2 Notable plants recorded within the LWS include pyramidal orchid (*Anacamptis pyramidalis;* Ellenberg value of 3) (desk study record)) and small teasel (*Dipsacus pilosus*; Ellenberg value of 7), which was recorded during the Phase 1 Habitat Survey adjacent to the River Brain through Whetmead LNR.

B.1.3 The woodland area was assessed as Moderate (Fairly poor) condition, scoring low due to an undeveloped canopy and understorey in early stages of development.

B.1.4 The grassland was assessed as Moderate condition using the Defra Biodiversity Metric 3.1, with a varied sward height with areas of closely grazed grass and bare ground due to rabbit activity. In addition, there were a high number of undesirable non-native and expansive species scattered throughout the sward.

B.2 Pressures and threats

B.2.1 There are several features attributable to on-going nutrient enrichment, however, they are located far away from the road on the slopes of this former landfill site and should be attributed to water seepage rather than airborne deposition.

B.2.2 Two species requiring nutrient-poor soils were recorded within the open grassland part of the site including squirrel-tail fescue and changing forget-me-not. Both of these species were recorded within the section of the grassland located in close proximity to the road in area with no obvious signs of the effects of increased N deposition.

Table B.1 List of species Whetmead. Date surveyed: 11 May 2022

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Artemisia vulgaris	Mugwort	7	Field	R	-
Achillea millefolium	Yarrow	4	Field	R	-
Rubus fruticosus	Bramble	6	Field	R	-
Lamium album	White dead-nettle	8	Field	R	-
Urtica dioica	Common nettle	8	Field	A	-
Festuca rubra	Red fescue	5	Field	R	-
Dactylis glomerata	Common cock's-foot	6	Field	O	-
Bromus sterilis	Sterile brome	5	Field	O	-
Acer campestre	Field maple	6	Canopy	F	-
Brachypodium sylvaticum	Wood false-brome	5	Field	R	-
Anthriscus sylvestris	Cow's parsley	7	Field	R	-
Geranium molle	Dove's-foot cranesbill	5	Field	R	-
Chenopodium album agg.	Fat-hen	7	Field	R	-
Picris echioides	Bristly oxtongue	6	Field	R	-
Galium aparine	Cleavers	8	Field	O	-
Alliaria petiolata	Garlic mustard	8	Field	F	-
Arrhenatherum elatius	False oat-grass	7	Field	O	-
Arctium lappa	Greater burdock	9	Field	R	-
Malva neglecta	Dwarf mallow	7	Field	R	-
Rumex crispus	Curled dock	6	Field	R	-
Crataegus monogyna	Common hawthorn	6	Understory	O	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Geum urbanum	Wood avens	7	Field	O	-
Rosa canina agg.	Dog's rose	6	Understory	R	-
Taraxacum officinale agg.	Dandelion	6	Field	R	-
Potentilla reptans	Creeping cinquefoil	5	Field	R	-
Bellis perennis	Daisy	4	Field	R	-
Geranium columbinum	Long-stalked crane's-bill	7	Field	R	-
Poa pratensis	Smooth meadow-grass	5	Field	R	-
Cornus sanguinea	Dogwood	6	Understory	R	-
Pentaglottis sempervirens	Green alkanet	7	Field	R	-
Ranunculus acris	Meadow buttercup	4	Field	R	-
Glechoma hederacea	Ground ivy	7	Field	O	-
Poa annua	Annual meadow-grass	7	Field	R	-
Medicago arabica	Spotted medick	5	Field	R	-
Lepidium draba	Hoary cress	6	Field	R	-
Conium maculatum	Hemlock	8	Field	R	-
Milium effusum	Wood millet	5	Field	R	-
Heracleum sphondylium	Common hogweed	7	Field	R	-
Symphytum officinale	Comfrey	8	Field	R	-
Holcus lanatus	Yorkshire fog	5	Field	R	-
Rumex obtusifolius	Broad-leaved dock	9	Field	R	-
Ligustrum vulgare	Common privet	5	Understory	R	-
Ranunculus repens	Creeping buttercup	7	Field	R	-
Euonymus europaeus	Spindle	5	Understory	R	-
Calystegia sepium	Hedge bindweed	7	Field	O	-
Cirsium arvense	Creeping thistle	6	Field	R	-
Geranium dissectum	Cut-leaved crane's-bill	6	Field	R	-
Veronica hederifolia	Ivy-leaved speedwell	6	Field	R	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Trifolium repens	White clover	6	Field	R	-
Poa trivialis	Rough meadow-grass	6	Field	R	-
Plantago major	Broadleaved plantain	7	Field	R	-
Plantago lanceolata	Ribwort plantain	4	Field	R	-
Salix cinerea	Grey willow	5	Understory	R	-
Salix alba	White willow	8	Canopy	R	-
Alnus glutinosa	Alder	6	Canopy	R	-
Lapsana communis	Nipplewort	7	Field	R	-
Dipsacus fullonum	Wild teasel	7	Field	R	-
Myosotis scorpioides	Water forget-me-not	6	Field	R	-
Cerastium fontanum	Common mouse-ear	4	Field	R	-
Crataegus media	Hybrid hawthorn	5	Understory	R	-
Veronica chamaedrys	Germander speedwell	5	Field	R	-
Lamium purpureum	Red dead-nettle	7	Field	R	-
Prunus spinosa	Blackthorn	6	Understory	R	-
Solanum dulcamara	Bittersweet	7	Field	R	-
Prunella vulgaris	Selfheal	4	Field	R	-
Veronica polita	Grey field-speedwell	5	Field	R	-
Arrhenatherum elatius	False oat-grass	7	Field	A	-
Anthriscus sylvestris	Cow's parsley	7	Field	R	-
Dactylis glomerata	Common cock's-foot	6	Field	R	-
Urtica dioica	Common nettle	8	Field	F	-
Acer campestre	Field maple	6	Canopy	R	-
Sambucus nigra	Elder	7	Understory	O	-
Brachypodium sylvaticum	Wood false-brome	5	Field	R	-
Rumex crispus	Curled dock	6	Field	R	-
Cirsium arvense	Spear thistle	6	Field	R	-
Oxalis stricta	Upright yellow-sorrel	5	Field	R	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Geum urbanum	Wood avens	7	Field	R	-
Arum maculatum	Lords-and-ladies	7	Field	R	-
Barbarea vulgaris	Winter-cress	8	Field	R	-
Festuca rubra	Red fescue	5	Field	R	-
Potentilla reptans	Creeping cinquefoil	5	Field	O	-
Senecio jacobaea	Ragwort	4	Field	O	-
Bellis perennis	Daisy	4	Field	O	-
Geranium columbinum	Dove's-foot cranesbill	7	Field	R	-
Trifolium repens	White clover	6	Field	O	-
Geranium dissectum	Cut-leaved crane's-bill	6	Field	R	-
Hypericum perforatum	Perforated St.John's-wort	5	Field	O	-
Medicago arabica	Spotted medick	5	Field	F	-
Rosa canina agg.	Dog's rose	6	Field	R	-
Hypericum maculatum	Imperforate St.John's-wort	5	Field	R	-
Pseudoscleropodium purum			Moss	R	-
Vulpia bromoides	Squirreltail fescue	3	Field	F	-
Myosotis arvensis	Field forget-me-not	6	Field	R	-
Myosotis discolor	Changing forget-me-not	3	Field	R	-
Cerastium fontanum	Common mouse-ear	4	Field	R	-
Veronica arvensis	Wall speedwell	5	Field	R	-
Sagina procumbens	Procumbent pearlwort	5	Field	R	-
Medicago lupulina	Black medick	4	Field	O	-
Lepidium draba	Hoary cress	6	Field	F	-
Prunella vulgaris	Selfheal	4	Field	R	-
Veronica serpyllifolia	Thyme-leaved speedwell	5	Field	R	-
Dipsacus fullonum	Wild teasel	7	Field	O	-
Picris echioides	Bristly oxtongue	6	Field	R	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Veronica chamaedrys	Germander speedwell	5	Field	R	-
Persicaria maculosa	Redshank	7	Field	R	-
Ranunculus repens	Creeping buttercup	7	Field	R	-
Agrostis stolonifera	Creeping bent	6	Field	R	-
Holcus lanatus	Yorkshire fog	5	Field	R	-
Viola odorata	Sweet violet	7	Field	R	-
Crataegus monogyna	Common hawthorn	6	Understory	R	-
Rubus fruticosus	Bramble	6	Field	R	-
Lamium album	White dead-nettle	8	Field	R	-
Conium maculatum	Hemlock	8	Field	R	-
Prunus spinosa	Blackthorn	6	Understory	R	-
Glechoma hederacea	Ground ivy	7	Field	O	-
Malva neglecta	Dwarf mallow	7	Field	R	-
Lysimachia punctata	Dotted loosestrife	5	Field	R	-
Galium aparine	Cleavers	8	Field	O	-
Sonchus asper	Prickly sow-thistle	6	Field	R	-
Cirsium arvense	Creeping thistle	6	Field	R	-

Ellenberg values	Whetmead T1	Whetmead T2
mean	6.17	5.87
median	6	6
min	4	3
max	9	8

Table B.2 Whetmead T1 and T2 site photographs.

Photo No. and Grid reference	Photo	Description
TL 83065 13966		Central part of the sites with steep slopes and lagoons collecting water seepage from the former landfill. Visible nutrient influx possibly associated with seepage from the reclaimed landfill. Vegetation dominated by Nettle and scattered Elder.
TL 83021 13947		Central part of the site partially grazed by rabbits with false oat in abundance accompanied by scattered ruderal herbs.

Photo No. and Grid reference	Photo	Description
TL 83210 13797		Eastern part of the site (furthest away from the road). Nettle dominated tall-herb in area of distinct nutrient influx.
TL 83231 13790		Eastern part of the site. Area of transition from fertile nettle-dominated tall-herb to floodplain tall herb with Comfrey

Photo No. and Grid reference	Photo	Description
TL 83017 13990		Lagoons with abundance of Nettle and pockets of reedbed
TL 82970 13983		Vegetation plot 1. Open rabbit-grazed grassland.

Photo No. and Grid reference	Photo	Description
TL 83002 13955		Vegetation plot 2. Rabbit grazed ruderal grassland.
TL 82861 13744		Transect 1. Photo 1. Tall-grass grassland within the roadside of A12.

Photo No. and Grid reference	Photo	Description
TL 82904 13727		Transect 1. Photo 2. Mixed shrub and tall herb alongside a footpath.
TL 82936 13715		Transect 1. Photo 3. Part of former line of willow trees with tall-herb dominated field layer.

Photo No. and Grid reference	Photo	Description
TL 82941 13974		Transect 2. Photo 1. Late-juvenile woodland. Highways screening planting with visible tall-grass dominated verge behind.
TL 82953 13972		Transect 2. Photo 2. Slopes of the Whetmead site in its part formed by a highways screening planting.

Photo No. and Grid reference	Photo	Description
TL 82972 13970		Transect 2. Photo 3. Short-sward rabbit-grazed grassland with recent rutting caused by heavy vehicles.
TL 82988 13966		Transect 2. Photo 4. Short-sward rabbit-grazed grassland with visible expansion of tall herbs including non-native hoary cress.

Photo No. and Grid reference	Photo	Description
TL 82991 13976		Short-sward part of the site with recent damage.

Annex C Site investigation results – Braxted Park LWS

C.1 Description

C.1.1 Braxted Park is a large site of approximately 201ha and supports an extensive mosaic of semi-improved meadows, broadleaved woodland, parkland, open water, reed and sedge beds, with several veteran oaks and networks of good hedgerows. A variety of small woods are present including oak-dominated stands, broadleaved plantations and wet willow woodland. The large lake is used by a mixture of native and introduced wildfowl and there are several small woodland ponds.

C.1.2 The condition assessment of the woodland area adjacent to the road resulted in a condition of Good (Fairly good) using the Defra Biodiversity Metric 3.1. The woodland contained a diverse planting of native species across different age classes. There were no invasive species recorded, no significant herbivore damage and no tree mortality observed. A few ancient woodland indicator species were present in low numbers and there was some nutrient enrichment evident on the edges of the woodland.

C.2 Pressures and threats

C.2.1 None noted.

Table C.1 List of species Braxted Park. Date surveyed: 11 May 2022

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Quercus robur	Pedunculate oak	4	Canopy	O	-
Acer campestre	Field maple	6	Canopy	F	-
Corylus avellana	Hazel	6	Understory	F	-
Mercurialis perennis	Dog's mercury	7	Field	F	-
Taxus baccata	Yew	5	Understory	R	-
Hedera helix	Common ivy	6	Field	O	-
Rubus fruticosus	Bramble	6	Field	F	-
Alliaria petiolata	Garlic mustard	8	Field	R	-
Ulmus minor	Small-leaved elm	7	Understory	R	-
Fraxinus excelsior	Ash	6	Canopy	R	-
Urtica dioica	Common nettle	8	Field	F	-
Brachypodium sylvaticum	Wood false-brome	5	Field	R	-
Bromopsis ramosa	Hairy brome	7	Field	R	-
Rumex sanguineus	Wood dock	7	Field	R	-
Geum urbanum	Wood avens	7	Field	R	-
Acer pseudoplatanus	Sycamore	6	Canopy	O	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Sambucus nigra	Elder	7	Understory	O	-
Glechoma hederacea	Ground ivy	7	Field	O	-
Arum maculatum	Lords-and-ladies	7	Field	R	-
Quercus cerris	Turkey oak	6	Canopy	O	-
Anthriscus sylvestris	Cow's parsley	7	Field	R	-
Galium aparine	Cleavers	8	Field	R	-
Poa trivialis	Rough meadow-grass	6	Field	R	-
Milium effusum	Wood millet	5	Field	R	-
Silene dioica	Red campion	7	Field	R	-
Crataegus media	Hybrid hawthorn	5	Understory	R	-
Stachys sylvatica	Hedge woundwort	8	Field	R	-
Myosotis scorpioides	Water forget-me-not	6	Field	R	-
Poa annua	Annual meadow-grass	7	Field	R	-
Dactylis glomerata	Common cock's-foot	6	Field	R	-
Ficaria verna	Lesser celandine	6	Field	R	-
Ilex aquifolium	Holly	5	Understory	O	-
Rosa canina agg.	Dog's rose	6	Field	R	-
Prunus domestica	Bullace	6	Understory	R	-
Aesculus hippocastanum	Horse chestnut	7	Canopy	R	-

Ellenberg values	Braxted Park
mean	6.37
median	6
min	4
max	8

Table C.2 Braxted site photographs

Photo No. and Grid reference	Photo	Description
TL 84832 15730		Transect 1. Photo 1. Field layer with visible nutrient enrichment.
TL 84849 15724		Transect 1. Photo 2. Open glade with nettle-dominated tall-herb vegetation.

Photo No. and Grid reference	Photo	Description
TL 84902 15698		Transect 1. Photo 3. More ornamental part of a green lane – unconstructed track followed by double line of trees composed of a combination of ornamental and native species,
TL 84813 15740		Western part of the site being formed by more natural shelterbelt with vegetation similar to W8 woodland with addition of ornamental species.

Annex D Site investigation results – Brockwell Meadows LWS

D.1 Description

D.1.1 Brockwell Meadows LWS is approximately 9.3ha and is adjacent to the proposed scheme. The LWS overlaps with Brockwell Meadows LNR, which is approximately 55m west of the proposed scheme and was screened out of the N deposition assessment. The LWS is associated with the River Blackwater and comprises former floodplain meadows, woodland, a pond and hedgerows.

D.1.2 The woodland was assessed as being in Poor condition using the Defra Biodiversity Metric 3.1 due to the lack of species and structural diversity with no natural regrowth and open structure managed for plantation works.

D.2 Pressures and threats

D.2.1 None noted.

Table D.1 List of species Brockwell Meadows. Date surveyed: 12 May 2022

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Impatiens glandulifera	Himalayan balsam	7	Field	O	-
Persicaria maculosa	Redshank	7	Field	O	-
Symphytum officinale	Comfrey	8	Field	A	-
Urtica dioica	Common nettle	8	Field	F	-
Carex riparia	Greater pond-sedge	7	Field	R	-
Schoenoplectus lacustris	Common club-rush	6	Field	R	-
Poa trivialis	Rough meadow-grass	6	Field	F	-
Poa annua	Annual meadow-grass	7	Field	R	-
Phragmites australis	Common reed	6	Field	R	-
Phalaris arundinacea	Reed canary-grass	7	Field	R	-
Anthriscus sylvestris	Cow's parsley	7	Field	O	-
Dactylis glomerata	Common cock's-foot	6	Field	R	-
Rumex obtusifolius	Broad-leaved dock	9	Field	O	-
Galium aparine	Cleavers	8	Field	O	-
Lolium perenne	Perennial rye-grass	6	Field	O	-
Ranunculus repens	Creeping buttercup	7	Field	O	-
Heracleum sphondylium	Common hogweed	7	Field	R	-
Ficaria verna	Lesser celandine	6	Field	O	-

Scientific Name	Common Name	Ellenberg value (N)	Layer	DAFOR	Note
Taraxacum officinale agg.	Dandelion	6	Field	R	-
Plantago major	Broadleaved plantain	7	Field	R	-
Cirsium arvense	Creeping thistle	6	Field	R	-
Geranium dissectum	Cut-leaved crane's-bill	6	Field	R	-
Dipsacus fullonum	Wild teasel	7	Field	R	-
Calystegia sepium	Hedge bindweed	7	Field	R	-
Agrostis stolonifera	Creeping bent	6	Field	O	-
Angelica sylvestris	Wild angelica	5	Field	R	-
Bromus sterilis	Sterile brome	5	Field	O	-
Arctium lappa	Greater burdock	9	Field	R	-
Silene dioica	Red campion	7	Field	R	-

Ellenberg values	Brockwell Twiggery
mean	6.76
median	7
min	5
max	9

Table D.2 Brockwell Meadows LWS site photographs

Photo No. and Grid reference	Photo	Description
TL 86627 18641		Brockwell Meadows LWS. Species-poor grassland part of the site with visible affiliation to floodplain grazing marsh.
TL 86139 18140		Cricket-bat willow plantation to the west of the LWS. Intensively managed woodland planting with tall-herb dominated field layer.

Photo No. and Grid reference	Photo	Description
TL 86091 18110		Transect 1. Photo 1. Floodplain tall-herb with dominance of comfrey and nettle, typical for plantation woodlands in the floodplains of Essex.
TL 86117 18124		Transect 1. Photo 2. Plantation part of the site.

Annex E Site investigation results – Perry's Wood

E.1 Description

E.1.1 Perry's Wood is an area of woodland which is listed on the Ancient Woodland Inventory and is designated at a county level as a Local Wildlife Site. Perry's Wood is small (3.7ha) and historic maps (accessed at https://www.oldmapsonline.org/) indicate that it has been isolated from other woodlands for a long time. In 1895 it was the same size as currently and surrounded by agriculture (as it is now). In 1799 it was smaller than it is now, suggesting that the southern one third of it is not ancient.

E.1.2 Most of the site was dominated by ash, with frequent aspen and field maple (Table E.1). The tree stems were relatively young, mostly arising from coppice stools. The canopy was quite thin and the ground well illuminated. Ash dieback was very obvious in the canopy, contributing to illumination. Pedunculate oak was locally dominant due to a stand of maiden trees near the eastern boundary (see photo 11 in Table E.2), which was shadier and the understorey less well developed, mostly dominated by bramble. This difference might be due to historic management practices but could be due to geology (e.g. a pocket of wind-blown sand or a gravel deposit). Hornbeam and elm occur only rarely.

E.1.3 Trees have been planted recently, probably in the last year (Photo 3 in Table E.2). Tree guards were present and there were clear access routes to the planted areas. Trees were just single plantings scattered through the site.

E.1.4 Species in the shrub layer include frequent Midland hawthorn and occasional hazel, common ivy, crab apple and elm.

E.1.5 The shrub and field layers in most areas were well-developed. The field layer in many areas had abundant grasses and common nettle, and other species indicative of higher fertility such as ground ivy and herb robert (W8e in terms of NVC). This is probably more likely than anything else due to disturbance and grazing by deer which are well-known to cause these changes in woodlands, and the level of illumination. There were quite a lot of ash seedlings but mostly from the last year and many were browsed, and saplings were absent.

E.1.6 There did not appear to be any gradient in vegetation composition in relation to distance from the road. The boundary along the road was well wooded with trees and shrubs so that you could hardly see the road from the interior (see photos 5, 7 and 9 in Table E.2).

E.1.7 There was a pond near the northern boundary of the site (Photo 1 in Table E.2) and a stream flowing north-south through the middle of the site (Photo 6 in Table E.2). Near the northern boundary, there were piles of brash wood (Photo 2 in Table E.2) and some structures that no longer seem to be used.

E.1.8 The only species that is potentially sensitive to additional nitrogen is compact rush, which has an Ellenberg N value of 3. This was just one plant in a disturbed area (rushes have persistent seedbanks). There were some bryophytes growing on the ground but all typical species of this kind of woodland, generally indicative of moderate to higher fertility soils.

E.1.9 The site was assessed as being in Good condition using the Defra Biodiversity Metric 3.1. The woodland contained three age classes within the original shelterbelt and was spatially diverse and species-rich. There was no evidence of damage from herbivores and no invasive species recorded. There was a full cover of native species in all three age classes, and minor areas of open vegetation in the part of the woodland adjacent to the garden centre. The woodland contained a diverse vertical structure with ancient woodland flora indicators present and no tree mortality was observed. The site scored poor on veteran trees with none present, and moderate for deadwood and nutrient enrichment with some enrichment present on the edges of the woodland and ground disturbance visible in the small areas of the woodland.

E.2 Pressures and threats

E.2.1 There are no obvious features attributable to historic and on-going N deposition. Ash is the dominant canopy species, but there is extensive ash dieback. There is evidence of deer browsing and tracks of muntjac all over the wood. During the site visit, garden waste was noted adjacent to the garden centre (near the pond), with some non-native plants persisting and resulting in habitat degradation in this area.

Table E.1 List of species for Perry's Wood. Date surveyed: 16 August 2021

Scientific name	Common name	Ellenberg N	Layer	DAFOR	Note
Acer campestre	Field Maple	6	Canopy	F	-
Carpinus betulus	Hornbeam	6	Canopy	R	-
Fraxinus excelsior	Ash	6	Canopy	D	-
Populus tremula	Aspen	6	Canopy	F	-
Quercus robur	Pedunculate Oak	4	Canopy	LD	-
Ulmus minor	Elm	7	Canopy	R	-
Acer campestre	Field Maple	6	Field	R	Young sapling
Agrostis stolonifera	Creeping Bent	6	Field	LA	-
Ajuga reptans	Bugle	5	Field	O	-
Alliaria petiolata	Garlic Mustard	8	Field	R	-
Arctium minus agg.	A Burdock	5	Field	R	-
Arrhenatherum elatius	False Oat-grass	7	Field	R	-
Atrichum undulatum	Common Smoothcap	5	Field	O	-
Bellis perennis	Daisy	4	Field	R	-

Scientific name	Common name	Ellenberg N	Layer	DAFOR	Note
Brachypodium sylvaticum	False Brome	5	Field	LF	-
Brachythecium rutabulum	Rough-stalked Feathermoss	6	Field	O	-
Bromopsis ramosa	Wood Brome	7	Field	R	-
Cardamine flexuosa	Wavy Bitter-cress	6	Field	R	-
Carex divulsa	Grey Sedge	6	Field	R	-
Carex otrubae	False Fox-sedge	7	Field	R	-
Carex pendula	Pendulous Sedge	6	Field	LF	-
Carex remota	Remote Sedge	6	Field	O	-
Carex sylvatica	Wood-sedge	5	Field	O	-
Circaea lutetiana	Enchanter's-nightshade	6	Field	O	-
Cirsium palustre	Marsh Thistle	4	Field	R	-
Deschampsia cespitosa	Tufted Hair-grass	4	Field	R	-
Dryopteris dilatata	Broad Buckler-fern	5	Field	R	-
Dryopteris filix-mas	Male Fern	5	Field	O	-
Epilobium montanum	Broad-leaved Willowherb	6	Field	R	-
Euphorbia peplus	Petty Spurge	6	Field	R	-
Fraxinus excelsior	Ash	6	Field	F	Young saplings
Galium album	Hedge Bedstraw	4	Field	R	-
Galium aparine	Cleavers	8	Field	O	-
Galium palustre	Marsh-bedstraw	4	Field	R	-
Geranium robertianum	Herb-Robert	6	Field	F	-
Geum urbanum	Wood Avens	7	Field	F	-
Glechoma hederacea	Ground-ivy	7	Field	A	-

Scientific name	Common name	Ellenberg N	Layer	DAFOR	Note
Glyceria declinata	Small Sweet-grass	6	Field	LF	Not in wood, along grass strip between garden centre and woodland edge
Holcus lanatus	Yorkshire-fog	5	Field	F	-
Hypericum hirsutum	Hairy St John's-wort	5	Field	R	-
Ilex aquifolium	Holly	5	Field	R	Small sapling
Juncus conglomeratus	Compact Rush	3	Field	R	-
Juncus effusus	Soft-rush	4	Field	O	-
Kindbergia praelonga	Common Feathermoss	5	Field	F	-
Lapsana communis	Nipplewort	7	Field	R	-
Lonicera periclymenum	Honeysuckle	5	Field	R	-
Melissa officinalis	Balm	6	Field	R	-
Mentha arvensis	Corn Mint	6	Field	R	-
Mimulus guttatus	Monkeyflower	6	Field	R	Escape from garden centre in ditch along boundary with centre
Mnium hornum	Swan's-neck Thyme-moss	4	Field	R	-
Moehringia trinervia	Three-nerved Sandwort	6	Field	O	-
Myosotis arvensis	Field Forget-me-not	6	Field	R	-
Plagiomnium undulatum	Hart's-tongue Thyme-moss	5	Field	R	-
Poa nemoralis	Wood Meadow-grass	5	Field	R	-
Poa trivialis	Rough Meadow-grass	6	Field	R	-
Polystichum setiferum	Soft Shield-Fern	6	Field	R	-
Primula vulgaris	Primrose	4	Field	R	-
Prunella vulgaris	Selfheal	4	Field	R	-
Quercus robur	Pedunculate Oak	4	Field	R	Planted trees in tubes

Scientific name	Common name	Ellenberg N	Layer	DAFOR	Note
Ranunculus repens	Creeping Buttercup	7	Field	R	-
Rubus vestitus	Bramble	6	Field	A	The Ellenberg N for *Rubus fruticosus* is 6
Rumex sanguineus	Wood Dock	7	Field	F	-
Senecio jacobaea	Common Ragwort	4	Field	R	-
Silene dioica	Red Campion	7	Field	R	-
Solanum dulcamara	Bittersweet	7	Field	R	-
Stachys sylvatica	Hedge Woundwort	8	Field	F	-
Symphytum sp.	A Comfrey	8	Field	R	Assumed *S. officinalis*
Tanacetum parthenium	Feverfew	6	Field	R	-
Thamnobryum alopecurum	Fox-tail Feathermoss	6	Field	R	-
Ulmus sp.	Elm	7	Field	R	Likely to be *Ulmus minor*
Urtica dioica	Common Nettle	8	Field	F	-
Veronica chamaedrys	Germander Speedwell	5	Field	R	-
Veronica montana	Wood Speedwell	6	Field	R	Just 1 small stand
Veronica serpyllifolia	Thyme-leaved Speedwell	5	Field	R	-
Viola reichenbachiana	Early Dog-violet	5	Field	F	-
Corylus avellana	Hazel	6	Shrub	O	-
Crataegus laevigata	Midland Hawthorn	5	Shrub	F	-
Crataegus monogyna	Hawthorn	6	Shrub	R	-
Crataegus x media	Hybrid Hawthorn	6	Shrub	R	No Ellenberg N – assigned same as C. monogyna
Hedera helix	Common Ivy	6	Shrub	O	-

Scientific name	Common name	Ellenberg N	Layer	DAFOR	Note
Malus sylvestris	Crab Apple	6	Shrub	O	-
Ulmus minor	Elm	7	Shrub	O	-
	mean	5.73			
	median	6			
Ellenberg Scores	minimum	3 (1 species)			
	maximum	8 (5 species)			

Table E.2 Perrys Wood site photographs

Photo No. and Grid reference	Photo	Description
1 TL 88280 17234		Artificial pond near northern boundary of site
2 TL 88322 17249		Pile of dead woody material near northern boundary of site

Photo No. and Grid reference	Photo	Description
3 TL 88332 17246		Recently planted trees in guards, mostly Pedunculate Oak

Photo No. and Grid reference	Photo	Description
4 TL 88350 17235		Well-developed understorey below ash canopy
5 TL 88368 17250		Eastern boundary along road

Photo No. and Grid reference	Photo	Description
6 TL 88359 17251		Small stream flowing into site from north-east corner

Photo No. and Grid reference	Photo	Description
7 TL 88400 17230		Eastern boundary along road

Photo No. and Grid reference	Photo	Description
8 TL 88409 17210		Well-developed understorey below ash canopy
9 TL 88449 17212		Eastern boundary along road

Photo No. and Grid reference	Photo	Description
10 TL 88460 17190		Ash dieback and dead elms

Photo No. and Grid reference	Photo	Description
11 TL 88402 17162		Stand of Pedunculate Oak trees with more open understorey
12 TL 88290 17175		Hornbeam tree and open disturbed understorey

Photo No. and Grid reference	Photo	Description
13 TL 88313 17224		Bare areas from vehicle access and deer tracks

Annex F Site investigation results – Smythe's Green LWS

F.1 Description

F.1.1 Survey in May 2022 confirmed that there are high value grassland habitats within the site (beyond the predicted nitrogen-affected area), with a mosaic of neutral and mildly-acidic indicators, interspersed with wet rush-dominated patches and small areas of tall herb. The species-rich part of the site consisted of indicators of poor-nutrient conditions such as lady's bedstraw (Ellenberg value of 2), sheep's sorrel (*Rumex acetosella*; Ellenberg value of 3), sweet vernal-grass (*Anthoxanthum odoratum*; Ellenberg value of 3), field wood-rush (*Luzula campestris*; Ellenberg value of 2), and common milkwort (*Polygala vulgaris*; Ellenberg value of 3).

F.1.2 Grassland closer to the boundary with the road appeared more characteristic of nutrient-enriched conditions, with taller grasses and robust tall herbs, including a higher frequency of tansy (*Tanacetum vulgare*; Ellenberg value of 7) and cow's parsley (*Anthriscus sylvestris*), both of which have a Ellenberg values for nitrogen of 7

F.1.3 The description for this site describes it as a small area (approximately 1ha) of rough grassland and scrub containing a range of grasses including crested dog's-tail (*Cynosurus cristatus*), sweet vernal-grass (*Anthoxanthum odoratum*) and meadow foxtail (*Alopecurus pratensis*). There are few herb species of special interest and coarse grasses such as false oat-grass and cock's-foot (*Dactylis glomerata*) are becoming more dominant. Herbs include common knapweed (Centaurea nigra), common fleabane (Pulicaria dysenterica) and greater bird's-foot trefoil (*Lotus pedunculatus*). There are several damp areas comprising abundant hard rush (*Juncus inflexus*) and soft rush (*Juncus effusus*).

F.1.4 The grassland at Smythe's Green was assessed as being in Good condition using the Defra Metric 3.1. The grassland appeared neutral but well drained with higher numbers of acid grassland indicators. The sward height was varied but the grassland is being managed by mowing and may appear homogenous at some times of year.

F.2 Pressures and threats

F.2.1 The citation for this site states that it appears to have declined in interest, which may be apportioned to encroachment of bramble (*Rubus fruticosus* agg.) and blackthorn (*Prunus spinosa*) scrub, lack of management and the inappropriate planting of willow (*Salix* sp.) and birch (*Betula* sp.) trees.

Table F.1 List of species Smythe's Green. Date surveyed: 12 May 2022

Scientific Name	Common Name	Layer	DAFOR	Note
Agrostis stolonifera	Creeping bent	Field	O	-
Rumex obtusifolius	Broad-leaved dock	Field	R	-
Matricaria recutita	Scented mayweed	Field	R	-
Urtica dioica	Common nettle	Field	R	-
Galium aparine	Cleavers	Field	R	-
Carex otrubae	False fox-sedge	Field	R	-
Silene dioica	Red campion	Field	R	-
Poa trivialis	Rough meadow-grass	Field	O	-
Geranium dissectum	Cut-leaved crane's-bill	Field	R	-
Anthriscus sylvestris	Cow's parsley	Field	O	-
Holcus lanatus	Yorkshire fog	Field	F	-
Galium verum	Lady's bedstraw	Field	R	-
Cerastium fontanum	Common mouse-ear	Field	R	-
Centaurea nigra	Common knapweed	Field	O	-
Alopecurus pratensis	Meadow fox-tail	Field	R	-
Tanacetum vulgare	Tansy	Field	O	-
Stellaria holostea	Greater stitchwort	Field	O	-
Rumex acetosa	Common sorrel	Field	R	-
Poa pratensis	Smooth meadow-grass	Field	R	-
Stellaria graminea	Lesser stitchwort	Field	R	-
Rumex acetosella	Sheep's sorrel	Field	R	-
Anthoxanthum odoratum	Sweet vernal-grass	Field	F	-
Luzula campestris	Field woodrush	Field	O	-
Ranunculus bulbosus	Bulbous buttercup	Field	R	-
Achillea millefolium	Yarrow	Field	R	-
Medicago lupulina	Black medick	Field	R	-
Festuca rubra	Red fescue	Field	O	-
Polygala vulgaris	Common milkwort	Field	R	-
Convolvulus arvensis	Field bindweed	Field	R	-
Pseudoscleropodium purum		Moss	R	-
Rubus fruticosus	Bramble	Field	R	-
Phleum pratense	Timothy	Field	R	-
Juncus effusus	Soft-rush	Field	R	-

Scientific Name	Common Name	Layer	DAFOR	Note
Potentilla reptans	Creeping cinquefoil	Field	R	-
Ranunculus repens	Creeping buttercup	Field	R	-
Myosotis scorpioides	Water forget-me-not	Field	R	-
Cirsium palustre	Marsh thistle	Field	R	-
Lathyrus pratensis	Meadow vetchling	Field	R	-
Pimpinella major	Greater burnet-saxifrage	Field	R	-
Vicia sativa	Common vetch	Field	R	-
Ranunculus acris	Meadow buttercup	Field	R	-
Senecio vulgaris	Groundsel	Field	R	-
Galium mollugo	Hedge bedstraw	Field	R	-

Ellenberg values	Smythe's Green
mean	5.29
median	5
min	2
max	9

Table F.2 Smythe's Green site photographs

Photo No. and Grid reference	Photo	Description
TL 92111 18669		Smythe's Green as seen from the roadside ditch. Some minor nutrient enrichment is visible in this part of the site.
TL 92080 18652		Smythe's Green as seen from the roadside towards the rush-pasture

Photo No. and Grid reference	Photo	Description
TL 92132 18628		Smythe's Green view towards the road